

### Considerations in analysing elemental carbon from marine engine exhaust using residual, distillate and biofuels

Elemental carbon (EC) concentrations in the exhaust of a medium-speed marine engine was evaluated using thermal-optical analysis (TOA). Particulate matter (PM) samples were collected at 75% and 25% engine loads using residual and distillate fuels with sulphur contents of 2.5%, 0.5% and 0.1%, and a biofuel (30% of bio-component). The EC analysis of PM samples from a marine engine proved to be challenging. For example, transformations of structure of the sampled particles in the inert and the oxygen mode were observed for marine engine exhaust samples. The relationship between constituents present in the samples from the marine engine using different fuels, and phenomena observed in the thermograms are discussed. Temperature protocol selection and sample pre-treatment (extractions and drying) affected the reported EC mass. Modifications in the methodology were suggested to increase the accuracy of the analysis. Repeatability and reproducibility of the EC analysis was studied in the round-robin of three laboratories.

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MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics, VTT Technical Research Centre of Finland, Finnish Meteorological Institute, University of Eastern Finland, Public Health Service (GGD) Amsterdam

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### Physical Characteristics of Particle Emissions from a Medium Speed Ship Engine Fueled with Natural Gas and Low-Sulfur Liquid Fuels

Particle emissions from marine traffic affect significantly air quality in coastal areas and the climate. The particle emissions were studied from a 1.4 MW marine engine operating on low-sulfur fuels natural gas (NG; dual-fuel with diesel pilot), marine gas oil (MGO) and marine diesel oil (MDO). The emitted particles were characterized with respect to particle number (PN) emission factors, PN size distribution down to nanometer scale (1.2-414 nm), volatility, electric charge, morphology, and elemental composition. The size distribution of fresh exhaust particles was bimodal for all the fuels, the nucleation mode highly dominating the soot mode. Total PN emission factors were  $2.7 \times 10^{15}$ - $7.1 \times 10^{15}$  #/kWh, the emission being the lowest with NG and the highest with MDO. Liquid fuel combustion generated 4-12 times higher soot mode particle emissions than the NG combustion, and the harbor-area-typical lower engine load (40%) caused higher total PN emissions than the higher load (85%). Nonvolatile particles consisted of nanosized fuel, and spherical lubricating oil core mode particles contained, e.g., calcium as well as agglomerated soot mode particles. Our results indicate the PN emissions from marine engines may remain relatively high regardless of fuel sulfur limits, mostly due to the nanosized particle emissions.

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Contributors: Alanen, J., Isotalo, M., Kuittinen, N., Simonen, P., Martikainen, S., Kuuluvainen, H., Honkanen, M., Lehtoranta, K., Nyssönen, S., Vesala, H., Timonen, H., Aurela, M., Keskinen, J., Rönkkö, T.

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Research output: Contribution to journal › Article › Scientific › peer-review

### Impact of selective catalytic reduction on exhaust particle formation over excess ammonia events

The introduction of selective catalytic reduction (SCR) aftertreatment to meet stringent diesel NO<sub>x</sub> emission standards around the world increases exhaust ammonia. Further to the direct air quality and health implications of ammonia, this may also lead to particle formation in the exhaust. In this study, an ammonia SCR system was examined with respect to its impact on both solid and total exhaust particle number and size distribution, downstream of a diesel particulate filter (DPF). Fuel post-injection was conducted in some tests to investigate the effect of ammonia during active DPF regeneration. On average, the post-DPF solid >23 nm and total x control. Ammonia did not have a significant additional effect on the high particle concentrations measured during DPF regeneration. Based on species availability and formation conditions, sulfate, nitrate, and chloride salts with ammonium are possible sources of the new particles formed. Ammonia-induced particle formation corresponds to an environmental problem which is not adequately addressed by current regulations.

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MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Laboratory of Applied Thermodynamics, Aristotle University of Thessaloniki, European Commission-JRC, AVL List GmbH

Contributors: Amanatidis, S., Ntziachristos, L., Giechaskiel, B., Bergmann, A., Samaras, Z.

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Research output: Contribution to journal › Article › Scientific › peer-review

### Evaluation of an oxidation catalyst ("catalytic stripper") in eliminating volatile material from combustion aerosol

Combustion aerosol is a mixture of solid and volatile particulate matter. Separation of solid particles for research or regulatory purposes is often conducted with thermal treatment of the aerosol. For example, European automotive emission regulations address solid particles above 23. nm, which are separated by dilution and heating in a volatile particle remover (VPR). This study evaluated an oxidation catalyst - often referred to as a "catalytic stripper" (CS) - as an alternative technique to remove volatile components. A version of the CS was examined in this paper, where the oxidation catalyst was combined with a sulphur trap in order to oxidise hydrocarbon species and to bind sulphates on the CS surface. In order to characterise the performance of the CS, the position of the sulphur trap upstream or downstream of the oxidation catalyst was examined in relation to the light-off temperature, hydrocarbon oxidation efficiency, and sulphur storage capacity, defined as the point where sulphate particles start to form downstream of the CS. With the best performance

achieved when the trap was positioned downstream of the oxidation catalyst, the CS was then characterised in terms of particle losses in the range 6-100. nm. Losses were found rather independent of particle size above 30. nm but significantly increased below 23. nm. The efficiency in removing volatile particles was characterised using tetracontane particles. Furthermore, the overall performance of the CS was compared against the VPR by using diesel nucleation mode particles as the challenge aerosol. Results showed that the CS could directly be used as an alternative to VPR for combustion aerosol measurements if only particles above 23. nm were considered. Extending the measurement below this range would also be possible. This would however require an evaporation tube to vaporise material before this reached the CS and attention in addressing the rapidly increasing losses with decreasing particle size in this range.

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Organisations: Urban circular bioeconomy (UrCirBio), Laboratory of Applied Thermodynamics, Aristotle University of Thessaloniki, AVL List GmbH

Contributors: Amanatidis, S., Ntziachristos, L., Giechaskiel, B., Katsaounis, D., Samaras, Z., Bergmann, A.

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Keywords: Exhaust aerosol, Exhaust sampling, Particle emissions, Sampling conditions

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Research output: Contribution to journal > Article > Scientific > peer-review

### Comparative performance of a thermal denuder and a catalytic stripper in sampling laboratory and marine exhaust aerosols

The performance of a thermal denuder (thermodenuder—TD) and a fresh catalytic stripper (CS) was assessed by sampling laboratory aerosol, produced by different combinations of sulfuric acid, octacosane, and soot particles, and marine exhaust aerosol produced by a medium-speed marine engine using high sulfur fuels. The intention was to study the efficiency in separating non-volatile particles. No particles could be detected downstream of either device when challenged with neat octacosane particles at high concentration. Both laboratory and marine exhaust aerosol measurements showed that sub-23 nm semi-volatile particles are formed downstream of the thermodenuder when upstream sulfuric acid approached 100 ppbv. Charge measurements revealed that these are formed by re-nucleation rather than incomplete evaporation of upstream aerosol. Sufficient dilution to control upstream sulfates concentration and moderate TD operation temperature (250°C) are both required to eliminate their formation. Use of the CS following an evaporation tube seemed to eliminate the risk for particle re-nucleation, even at a ten-fold higher concentration of semi-volatiles than in case of the TD. Particles detected downstream of the CS due to incomplete evaporation of sulfuric acid and octacosane aerosol, did not exceed 0.01% of upstream concentration. Despite the superior performance of CS in separating non-volatile particles, the TD may still be useful in cases where increased sensitivity over the traditional evaporation tube method is needed and where high sulfur exhaust concentration may fast deplete the catalytic stripper adsorption capacity.

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Organisations: Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Aristotle University of Thessaloniki, VTT Technical Research Centre of Finland, Finnish Meteorological Institute

Contributors: Amanatidis, S., Ntziachristos, L., Karjalainen, P., Saukko, E., Simonen, P., Kuittinen, N., Aakko-Saksa, P., Timonen, H., Rönkkö, T., Keskinen, J.

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ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

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#### The critical velocity of rebound determined for sub-micron silver particles with a variable nozzle area impactor

The critical velocity of rebound was determined for spherical silver aerosol particles in the size range of 20-1000. nm. A novel instrument, a variable nozzle area impactor, was especially designed for measuring the particle-surface interaction as a function of the particle impact velocity. The experimental results were combined with a numerical model in order to obtain the impact velocities. The experiments were carried out using a plain aluminum collection substrate in the impactor. Our results show that the critical velocity of rebound decreases from 14 to 0.022. m/s as the particle size increases from 20 to 1000. nm. Furthermore, the critical velocity was found to be proportional to the power of -1.6 of the particle size, instead of the theoretical inverse proportionality. This result is in line with the previous studies for micron-sized particles. In the nanoparticle size range, the obtained values are approximately 3-10 times greater than the recent literature values. This discrepancy can most likely be explained by the different surface materials. All in all, our results give valuable information about the particle-surface interactions in the sub-micron size range.

#### General information

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Organisations: Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Engineering materials science and solutions (EMASS), Urban circular bioeconomy (UrCirBio)

Contributors: Arffman, A., Kuuluvainen, H., Harra, J., Vuorinen, O., Juuti, P., Yli-Ojanperä, J., Mäkelä, J., Keskinen, J.

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ASJC Scopus subject areas: Materials Science(all), Environmental Chemistry, Pollution

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Research output: Contribution to journal › Article › Scientific › peer-review

#### Differential diffusion analyzer

In this article, a proof of concept of a new measurement instrument, differential diffusion analyzer (DDA), is established. The DDA enables the measurement of the size distribution of sub-10 nm aerosol particles, and it can also be used as a

size classifier to separate a certain particle size from a size distribution for subsequent analysis. The developed technique is based on the diffusion separation of different size particles. Thus, the main advantage of the DDA compared to other methods is that particle charging is not required. Simulated and experimentally measured transmission efficiencies show that the diffusion-based differential size classification is a feasible concept, and moreover, shows that particle size is inversely proportional to the square root of the total flow rate.

#### General information

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Organisations: Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group

Contributors: Arffman, A., Juuti, P., Harra, J., Keskinen, J.

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ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

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Research output: Contribution to journal > Article > Scientific > peer-review

#### Screening pretreatment methods to enhance thermophilic anaerobic digestion of pulp and paper mill wastewater treatment secondary sludge

The effect of hydrothermal (150°C for 10min and 70°C for 40min), enzymatic (Accelerase 1500, 0.07g/g volatile solids (VS)), ultrasound (45kHz for 30min) and chemical pretreatments (HNO<sub>3</sub> at pH3 and NaOH at pH12) alone or in combination on the chemical composition and methane yield of the pulp and paper mill secondary sludge was studied in batch assays at 55°C. In total, 12 different pretreatment combinations were compared. Chemical analyses showed that all pretreatments except for HNO<sub>3</sub> and ultrasound pretreatments improved the organic matter solubilization. Among the studied pretreatments, hydrothermal (150°C, 10min) pretreatment alone or in combination with enzymatic and/or ultrasound pretreatment had the highest impact on sludge solubilization and methane yield. The increase in methane yield was 31% (from 108ml/g VS<sub>original</sub> to 141ml/gVS<sub>original</sub>). In addition, enzymatic pretreatment also improved the methane yields but only when combined with hydrothermal pretreatment at 150°C or ultrasound+hydrothermal pretreatment at 150°C. On the other hand, ultrasound pretreatment did not improve the methane yields while acid and alkaline pretreatments resulted in lower methane yields than control. Improved hydrolysis and higher methane production rates noticed in assays subjected to hydrothermal pretreatment alone or in combination with enzymes and/or ultrasound could make these treatments more attractive in reducing the retention times required during full-scale anaerobic digestion of pulp and paper mill wastewater sludges. © 2013 Elsevier B.V.

#### General information

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Organisations: Tampere University of Technology, Department of Chemistry and Bioengineering, Urban circular bioeconomy (UrCirBio), Jyväskylän yliopisto, University of Jyväskylä

Contributors: Bayr, S., Kaparaju, P., Rintala, J.

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Keywords: Anaerobic digestion, Methane yield, Pretreatment, Pulp and paper mill, Secondary sludge

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Research output: Contribution to journal > Article > Scientific > peer-review

#### **Distinguishing fuel and lubricating oil combustion products in diesel engine exhaust particles**

The main sources of particulate emissions from engines are fuel and lubricating oil. In this study, particles emitted by a medium speed diesel engine for locomotive use were characterized chemically by using a soot particle aerosol mass spectrometer (SP-AMS). Additionally, positive matrix factorization (PMF) was applied to the SP-AMS data for the separation of fuel from lubricating oil and/or oil additives in diesel engine emissions. The mass spectra of refractory species, i.e., metals and rBC, were included in the PMF input matrix in addition to organics in order to utilize the benefit of the SP-AMS to measure non-refractory and refractory species. In general, particulate matter emitted by the diesel engine was dominated by organics (51%) followed by refractory black carbon (rBC; 48%), trace metals and inorganic species (1%). Regarding the sources of particles, PMF indicated four factors for particle mass of which two were related to lubricating oil-like aerosol (LOA1, 29% and LOA2, 24%) and two others to diesel-like fuel aerosol (DFA1, 35% and DFA2, 12%). The main difference between LOA1 and LOA2 was the presence of soot in LOA1 and metals in LOA2 factors. DFA factors represented burned (DFA1) and unburned fuel (DFA2). The results from the PMF analysis were completed with particle size distributions, volatility measurements and particle morphology analyses.

#### **General information**

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Organisations: Physics, Research area: Aerosol Physics

Contributors: Carbone, S., Timonen, H. J., Rostedt, A., Happonen, M., Rönkkö, T., Keskinen, J., Ristimäki, J., Korpi, H., Artaxo, P., Canagaratna, M., Worsnop, D., Canonaco, F., Prévôt, A. S., Hillamo, R., Saarikoski, S.

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Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

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Research output: Contribution to journal > Article > Scientific > peer-review

#### **Effect of tungsten and selenium on C<sub>1</sub> gas bioconversion by an enriched anaerobic sludge and microbial community analysis**

The effect of trace metals, namely tungsten and selenium, on the production of acids and alcohols through gas fermentation by a CO-enriched anaerobic sludge in a continuous gas-fed bioreactor was investigated. The CO-enriched sludge was first supplied with a tungsten-deficient medium (containing selenium) and in a next assay, a selenium-deficient medium (containing tungsten) was fed to the bioreactor, at a CO gas flow rate of 10 mL/min. In the absence of tungsten (tungstate), an initial pH of 6.2 followed by a pH decrease to 4.9 yielded 7.34 g/L acetic acid as the major acid during the high pH period. Subsequently, bioconversion of the acids at a lower pH of 4.9 yielded only 1.85 g/L ethanol and 1.2 g/L butanol in the absence of tungsten (tungstate). A similar follow up assay in the same bioreactor with two consecutive

periods at different pH values (i.e., 6.2 and 4.9) with a selenium deficient medium yielded 6.6 g/L acetic acid at pH 6.2 and 4 g/L ethanol as well as 1.88 g/L butanol at pH 4.9. The results from the microbial community analysis showed that the only known CO fixing microorganism able to produce alcohols detected in the bioreactor was *Clostridium autoethanogenum*, both in the tungsten and the selenium deprived media, although that species has so far not been reported to be able to produce butanol. No other solventogenic acetogen was detected.

#### General information

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MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Research group: Bio- and Circular Economy, University of La Coruña (UDC), UNESCO-IHE Institute for Water Education

Contributors: Chakraborty, S., Rene, E. R., Lens, P. N., Rintala, J., Veiga, M. C., Kennes, C.

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#### Bibliographical note

EXT="Chakraborty, Samayita"

EXT="Lens, Piet N.L."

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Research output: Contribution to journal > Article > Scientific > peer-review

#### Particle growth with photochemical age from new particle formation to haze in the winter of Beijing, China

Secondary aerosol formation in the aging process of primary emission is the main reason for haze pollution in eastern China. Pollution evolution with photochemical age was studied for the first time at a comprehensive field observation station during winter in Beijing. The photochemical age was used as an estimate of the timescale attributed to the aging process and was estimated from the ratio of toluene to benzene in this study. A low photochemical age indicates a fresh emission. The photochemical age of air masses during new particle formation (NPF) days was lower than that on haze days. In general, the strongest NPF events, along with a peak of the formation rate of 1.5 nm ( $J_{1.5}$ ) and 3 nm particles ( $J_3$ ), were observed when the photochemical age was between 12 and 24 h while rarely took place with photochemical ages less than 12 h. When photochemical age was larger than 48 h, haze occurred and NPF was suppressed. The sources and sinks of nanoparticles had distinct relation with the photochemical age. Our results show that the condensation sink (CS) showed a valley with photochemical ages ranging from 12 to 24 h, while  $H_2SO_4$  concentration showed no obvious trend with the photochemical age. The high concentrations of precursor vapours within an air mass lead to persistent nucleation with photochemical age ranging from 12 to 48 h in winter. Coincidentally, the fast increase of  $PM_{2.5}$  mass was also observed during this range of photochemical age. Noteworthy, CS increased with the photochemical age on NPF days only, which is the likely reason for the observation that the  $PM_{2.5}$  mass increased faster with photochemical age on NPF days compared with other days. The evolution of particles with the photochemical age provides new insights into understanding how particles originating from NPF transform to haze pollution.

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Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Beijing University of Chemical Technology, University of Helsinki, Shanghai Institute of Ceramics Chinese Academy of Sciences, Research Center for Eco-Environmental Sciences Chinese Academy of Sciences, Tsinghua University, Nanjing University  
Contributors: Chu, B., Dada, L., Liu, Y., Yao, L., Wang, Y., Du, W., Cai, J., Dällenbach, K. R., Chen, X., Simonen, P., Zhou, Y., Deng, C., Fu, Y., Yin, R., Li, H., He, X. C., Feng, Z., Yan, C., Kangasluoma, J., Bianchi, F., Jiang, J., Kujansuu, J., Kerminen, V. M., Petäjä, T., He, H., Kulmala, M.

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### Improving urban air quality measurements by a diffusion charger based electrical particle sensors: A field study in Beijing, China

High aerosol loadings contribute significantly to the air quality problems of Asian megacities. To address this, monitoring data for aerosol mass and number that is spatially and temporally of high resolution is needed, while the cost of obtaining such data remains high. Here, we present a field study in a polluted megacity, Beijing, using a diffusion-chargebased electrical aerosol sensor, the Pegasor PPS-M, which is a robust and comparatively low-cost instrument for the monitoring of both aerosol mass and number simultaneously. We present data over several months in the year 2014, and for varying aerosol size distributions, and analyze the performance against particle number and mass (volume) measured using a wide range particle sizer (WPS) and beta-attenuation-based PM<sub>2.5</sub> observations. We show that using a single trap voltage, the PPS-M correlates well with particle mass, but not so well with particle number due to the variability in particle size distributions. However, the instrument response to number was improved by running the instrument with a variable trap voltage, and using the ratio of the different signals to gain information on the particle average volume. With this method, we were able to improve the correlation of the PPS-M; with the observed particle number from R = 0.14 to R = 0.72 for the measurement time period. Altogether, the PPS-M instrument displayed robustness and low maintenance requirements, and it showed good correlation with the other instruments in this study.

### General information

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Research output: Contribution to journal > Article > Scientific > peer-review

### Chemolithotrophic denitrification in biofilm reactors

Chemolithotrophic denitrification is an inexpensive and advantageous process for nitrate removal and represents a promising alternative to classical denitrification with organics. Chemolithotrophic denitrifiers are microorganisms able to reduce nitrate and nitrite using inorganic compounds as source of energy. Ferrous iron, sulfur-reduced compounds (e.g. hydrogen sulfide, elemental sulfur and thiosulfate), hydrogen gas, pyrite and arsenite have been used as inorganic electron donors resulting in diverse outcomes. In the last 40years, a large number of engineered systems have been used to maintain chemolithotrophic denitrification and improve rate and efficiency of the process. Among them, biofilm reactors

proved to be robust and high-performing technologies. Packed bed reactors are particularly suitable for the removal of low nitrate concentrations, since high retention times are required to complete denitrification. Fluidized bed and membrane biofilm reactors result in the highest denitrification rates ( $>20 \text{ kg N-NO}_3^-/\text{m}^3/\text{d}$ ) when hydrogen gas and sulfur reduced compounds are used as electron donors. Hydrogen gas pressure and current intensity rule the performance of membrane biofilm and biofilm electrode reactors, respectively. Biofouling is the most common and detrimental issue in biofilm reactors. Bed fluidization and hydrogen supply limitation are convenient and effective solutions to mitigate biofouling.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Department of Civil and Mechanical Engineering, University of Cassino and Southern Lazio

Contributors: Di Capua, F., Papirio, S., Lens, P. N. L., Esposito, G.

Number of pages: 15

Pages: 643-657

Publication date: 2015

Peer-reviewed: Yes

Early online date: 15 Jun 2015

#### Publication information

Journal: Chemical Engineering Journal

Volume: 280

ISSN (Print): 1385-8947

Ratings:

Scopus rating (2015): CiteScore 8.6 SJR 1.676 SNIP 1.912

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Chemistry(all), Industrial and Manufacturing Engineering, Environmental Chemistry

Keywords: Biofilm, Biofilm electrode reactor, Chemolithotrophic denitrification, Fluidized bed reactor, Membrane biofilm reactor, Packed bed reactor

DOIs:

10.1016/j.cej.2015.05.131

#### Bibliographical note

AUX=keb,"Di Capua, Francesco"

EXT="Papirio, Stefano"

Source: Scopus

Source ID: 84932636341

Research output: Contribution to journal > Article > Scientific > peer-review

#### Adsorption of furfural from torrefaction condensate using torrefied biomass

Torrefaction is a biomass energy densification process that generates a major byproduct in the form of torrefaction condensate. Microbial conversion of torrefaction condensate could be an attractive option for energy integration within torrefaction process. However, torrefaction condensate contains several compounds, such as furfural, 5-hydroxymethylfurfural and guaiacol that are inhibitory to microbes. In this study, for the first time, we reported detoxification of torrefaction condensate, by removing the major inhibitory compound furfural, using torrefied biomass and later used the detoxified torrefaction condensate for anaerobic digestion. The effect of varying torrefaction temperature (225–300 °C), torrefied biomass dosage (25–250 g/L), initial pH (2.0–9.0), and contact time (1–12 h) on furfural adsorption was studied with batch adsorption experiments. The furfural adsorption on torrefied biomass was best represented by pseudo second order kinetic model. The adsorption of furfural and other inhibitory compounds on torrefied biomass was likely a hydrophobic interaction. A maximum of 60% of furfural was adsorbed from torrefaction condensate containing 9000 mg furfural/L using 250 g/L of torrefied biomass in batch adsorption. For, column (20 mm internal diameter and 200 mm bed height), the saturation time for furfural adsorption was around 50 min. Anaerobic digestion of the detoxified torrefaction condensate shows that the lag phase in methane production was reduced from 25 d to 15 d for 0.2 volatile solid (VS)<sub>substrate</sub>:VS<sub>inoculum</sub> loading. The study shows that torrefaction condensate can be effectively detoxified using torrefied biomass for microbial conversion and can be integrated within the torrefied biomass pellet production process.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, Helmholtz-Zentrum Dresden-Rossendorf, Univ of Oulu

Contributors: Doddapaneni, T. R. K. C., Jain, R., Praveenkumar, R., Rintala, J., Romar, H., Konttinen, J.

Number of pages: 11  
Pages: 558-568  
Publication date: 2018  
Peer-reviewed: Yes  
Early online date: 2017

#### Publication information

Journal: Chemical Engineering Journal

Volume: 334

ISSN (Print): 1385-8947

Ratings:

Scopus rating (2018): CiteScore 12.5 SJR 2.066 SNIP 1.962

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry, Chemical Engineering(all), Industrial and Manufacturing Engineering

Keywords: Anaerobic digestion, Detoxification, Energy densification, Pellets, Torrefaction volatiles

DOIs:

10.1016/j.cej.2017.10.053

Source: Scopus

Source ID: 85033666908

Research output: Contribution to journal › Article › Scientific › peer-review

#### The mechanism of the oxidation of benzyl alcohol by iron(III)nitrate: Conventional versus microwave heating

The mechanism of the oxidation of benzyl alcohol with iron(III)nitrate nonahydrate under conventional and under microwave heating conditions has been investigated and the reaction conditions have been optimized. A series of redox reactions leads to the formation of benzaldehyde and other products. Direct comparison between conventional and microwave heating revealed identical conversions profiles. Mastering the microwave induced heat, absence of a real microwave effect and byproduct formation are the major factors to advise a traditional batch-wise way of process development to a larger scale.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Eindhoven University of Technology, Laboratory of Macromolecular and Organic Chemistry, DSM Research

Contributors: Dressen, M. H. C. L., Stumpel, J. E., Van De Kruijs, B. H. P., Meuldijk, J., Vekemans, J. A. J. M., Hulshof, L. A.

Number of pages: 5

Pages: 60-64

Publication date: 2009

Peer-reviewed: Yes

#### Publication information

Journal: Green Chemistry

Volume: 11

Issue number: 1

ISSN (Print): 1463-9262

Ratings:

Scopus rating (2009): SJR 2.088 SNIP 1.738

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

DOIs:

10.1039/b813030b

URLs:

<http://www.scopus.com/inward/record.url?scp=58149280111&partnerID=8YFLogxK> (Link to publication in Scopus)

#### Bibliographical note

EXT="Stumpel, Jelle"

Source: Scopus

Source ID: 58149280111

Research output: Contribution to journal › Article › Scientific › peer-review

#### Methane oxidation in a boreal climate in an experimental landfill cover composed from mechanically-biologically treated waste

The present study evaluated microbial methane (CH<sub>4</sub>) oxidation in a boreally located outdoor landfill lysimeter (volume 112 m<sup>3</sup>, height 3.9 m) filled with mechanically-biologically treated waste (MBT residual) and containing a cover layer made from the same MBT residual. The calculations based on gas emission and pore gas measurements showed that, between April and October 2005, a significant proportion (> 96%) of the methane produced (< 23 l CH<sub>4</sub> m<sup>-2</sup> d<sup>-1</sup>) in the lysimeter was oxidized. Methane was oxidized mainly at the depths of 35-75 cm, as indicated by the upward decrease both in the methane concentration and in the methane-to-carbon dioxide ratio in the pore gas. Lower methane oxidation (< 0.8 CH<sub>4</sub> m<sup>-2</sup> d<sup>-1</sup>; this was < 22% of the methane produced) was observed only during the coldest time of the year (January 2006), apparently due to the fall in temperature at the depths of 25-70 cm (from 9-25 °C during April to October to 2-9 °C in January). Unexpectedly, the highest methane oxidation potential (MOP) was observed in samples from the top layer where exposure to methane was low. Overall, the results show that MBT residual is a suitable support medium for methane oxidation in landfill covers in field conditions in a boreal climate.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Einola, J. M., Sormunen, K. M., Rintala, J. A.

Number of pages: 17

Pages: 67-83

Publication date: 15 Dec 2008

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 407

Issue number: 1

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2008): SJR 1.461 SNIP 1.489

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution, Waste Management and Disposal, Environmental Engineering

Keywords: Greenhouse gases, Landfill gas, Low temperature, Mechanical-biological treatment, Methane oxidation, Municipal solid waste

DOIs:

10.1016/j.scitotenv.2008.08.016

Source: Scopus

Source ID: 56249090340

Research output: Contribution to journal > Article > Scientific > peer-review

#### Volatile fatty acid production from Kraft mill foul condensate in upflow anaerobic sludge blanket reactors

The utilization of foul condensate (FC) collected from a Kraft pulp mill for the anaerobic production of volatile fatty acids (VFA) was tested in upflow anaerobic sludge blanket (UASB) reactors operated at 22, 37 and 55°C at a hydraulic retention time (HRT) of ~75 h. The FC consisted mainly of 11370, 500 and 592 mg/L methanol, ethanol and acetone, respectively. 42–46% of the organic carbon (methanol, ethanol and acetone) was utilized in the UASB reactors operated at an organic loading of ~8.6 gCOD/L.d and 52–70% of the utilized organic carbon was converted into VFA. Along with acetate, also propionate, isobutyrate, butyrate, isovalerate and valerate were produced from the FC. Prior to acetogenesis of FC, enrichment of the acetogenic biomass was carried out in the UASB reactors for 113 d by applying operational parameters that inhibit methanogenesis and induce acetogenesis. Activity tests after 158 d of reactor operation showed that the biomass from the 55°C UASB reactor exhibited the highest activity after the FC feed compared to the biomass from the reactors at 22 and 37°C. Activity tests at 37°C to compare FC utilization for CH<sub>4</sub> versus VFA production showed that an organic carbon utilization >98% for CH<sub>4</sub> production occurred in batch bottles, whereas the VFA production batch bottles showed 51% organic carbon utilization. Furthermore, higher concentrations of C<sub>3</sub>–C<sub>5</sub> VFA were produced when FC was the substrate compared to synthetic methanol rich wastewater.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Research group: Bio- and Circular Economy, Tampere University, Wageningen University and the UNESCO-IHE Institute for Water Education, Delft, The Netherlands, 18.10.2013

Contributors: Eregowda, T., Kokko, M. E., Rene, E. R., Rintala, J., Lens, P. N.

Number of pages: 14

Publication date: 2020

Peer-reviewed: Yes

### Publication information

Journal: Environmental Technology (United Kingdom)

ISSN (Print): 0959-3330

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Water Science and Technology, Waste Management and Disposal

Keywords: acetogenesis, Foul condensate, Kraft pulp mill effluent, UASB, VFA production

DOIs:

10.1080/09593330.2019.1703823

### Bibliographical note

INT=msee,"Eregowda, Tejaswini"

Source: Scopus

Source ID: 85078586999

Research output: Contribution to journal > Article > Scientific > peer-review

### Sorption of zinc onto elemental selenium nanoparticles immobilized in *Phanerochaete chrysosporium* pellets

The use of a novel hybrid biosorbent, elemental selenium nanoparticles ( $n\text{Se}^0$ ) immobilized in pellets of *Phanerochaete chrysosporium*, to remove Zn from aqueous solutions was investigated. Fungal pellets containing  $n\text{Se}^0$  ( $n\text{Se}^0$ -pellets) showed to be better biosorbents as they removed more Zn ( $88.1 \pm 5.3\%$ ) compared to Se-free fungal pellets ( $56.2 \pm 2.8\%$ ) at pH 4.5 and an initial Zn concentration of  $10 \text{ mg L}^{-1}$ . The enhanced sorption capacity of  $n\text{Se}^0$ -pellets was attributed to a higher concentration of sorption sites resulting in a more negative surface charge density, as determined by analysis of the potentiometric titration data. Fourier transform infrared spectroscopy (FT-IR) analysis of fungal pellets prior to and after being loaded with Zn showed the functional groups, including hydroxyl and carboxyl groups, involved in the sorption process. The experimental data indicated that the sorption rate of the  $n\text{Se}^0$ -pellets fitted well to the pseudo-second order kinetic model ( $R^2 = 0.99$ ), and the sorption isotherm was best represented by the Sips model (Langmuir-Freundlich) with heterogeneous factor  $n = 1$  ( $R^2 = 0.99$ ), which is equivalent to the Langmuir model. Operational advantages of fungal pelleted reactors and the Zn removal efficiencies achieved by  $n\text{Se}^0$ -pellets under mild acidic conditions make  $n\text{Se}^0$ -pellet based bioreactors an efficient biosorption process.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Hydraulic and Environmental Engineering (IHE) Inst. for Water Education, Environmental Engineering and Water Technology Department, Université Paris-Est

Contributors: Espinosa-Ortiz, E. J., Shakya, M., Jain, R., Rene, E. R., van Hullebusch, E. D., Lens, P. N. L.

Number of pages: 12

Pages: 21619–21630

Publication date: 2016

Peer-reviewed: Yes

### Publication information

Journal: Environmental Science and Pollution Research

Volume: 23

Issue number: 21

ISSN (Print): 0944-1344

Ratings:

Scopus rating (2016): CiteScore 4 SJR 0.891 SNIP 1.127

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Medicine(all), Pollution, Health, Toxicology and Mutagenesis

Keywords: Fungal pellets, Hybrid biosorbent, *Phanerochaete chrysosporium*, Selenium nanoparticles, Zinc biosorption

DOIs:

10.1007/s11356-016-7333-6

Source: Scopus

Source ID: 84982179903

Research output: Contribution to journal > Article > Scientific > peer-review

### Induction of genotoxic effects by chlorohydroxyfuranones, byproducts of water disinfection, in *E. coli* K-12 cells recovered from various organs of mice

The genotoxic effects of three chlorohydroxyfuranones (CHF), 3-chloro-4-(dichloromethyl)-5-hydroxy-2[5H]-furanone (MX), 3-chloro-4-(chloromethyl)-5-hydroxy-2[5H]furanone (CMCF) and 3,4,-dichloro-5-hydroxy-2[5H]furanone (MCA), which are formed as byproducts of water disinfection with chlorine, were investigated in bacterial differential DNA repair assays in vitro and in animal-mediated assays in vivo. As indicators of DNA damage, *E. coli* K-12 strains were used that differ in their repair capacity (*uvrB/recA* vs. *uvr+/rec+*). Liquid incubation of the compounds without metabolic activation caused a pronounced reduction of the viability of the repair-deficient strain relative to the repair-proficient wild-type strain.

The order of potency of genotoxic activity in vitro (dose range 0.004-10 µg/ml) was MX > CMCF > MCA. Addition of mouse S-9 mix or bovine serum albumin to the incubation mixtures resulted in an almost complete loss of the activity of all three test compounds. In the animal-mediated assays, mixtures of the indicator bacteria were injected intravenously into mice which were subsequently treated with the test compounds (200 mg/kg b.w.). Two hours later, the cells were recovered from various organs and the relative survival frequencies determined. Under these conditions, all three compounds caused pronounced genotoxic effects, MX and CMCF being stronger genotoxins than MCA. The strongest effects were consistently found in the gastrointestinal tract, but statistically significant DNA damage was also observed in indicator cells recovered from lungs, liver, spleen and kidneys. In a further experiment, the effects of lower doses of MX (4.3, 13 and 40 mg/kg) were investigated. In these experiments dose-dependent effects were measured in all organs. CMCF and MA caused only marginal effects at 40 mg/kg except in the stomach where approximately a 50% reduction of relative survival frequency was observed with CMCF. The results of these animal-mediated assays indicate that (i) all three CHF's cause genotoxic effects in the living animal, and (ii) the potencies of the three compounds observed under in vivo conditions are not commensurate with their extremely high activities measured in vitro. One possible explanation for the weaker responses observed in the animal-mediated assays might be that CHF's are inactivated by nonspecific protein binding.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Tumor Biology/Cancer Research Inst., Institute of Tumor Biology, Cancer Research, Åbo Akademi University

Contributors: Fekadu, K., Parzefall, W., Kronberg, L., Franzen, R., Schulte-Hermann, R., Knasmüller, S.

Number of pages: 8

Pages: 317-324

Publication date: 1994

Peer-reviewed: Yes

#### Publication information

Journal: Environmental and Molecular Mutagenesis

Volume: 24

Issue number: 4

ISSN (Print): 0893-6692

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry, Genetics, Genetics(clinical), Toxicology, Health, Toxicology and Mutagenesis

Keywords: Bacterial host mediated assay, Mucochloric acid, MX

DOIs:

10.1002/em.2850240409

URLs:

<http://www.scopus.com/inward/record.url?scp=0028618759&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 0028618759

Research output: Contribution to journal > Article > Scientific > peer-review

#### Ring-chain tautomerism of chlorinated hydroxyfuranones and reaction with nucleosides

Several genotoxic hydroxyfuranones present in chlorine disinfected drinking water, were reacted with adenosine, guanosine, and cytidine in aqueous solution. HPLC analyses with UV detection at 254 and 325 nm showed that adducts were formed. The compounds MCF, 3-chloro-4-methyl-5-hydroxy-2(5H)-furanone and mCMF, 4-(chloromethyl)-5-hydroxy-2(5H)-furanone tautomerized to the corresponding oxobutenic acids at pH 7.4 and formed 4-(N<sup>6</sup>-adenosinyl)-3-formyl-3-butenic acid (I) as the major product. The hydroxyfuranone MX, 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone reacted with guanosine, and formed 10-formyl-1,N<sup>2</sup>-benzoquinone propenoguanosine. The adducts were isolated by C18 column chromatography, and characterized by UV absorbance, <sup>1</sup>H spectroscopy, and mass spectrometry.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Helsinki University, Department of Pharmacy, Natl. Inst. for Environ. Studies

Contributors: Franzén, R., Tanabe, K., Morita, M.

Number of pages: 8

Pages: 973-980

Publication date: Feb 1999

Peer-reviewed: Yes

#### Publication information

Journal: Chemosphere

Volume: 38

Issue number: 5  
ISSN (Print): 0045-6535  
Ratings:

Scopus rating (1999): SJR 1.022 SNIP 0.844

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

DOIs:

10.1016/S0045-6535(98)00358-0

Source: Scopus

Source ID: 0033081579

Research output: Contribution to journal > Article > Scientific > peer-review

### Isolation of a MX-guanosine adduct formed at physiological conditions

3-Chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX), a highly potent mutagen present in chlorine-disinfected drinking water, was allowed to react with adenosine, guanosine, and cytidine in aqueous solutions. HPLC analyses, with detection at 254 and 310 nm, showed that a clearly detectable base adduct was formed in the reaction with guanosine. This substance was isolated by C18 column chromatography and characterized by UV absorbance, <sup>1</sup>H NMR spectroscopy, and mass spectrometry. The compound was identified as 10-formyl-1,N<sup>2</sup>-benzoquinone propenoguanosine (1), and the yield was estimated to be approximately 0.1% in reactions performed at pH 7.4 and 37°C.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Natl. Inst. for Environ. Studies, University of Helsinki

Contributors: Franzén, R., Tanabe, K., Morita, M.

Number of pages: 6

Pages: 2803-2808

Publication date: Jun 1998

Peer-reviewed: Yes

### Publication information

Journal: Chemosphere

Volume: 36

Issue number: 13

ISSN (Print): 0045-6535

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all)

DOIs:

10.1016/S0045-6535(97)10237-5

URLs:

<http://www.scopus.com/inward/record.url?scp=0032104862&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 0032104862

Research output: Contribution to journal > Article > Scientific > peer-review

### Determination of chlorinated 5-methyl-5-hydroxyfuranones in drinking water, in chlorinated humic water, and in pulp bleaching liquor

Hydroxyfuranones with monochloro-, dichloro-, and trichloromethyl groups at C-5 (5-MHF<sub>s</sub>) were qualitatively and quantitatively determined in extracts of chlorination stage bleaching liquors (CBL) from a pulp mill, of chlorinated natural humic water (HW), and of three samples of drinking water (DW1-3) treated with various disinfectants. In addition, the mutagenic potency of the compounds in Ames tester strain TA100 was observed, and their stability in water at pH 2 and pH 8 was determined. In CBL, eight of the nine hydroxyfuranones studied were observed, and some of the compounds were found in concentrations higher than 0.5 mg/L. Thus, these compounds must be considered as major chlorinated byproducts of chlorine bleaching. In the drinking water extracts, the 5-dichloromethyl compounds and one 5-monochloromethyl compound were detected. The concentration of the compounds ranged from <1 to 45 ng/L. The compounds were found to be mutagenic in the Ames assay; the most potent mutagen generated about 1.5 revertants/nmol, while the weakest mutagen generated about 0.3 revertants/nmol. The total mutagenicity contribution of these hydroxyfuranones was approximately 2% in the sample of CBL and much less than 1% in the samples of drinking water. The stability of the compounds was higher at pH 2 than at pH 8, and in general, a higher degree of chlorine substitution increased the compound stability.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Organic Chemistry, Abo Akademi University, Åbo Akademi University  
Contributors: Franzén, R., Kronberg, L.  
Number of pages: 6  
Pages: 2222-2227  
Publication date: 1994  
Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 28

Issue number: 12

ISSN (Print): 0013-936X

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry, Environmental Engineering

DOIs:

10.1021/es00061a035

URLs:

<http://www.scopus.com/inward/record.url?scp=0027946151&partnerID=8YFLogxK> (Link to publication in Scopus)

#### Bibliographical note

EXT="Franzen, Robert"

Source: Scopus

Source ID: 0027946151

Research output: Contribution to journal > Article > Scientific > peer-review

#### Cell toxicity and oxidative potential of engine exhaust particles: Impact of using particulate filter or biodiesel fuel blend

The link between emissions of vehicular particulate matter (PM) and adverse health effects is well established. However, the influence of new emission control technologies and fuel types on both PM emissions and health effects has been less well investigated. We examined the health impact of PM emissions from two vehicles equipped with or without a diesel particulate filter (DPF). Both vehicles were powered either with diesel (B0) or a 50% v/v biodiesel blend (B50). The DPF effectively decreased PM mass emissions (~85%), whereas the fuel B50 without DPF led to less reduction (~50%). The hazard of PM per unit distance driven was decreased for the DPF-equipped vehicle as indicated by a reduced cytotoxicity, oxidative, and pro-inflammatory potential. This was not evident and even led to an increase when the hazard was expressed on a per unit of mass basis. In general, the PM oxidative potential was similar or reduced for the B50 compared to the B0 powered vehicle. However, the use of B50 resulted in increased cytotoxicity and IL-6 release in BEAS-2B cells irrespective of the expression metric. This study shows that PM mass reduction achieved by the use of B50 will not necessarily decrease the hazard of engine emissions, while the application of a DPF has a beneficial effect on both PM mass emission and PM hazard.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), National Institute for Public Health and the Environment, Norwegian Institute of Public Health, Aristotle University of Thessaloniki, Laboratory of Applied Thermodynamics, Utrecht University

Contributors: Gerlofs-Nijland, M. E., Totlandsdal, A. I., Tzamkiozis, T., Leseman, D. L. A. C., Samaras, Z., Låg, M., Schwarze, P., Ntziachristos, L., Cassee, F. R.

Number of pages: 8

Pages: 5931-5938

Publication date: 4 Jun 2013

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 47

Issue number: 11

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2013): CiteScore 8.9 SJR 2.952 SNIP 2.094

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

DOIs:

10.1021/es305330y

URLs:

<http://www.scopus.com/inward/record.url?scp=84878655379&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84878655379

Research output: Contribution to journal › Article › Scientific › peer-review

### **Review of motor vehicle particulate emissions sampling and measurement: From smoke and filter mass to particle number**

Particulate emissions from motor vehicles have received increased attention over the past two decades owing to associations observed between ambient particulate matter (PM) levels and health effects. This has led to numerous changes in emissions regulations worldwide, including more stringent standards, the broadening of these to include non-road engines, and the adoption of new metrics. These changes have created a demand for new instruments that are capable of real time measurement, enhanced sensitivity, and on-board vehicle operation. In response, researchers and instrument manufacturers have developed an array of new and improved instruments and sampling methods. It is generally recognized that the exhaust aerosol concentration measured depends on both the sampling technique and the instrument used. Hence, many of the new instruments are complementary and offer merits in measuring a variety of particulate emissions attributes. However, selecting the best instrument for each application is not a straightforward task; it requires on one hand a clear measurement objective and, on the other, an understanding of the characteristics of the instrument employed. This paper reviews how vehicle exhaust particulate emission measurements have evolved over the years. The focus is on current and newly evolving instrumentation, including gravimetric filter measurement, chemical analysis of filters, light extinction, scattering and absorption instruments, and instruments based on the electrical detection of exhaust aerosols. Correlations between the various instruments are examined in the context of steadily more stringent exhaust emissions standards. The review concludes with a discussion of future instrument and sampling requirements for the changing nature of exhaust aerosols from current and future vehicles.

#### **General information**

Publication status: Published

MoE publication type: A2 Review article in a scientific journal

Organisations: Urban circular bioeconomy (UrCirBio), European Commission-JRC, Ford Motor Company, Laboratory of Applied Thermodynamics, Aristotle University of Thessaloniki, Desert Research Institute, AVL DiTest Fahrzeugdiagnose GmbH, AVL List GmbH, AVL North America Inc

Contributors: Giechaskiel, B., Maricq, M., Ntziachristos, L., Dardiotis, C., Wang, X., Axmann, H., Bergmann, A., Schindler, W.

Number of pages: 39

Pages: 48-86

Publication date: Jan 2014

Peer-reviewed: Yes

#### **Publication information**

Journal: Journal of Aerosol Science

Volume: 67

ISSN (Print): 0021-8502

Ratings:

Scopus rating (2014): CiteScore 4.2 SJR 1.081 SNIP 1.594

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Aerosol instrumentation, Aerosol sampling, Emission regulations, Exhaust aerosol

DOIs:

10.1016/j.jaerosci.2013.09.003

URLs:

<http://www.scopus.com/inward/record.url?scp=84886264597&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84886264597

Research output: Contribution to journal › Review Article › Scientific › peer-review

### **Effects of anode materials on electricity production from xylose and treatability of TMP wastewater in an up-flow microbial fuel cell**

The aim of this study was to determine an optimal anode material for electricity production and COD removal from xylose containing synthetic wastewater in an up-flow microbial fuel cell (MFC), and assess its suitability for treatment of thermomechanical pulping (TMP) wastewater with an enrichment culture at 37 °C. The anode materials tested included carbon-based electrodes (graphite plate, carbon cloth and zeolite coated carbon cloth), metal-based electrodes (tin coated copper) and a metal-carbon assembly (granular activated carbon in stainless steel cage). During continuous operation with xylose, COD removal was 77–86% of which 25–28% was recovered as electricity. The highest power density of 333 ( $\pm 15$ ) mW/m<sup>2</sup> was obtained with the carbon cloth electrode. However, based on an overall analysis including electrode performance, surface area and scalability, the granular activated carbon in stainless steel cage (GAC in SS cage) was chosen to be used as electrode for bioelectrochemical treatment of TMP wastewater. The TMP fed MFC was operated in continuous mode with 1.8 days hydraulic retention time, resulting in 47 ( $\pm 13\%$ ) COD removal of which 1.5% was recovered as electricity with the average power production of 10–15 mW/m<sup>2</sup>. During operation with TMP wastewater,

membrane fouling increased the polarization resistance causing a 50% decrease in power production within 30 days. This study shows that MFC pretreatment removes half of the TMP wastewater COD load, reducing the energy required for aerobic treatment.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research group: Bio- and Circular Economy, Materials Science and Environmental Engineering, Natl. University of Ireland, Galway, Indian Institute of Technology Hyderabad, Microscopy Center, Kyung Hee University

Contributors: Haavisto, J., Dessì, P., Chatterjee, P., Honkanen, M., Noori, M. T., Kokko, M., Lakaniemi, A. M., Lens, P. N., Puhakka, J. A.

Number of pages: 10

Pages: 141-150

Publication date: 15 Sep 2019

Peer-reviewed: Yes

#### Publication information

Journal: Chemical Engineering Journal

Volume: 372

ISSN (Print): 1385-8947

Ratings:

Scopus rating (2019): CiteScore 15.2 SJR 2.315 SNIP 2.177

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry, Chemical Engineering(all), Industrial and Manufacturing Engineering

Keywords: Electricity production, Electrode material, Granular activated carbon, Membrane fouling, Microbial electrochemical technology, Thermomechanical pulping wastewater

Electronic versions:

Effects of anode materials on electricity production from xylose and treatability of TMP wastewater in an up-flow microbial fuel cell

DOIs:

10.1016/j.cej.2019.04.090

URLs:

<http://urn.fi/URN:NBN:fi:tuni-202001201421>

Source: Scopus

Source ID: 85064600846

Research output: Contribution to journal > Article > Scientific > peer-review

#### Kinetics and modelling of thiosulphate biotransformations by haloalkaliphilic Thioalkalivibrio versutus

Biotransformation of thiosulphate by Thioalkalivibrio versutus was studied under haloalkaline conditions (pH 10, 0.66–1.2 M Na<sup>+</sup>) using batch assays and modelling tools for possible sulphur recovery from haloalkaline industrial streams. The thiosulphate was fully biotransformed to sulphate or to sulphate and elemental sulphur at initial S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S concentrations of 25–550 mM within 10 days. The highest biotransformation rate of 2.66 mM [S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S] h<sup>-1</sup> was obtained at initial S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S concentration of 550 mM with half saturation constant (K<sub>s</sub>) of 54.5 mM [S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S]. At initial concentrations below 100 mM S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S, the main product was sulphate whilst at above 100 mM also elemental sulphur was produced with up to 29% efficiency. The model approach developed incorporated S<sub>2</sub>O<sub>3</sub><sup>2-</sup> biotransformation to SO<sub>4</sub><sup>2-</sup> and S<sup>0</sup>. The kinetic modelling results were compatible (R<sup>2</sup> > 0.90) with the experimental data. The maximum growth rate (μ<sub>m</sub>) was 0.048 h<sup>-1</sup> (0.47 mM C<sub>5</sub>H<sub>7</sub>NO<sub>2</sub> h<sup>-1</sup>) and the maximum growth yield 0.18 mM C<sub>5</sub>H<sub>7</sub>NO<sub>2</sub>/mM S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S (20 g cell/mol S<sub>2</sub>O<sub>3</sub><sup>2-</sup>-S). The high rate thiosulphate biotransformation and elemental sulphur recovery results together with the developed kinetic model can be used for bioprocess design and operation. The potential industrial applications would aim at sustainable resource recovery from industrial haloalkaline and sulphurous process and/or effluent streams.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Research group: Bio- and Circular Economy, Yildiz Technical University

Contributors: Hajdu-Rahkama, R., Özkaya, B., Lakaniemi, A. M., Puhakka, J. A.

Number of pages: 9

Publication date: 2020

Peer-reviewed: Yes

#### Publication information

Journal: Chemical Engineering Journal

Volume: 401

Article number: 126047

ISSN (Print): 1385-8947

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry, Chemical Engineering(all), Industrial and Manufacturing Engineering

Keywords: Haloalkaliphilic sulfur oxidizing bacteria, Kinetics, Resource recovery, Sulfur disproportionation, Thioalkalivibrio versutus, Thiosulfate biotransformation

DOIs:

10.1016/j.cej.2020.126047

### Bibliographical note

INT=msee,"Özkaya, Bestamin"

Source: Scopus

Source ID: 85087487287

Research output: Contribution to journal › Article › Scientific › peer-review

### Toward elemental analysis of ambient single particles using electrodynamic balance and laser-induced breakdown spectroscopy

In this article, we present a novel method for the elemental analysis of airborne aerosol particles using electrodynamic balance (EDB) trapping followed by laser-induced breakdown spectroscopy. The setup consists of a newly designed corona-based aerosol charger, double-ring electrodynamic balance trap and optical arrangement for the spectroscopy. Experimental laboratory measurements using the method show that the minimum particle size for successful analysis is 1  $\mu\text{m}$  in diameter, and the minimum airborne concentration is of the order of 1 particle/ $\text{cm}^3$ . In addition to the method, we will present results on the charging efficiency of the developed charger and novel stability analysis of the EDB at the charge region. The results from the stability analysis will ease the way toward analyzing submicron particles with the technique.

### General information

Publication status: E-pub ahead of print

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics

Contributors: Heikkilä, P., Rossi, J., Rostedt, A., Huhtala, J., Järvinen, A., Toivonen, J., Keskinen, J.

Publication date: 2020

Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology

ISSN (Print): 0278-6826

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Kihong Park

DOIs:

10.1080/02786826.2020.1727408

Source: Scopus

Source ID: 85081358750

Research output: Contribution to journal › Article › Scientific › peer-review

### Quantitative characterization of pore structure of several biochars with 3D imaging

Pore space characteristics of biochars may vary depending on the used raw material and processing technology. Pore structure has significant effects on the water retention properties of biochar amended soils. In this work, several biochars were characterized with three-dimensional imaging and image analysis. X-ray computed microtomography was used to image biochars at resolution of 1.14  $\mu\text{m}$  and the obtained images were analysed for porosity, pore size distribution, specific surface area and structural anisotropy. In addition, random walk simulations were used to relate structural anisotropy to diffusive transport. Image analysis showed that considerable part of the biochar volume consist of pores in size range relevant to hydrological processes and storage of plant available water. Porosity and pore size distribution were found to depend on the biochar type and the structural anisotropy analysis showed that used raw material considerably affects the pore characteristics at micrometre scale. Therefore, attention should be paid to raw material selection and quality in applications requiring optimized pore structure.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, Research group: Computational Biophysics and Imaging Group, BioMediTech, Natural Resources Institute Finland (Luke), VTT Technical Research Centre of Finland

Contributors: Hyväluoma, J., Kulju, S., Hannula, M., Wikberg, H., Källi, A., Rasa, K.  
Number of pages: 11  
Pages: 1-11  
Publication date: Sep 2018  
Peer-reviewed: Yes  
Early online date: 24 Mar 2017

#### Publication information

Journal: Environmental Science and Pollution Research  
Volume: 25  
Issue number: 26  
ISSN (Print): 0944-1344  
Ratings:  
Scopus rating (2018): CiteScore 4.5 SJR 0.828 SNIP 1.05  
Original language: English  
ASJC Scopus subject areas: Environmental Chemistry, Pollution, Health, Toxicology and Mutagenesis  
Keywords: Biochar, Image analysis, Pore structure, Soil amendment, Water retention, X-ray tomography  
DOIs:  
10.1007/s11356-017-8823-x

#### Bibliographical note

EXT="Kulju, Sampo"  
Source: Scopus  
Source ID: 85015999251  
Research output: Contribution to journal > Article > Scientific > peer-review

#### CO-digestion of grass silage and cow manure in a CSTR by re-circulation of alkali treated solids of the digestate

Three laboratory, continuously stirred tank reactors (CSTRs) co-digesting grass silage and cow manure (forming 30% and 70% of substrate volatile solids (VS), respectively) were operated to evaluate the effects of re-circulating an alkali-treated and untreated solid fraction of the digestate back to the reactors. The CSTRs were operated at an organic loading rate (OLR) of 2 kg VS m<sup>-3</sup> day<sup>-1</sup> and hydraulic retention time (HRT) of 20 days with a semi-continuous mode of feeding. The feasibility of co-digestion with substrate VS containing 30% VS of crop was reinforced, resulting in average specific methane yield of about 180-185 l CH<sub>4</sub> kg<sup>-1</sup> VS. Re-circulation of the solid fraction of digestate back to the reactors in both alkali-treated and untreated forms decreased the methane yield by 11% and 21%, respectively, and resulted in operational problems such as scum formation and accumulation of the reactor materials. Batch studies were conducted to evaluate (i) the methane potentials of the solid fraction of digestate, and whole digestate with alkali treatments ranging from 20-60 g NaOH kg<sup>-1</sup> VS of substrate, and (ii) methane potentials of the accumulated reactor materials as top, middle and bottom layers. The solid fraction of digestate treated with 20 g NaOH kg<sup>-1</sup> VS showed higher specific methane yield (340 l CH<sub>4</sub> kg<sup>-1</sup> VS) than the higher range of alkali treatments. The bottom layers of the control reactor and the reactor fed with alkali-treated solids gave a higher specific methane yield (93 and 85 l CH<sub>4</sub> kg<sup>-1</sup> VS, respectively), and all three layers of untreated solids gave similar methane potentials.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Jyväskylän yliopisto, Jyväskylä Innovation Ltd., University of Jyväskylä  
Contributors: Jagadabhi, P. S., Lehtomäki, A., Rintala, J.  
Number of pages: 9  
Pages: 1085-1093  
Publication date: Oct 2008  
Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology  
Volume: 29  
Issue number: 10  
ISSN (Print): 0959-3330  
Ratings:  
Scopus rating (2008): SJR 0.424 SNIP 0.563  
Original language: English  
ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry  
Keywords: Alkali treatment, Biogas, Energy crops, Solids, Stratification  
DOIs:  
10.1080/09593330802180385

Source: Scopus

Source ID: 50649086804

Research output: Contribution to journal > Article > Scientific > peer-review

### Effect of macro- and micro-nutrients addition during anaerobic mono-digestion of grass silage in leach-bed reactors

The effect of macro- ( $\text{NH}_4\text{Cl}$ ) (set I) and micro-nutrients (Fe, Ni, Co and Mo) (set II) addition on chemical oxygen demand (COD) solubilisation during anaerobic mono-digestion of grass silage was investigated in two sets of leach bed reactor experiments at  $35^\circ\text{C}$ . Results showed that addition of  $\text{NH}_4\text{Cl}$  and micro-nutrients improved COD solubilisation by 18% ( $0.56 \text{ g SCOD g}^{-1}$  volatile solids) and 7% ( $0.45 \text{ g SCOD g}^{-1}$  VS), respectively than control. About 20–50% of the added micro-nutrients were bioavailable in the produced leachates, while the rest (50–80%) were adsorbed onto the grass silage. Results of biological methane potential assays showed that, specific methane yields of grass silage were improved by 17% ( $0.36 \pm 0.02 \text{ m}^3 \text{ CH}_4 \text{ kg}^{-1} \text{ VS}_{\text{added}}$ ) when  $\text{NH}_4\text{Cl}$  was supplemented while Fe, Ni, Co and Mo addition improved methane yields by 15% ( $0.33 \pm 0.005 \text{ m}^3 \text{ CH}_4 \text{ kg}^{-1} \text{ VS}_{\text{added}}$ ) when compared to control.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, International Crops Research Institute for the Semi-Arid Tropics, Griffith University, Jyväskylä yliopisto

Contributors: Jagadabhi, P. S., Kaparaju, P., Väisänen, A., Rintala, J.

Number of pages: 12

Pages: 418-429

Publication date: 2019

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology

Volume: 40

Issue number: 4

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2019): CiteScore 3.4 SJR 0.485 SNIP 0.693

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Water Science and Technology, Waste Management and Disposal

Keywords: anaerobic digestion, grass silage, Leach bed reactor, methane, micro-nutrients

DOIs:

10.1080/09593330.2017.1393462

Source: Scopus

Source ID: 85032370604

Research output: Contribution to journal > Article > Scientific > peer-review

### Preferential adsorption of Cu in a multi-metal mixture onto biogenic elemental selenium nanoparticles

Preferential adsorption of Cu contained in wastewaters is desirable as the Cu can then be reprocessed and reused more easily. In this study, biogenic elemental selenium nanoparticles (BioSeNPs) were assessed for their ability to preferentially adsorb Cu from an equimolar mixture containing Cu, Cd and Zn. Variations in metal to BioSeNPs ratios and initial metal solution pH improved the preferential adsorption capacity of BioSeNPs toward Cu, with the ratio of Cu adsorbed to combined Cd and Zn adsorbed varying from 2.3 to 6.6. More than 78% of the added Cu was adsorbed at an initial metal solution pH of 5.2 and metal to BioSeNPs ratio of  $0.21 \text{ mg mg}^{-1}$  when the ratio of Cu adsorbed to the sum of Cd and Zn adsorbed was 2.3. Infrared spectroscopy revealed that the Cu, Cd and Zn were interacting with the hydroxyl and carboxyl surface functional groups of the BioSeNPs. The modeling of BioSeNPs' acid-base titration revealed the presence of high concentrations of carboxylic groups ( $C=60.3 \text{ mol kg}^{-1}$ ) with a  $\text{pK}_a$  of 3.9, providing further evidence of their interaction with Cu. The adsorption of Cu resulted in a lower colloidal stability of the BioSeNPs as indicated by more than 99% retention of added BioSeNPs after adsorption of heavy metals and filtration. BioSeNPs showed a good preferential adsorption capacity toward Cu as compared to other adsorbent. This study provides a proof-of-concept for the preferential adsorption of Cu onto BioSeNPs which are present in the effluent of a bioreactor treating selenium oxyanions containing wastewater.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Tampere University of Technology, Research group: Industrial Bioengineering and Applied Organic Chemistry, Université Paris-Est

Contributors: Jain, R., Dominic, D., Jordan, N., Rene, E. R., Weiss, S., van Hullebusch, E. D., Hübner, R., Lens, P. N. L.

Pages: 917-925

Publication date: 2016

Peer-reviewed: Yes  
Early online date: 2015

### Publication information

Journal: Chemical Engineering Journal

Volume: 284

ISSN (Print): 1385-8947

Ratings:

Scopus rating (2016): CiteScore 9.7 SJR 1.758 SNIP 1.952

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Chemistry(all), Industrial and Manufacturing Engineering, Environmental Chemistry

Keywords: Biogenic, Copper, FT-IR, Heavy metals, Preferential adsorption, Selenium nanoparticles

DOIs:

10.1016/j.cej.2015.08.144

Source: Scopus

Source ID: 84942540702

Research output: Contribution to journal › Article › Scientific › peer-review

### Higher Cd adsorption on biogenic elemental selenium nanoparticles

Cadmium (Cd) is a carcinogenic metal contaminating the environment and ending up in wastewaters. There is therefore a need for improved methods to remove Cd by adsorption. Biogenic elemental selenium nanoparticles have been shown to adsorb Zn, Cu and Hg, but these nanoparticles have not been tested for Cd removal. Here we studied the time-dependency and adsorption isotherm of Cd onto biogenic elemental selenium nanoparticles using batch adsorption experiments. We measured  $\zeta$ -potential values to assess the stability of nanoparticles loaded with Cd. Results show that the maximum Cd adsorption capacity amounts to 176.8 mg of Cd adsorbed per g of biogenic elemental selenium nanoparticles. The  $\zeta$ -potential of Cd-loaded nanoparticles became less negative from  $-32.7$  to  $-11.7$  mV when exposing nanoparticles to an initial Cd concentration of  $92.7 \text{ mg L}^{-1}$ . This is the first study that demonstrates the high Cd uptake capacity of biogenic elemental selenium nanoparticles, of  $176.8 \text{ mg g}^{-1}$ , when compared to that of traditional adsorbents such as carboxyl-functionalized activated carbon, of  $13.5 \text{ mg g}^{-1}$ . An additional benefit is the easy solid-liquid separation by gravity settling due to coagulation of Cd-loaded biogenic elemental selenium nanoparticles.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, Institute for Water Education, UNESCO-IHE Institute for Water Education, Helmholtz-Zentrum Dresden-Rossendorf, Laboratoire Géomatériaux et Environnement (EA 4508)

Contributors: Jain, R., Dominic, D., Jordan, N., Rene, E. R., Weiss, S., van Hullebusch, E. D., Hübner, R., Lens, P. N. L.

Number of pages: 6

Pages: 381–386

Publication date: Sep 2016

Peer-reviewed: Yes

### Publication information

Journal: ENVIRONMENTAL CHEMISTRY LETTERS

Volume: 14

Issue number: 3

ISSN (Print): 1610-3653

Ratings:

Scopus rating (2016): CiteScore 5.6 SJR 1.05 SNIP 1.604

Original language: English

ASJC Scopus subject areas: Environmental Chemistry

Keywords: Adsorption isotherm, Cd, Intraparticle diffusion, Pseudo-second order, Selenium nanoparticles,  $\zeta$ -Potential

DOIs:

10.1007/s10311-016-0560-8

Source: Scopus

Source ID: 84966447038

Research output: Contribution to journal › Article › Scientific › peer-review

### Extending the Faraday cup aerosol electrometer based calibration method up to 5 $\mu\text{m}$

A Faraday cup aerosol electrometer based electrical aerosol instrument calibration setup from nanometers up to micrometers has been designed, constructed, and characterized. The set-up utilizes singly charged seed particles, which are grown to the desired size by condensation of diethylhexyl sebacate. The calibration particle size is further selected with a Differential Mobility Analyzer (DMA). For micrometer sizes, a large DMA was designed, constructed, and

characterized. The DMA electrical mobility resolution was found to be 7.95 for 20 L/min sheath and 2 L/min sample flows. The calibration is based on comparing the instrument's response against the concentration measured with a reference Faraday cup aerosol electrometer. The set-up produces relatively high concentrations in the micrometer size range (more than 2500 1/cm<sup>3</sup> at 5.3 μm). A low bias flow mixing and splitting between the reference and the instrument was constructed from a modified, large-sized mixer and a four-port flow splitter. It was characterized at different flow rates and as a function of the particle size. Using two of the four outlet ports at equal 1.5 L/min flow rates, the particle concentration bias of the flow splitting was found to be less than ±1% in the size range of 3.6 nm–5.3 μm. The developed calibration set-up was used to define the detection efficiency of a condensation particle counter from 3.6 nm to 5.3 μm with an expanded measurement uncertainty (k = 2) of less than 4% over the entire size range and less than 2% for most of the measurement points.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics

Contributors: Järvinen, A., Keskinen, J., Yli-Ojanperä, J.

Number of pages: 13

Pages: 828-840

Publication date: 3 Aug 2018

Peer-reviewed: Yes

#### Publication information

Journal: Aerosol Science and Technology

Volume: 52

Issue number: 8

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2018): CiteScore 3.8 SJR 0.786 SNIP 0.995

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Pramod Kulkarni

Electronic versions:

Järvinen\_et\_al\_Calibration\_rev\_11

DOIs:

10.1080/02786826.2018.1472742

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201910033665>

Source: Scopus

Source ID: 85051115278

Research output: Contribution to journal > Article > Scientific > peer-review

#### Real-time effective density monitor (DENSMO) for aerosol nanoparticle production

A new instrument, density monitor (DENSMO), for aerosol particle size distribution characterization and monitoring has been developed. DENSMO is operationally simple and capable of measuring the effective density as well as the aerodynamic and the mobility median diameters with a time resolution of 1 s, from unimodal particle size distributions. The characterization is performed with a zeroth order mobility analyzer in series with a low pressure impactor and a filter stage. The operation of DENSMO was investigated with sensitivity analysis and, based on the results, optimal operation parameters were determined. DENSMO was also compared, in lab test measurements, against a reference method with several particle materials with bulk densities from 0.92 to 10.5 g/cm<sup>3</sup>. The results show that the deviation from the reference method was less than 25% for suitable materials.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis

Contributors: Juuti, P., Arffman, A., Rostedt, A., Harra, J., Mäkelä, J. M., Keskinen, J.

Number of pages: 10

Pages: 487-496

Publication date: 3 May 2016

Peer-reviewed: Yes

#### Publication information

Journal: Aerosol Science and Technology

Volume: 50

Issue number: 5  
ISSN (Print): 0278-6826  
Ratings:

Scopus rating (2016): CiteScore 3.7 SJR 0.992 SNIP 0.901  
Original language: English  
ASJC Scopus subject areas: Materials Science(all), Environmental Chemistry, Pollution  
DOIs:

10.1080/02786826.2016.1168511

Source: Scopus

Source ID: 84964337077

Research output: Contribution to journal > Article > Scientific > peer-review

### **Fabrication of fiber filters with antibacterial properties for VOC and particle removal**

The use of filters to control air quality has been implemented widely in all types of structures. Unfortunately, filters risk becoming platforms for the growth of bacteria, which can then be dispersed further in the air stream. To combat this, antibacterial materials are being incorporated into filter media. In this work, we tested two routes for introducing nanoscale silver into filters containing activated carbon fibers (ACF): first, by adding silver nanofibers directly to the fiber fabrication process and second, by coating a pre-existing filter with silver nanoparticles generated by a liquid flame spray (LFS). The resultant filters were evaluated for methanol adsorption, particle penetration and antibacterial activity. The results show that both methods are suitable for producing antibacterial filters as well as being highly tailorable and scalable for specific needs.

### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: Aerosol Synthesis, Research area: Aerosol Physics, Tampere University, Turku University Hospital, Turku University of Applied Science, University of Eastern Finland, Sanzen Seishi Co. Ltd., Kanazawa University

Contributors: Juuti, P., Nikka, M., Gunell, M., Eerola, E., Saarinen, J. J., Omori, Y., Seto, T., Mäkelä, J. M.

Number of pages: 8

Pages: 1892-1899

Publication date: 1 Aug 2019

Peer-reviewed: Yes

### **Publication information**

Journal: Aerosol and Air Quality Research

Volume: 19

Issue number: 8

ISSN (Print): 1680-8584

Ratings:

Scopus rating (2019): CiteScore 5.4 SJR 0.965 SNIP 0.966

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

Keywords: Adsorption, Air filtration, Liquid flame spray, Nanoscale silver

DOIs:

10.4209/aaqr.2018.12.0474

Source: Scopus

Source ID: 85073273179

Research output: Contribution to journal > Article > Scientific > peer-review

### **Thermophilic anaerobic digestion of industrial orange waste**

Thermophilic anaerobic digestion of industrial orange waste (pulp and peel) with subsequent aerobic post-treatment of the digestate was evaluated. Methane production potential was first determined in batch assays and the effects of operational parameters such as hydraulic retention times (HRT) and organic loading rates (OLR) on process performance were studied through semi-continuous digestion. In batch assays, methane production potential of about  $0.49 \text{ m}^3 \text{ kg}^{-1}$  volatile solids (VS) added waste was achieved. In semi-continuous digestion, loading at  $2.8 \text{ kg VS m}^{-3} \text{ d}^{-1}$  ( $2.9 \text{ kg total solids (TS) m}^{-3} \text{ d}^{-1}$ ) and HRT of 26 d produced specific methane yields of  $0.6 \text{ m}^3 \text{ kg}^{-1}$  VS added waste ( $0.63 \text{ m}^3 \text{ kg}^{-1}$  TS added waste). Operating at a higher OLR of  $4.2 \text{ kg VS m}^{-3} \text{ d}^{-1}$  ( $4.4 \text{ kg TS m}^{-3} \text{ d}^{-1}$ ) and 40 d HRT produced  $0.5 \text{ m}^3$  of methane  $\text{kg}^{-1}$  VS added waste ( $0.63\text{-}0.52 \text{ m}^3 \text{ kg}^{-1}$  TS added waste). Up to 70% of TS of industrial orange waste (11.6% TS) was methanised. Further increase in OLR to  $5.6 \text{ kg VS m}^{-3} \text{ d}^{-1}$  ( $5.9 \text{ kg TS m}^{-3} \text{ d}^{-1}$ ; HRT of 20 d) resulted in an unstable and non-functional digester process shown directly through complete cessation of methanogenesis, drop in methane content, reduced pH and increase in volatile fatty acid (VFA) concentrations, especially acetate and soluble chemical oxygen demand. A pH adjustment (from an initial 3.2 to ca. 8) for the low pH orange waste was necessary and was found to be a crucial factor for stable digester operation as the process showed a tendency to be inhibited due to accumulation of VFAs and decrease in digester pH. Aerobic post-treatment of digestate resulted in removal of ammonia and VFAs.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Danmarks Tekniske Universitet, DTU Informatik, University of Jyväskylä, Jyväskylän yliopisto  
Contributors: Kaparaju, P. L. N., Rintala, J. A.  
Number of pages: 11  
Pages: 623-633  
Publication date: Jun 2006  
Peer-reviewed: Yes

### Publication information

Journal: Environmental Technology  
Volume: 27  
Issue number: 6  
ISSN (Print): 0959-3330  
Ratings:  
Scopus rating (2006): SJR 0.477 SNIP 0.545  
Original language: English  
ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry  
Keywords: Aerobic-post treatment, CSTR, Industrial orange waste, Methane, Thermophilic anaerobic digestion  
DOIs:  
10.1080/09593332708618676  
Source: Scopus  
Source ID: 33745802042  
Research output: Contribution to journal › Article › Scientific › peer-review

### The effects of post-treatments and temperature on recovering the methane potential of >2 mm solid fraction of digested cow manure

The effects of thermal and chemical treatments, mechanical maceration and freezing and thawing on recovering the remaining methane potential of the >2 mm solid fraction of digested cow manure - which accounted for 30% of the original potential of digested cow manure - were studied in laboratory batch assays at 5-20°C and at 35-55°C to evaluate the treatment effects both under long-term (340 d) storage of solids and during active digestion (30 d), respectively. The effects of different treatments on the methane production of the solids varied with incubation temperatures and time. However, in all cases, methane productions at 15°C and lower were slow and low for both untreated and treated solids even after long-term incubation. At 35 and 55°C more methane was recovered from untreated solids producing up to 61-82 ml g<sup>-1</sup> volatile solids (VS)<sub>added</sub> in 30 d and 179-215 ml g<sup>-1</sup> VS<sub>added</sub> in 340 d. Only chemical treatment with or without thermal treatment enhanced the methane yields while some treatments even decreased the yields. An increase in temperature to 35°C of the assays incubated for 6 months at ≤20°C initiated more significant methane production. In conclusion, the methane potential of the digested solids in a farm-scale biogas system can be recovered by active digestion at 35 or 53°C and can be improved to a smaller extent through chemical treatment of separated solids fraction, while methane recovery at lower temperatures and with some of the treatments studied would not be effective.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Danmarks Tekniske Universitet, DTU Informatik, University of Jyväskylä, Jyväskylän yliopisto  
Contributors: Kaparaju, P. L. N., Rintala, J. A.  
Number of pages: 7  
Pages: 625-631  
Publication date: Jun 2005  
Peer-reviewed: Yes

### Publication information

Journal: Environmental Technology  
Volume: 26  
Issue number: 6  
ISSN (Print): 0959-3330  
Ratings:  
Scopus rating (2005): SJR 0.506 SNIP 0.677  
Original language: English  
ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry  
Keywords: Anaerobic digestion, Biogas, Chemical, Freeze/thaw, Maceration, Manure, Post-treatments, Thermal  
Source: Scopus  
Source ID: 22744445590  
Research output: Contribution to journal › Article › Scientific › peer-review

### Effects of temperature on post-methanation of digested dairy cow manure in a farm-scale biogas production system

A post-methanation process that could be adopted at farm-scale, operating at temperatures prevailing in farm manure digester post-storage tanks, was evaluated. Digested manure samples from a farm digester (35°C) and post-storage tank (5-10°C) were incubated in parallel batches at 5-20°C and as reference at 35 and 55°C. Specific methane yields ( $\text{kg}^{-1}$  volatile solids (VS)<sub>added waste</sub>) were 0.20-0.26  $\text{m}^3$  at 35-55°C and 0.085-0.09  $\text{m}^3$  at 10-20°C for digester material (345 days of incubation) and 0.16-0.21  $\text{m}^3$  at 35-55°C, 0.053-0.087  $\text{kg}^{-1}$  VS<sub>added waste</sub>  $\text{m}^3$  at 15-20 °C and 0.026  $\text{m}^3$  at 10°C for post-storage tank material (250 days). Both materials produced less than 0.005  $\text{m}^3$  at 5°C. However, an increase in temperature to 35°C (40 days) improved methane production in assays pre-incubated at 5-20°C (9 months). These results suggest that the untapped methane potential of the digested manure cannot effectively be recovered at temperatures prevailing in farm digested manure storage tanks during the winter in Northern latitudes. Nevertheless, as ambient temperatures increase during the late spring, an increase in methanogenesis can be expected.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Kaparaju, P. L. N., Rintala, J. A.

Number of pages: 7

Pages: 1315-1321

Publication date: 2003

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology

Volume: 24

Issue number: 10

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2003): SJR 0.545 SNIP 0.657

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Biogas, Digested manure, Farm-scale digestion, Post-methanation, Temperature

URLs:

<http://www.scopus.com/inward/record.url?scp=0344897245&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 0344897245

Research output: Contribution to journal > Article > Scientific > peer-review

### Agricultural potential of anaerobically digested industrial orange waste with and without aerobic post-treatment

The potential of anaerobically digested orange waste with (AAD) and without (AD) aerobic post-treatment for use in agriculture was evaluated through chemical analyses, short-term phytotoxicity and long-term plant assays. Chemical analyses showed that AD contained ammonia and organic acids, and aerobic post-treatment did not significantly remove these phytotoxins. The N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ratio in AD was 1:0.26:0.96 and aerobic post-treatment did not change the composition in AAD except for K<sub>2</sub>O (1:0.26:1.24). Heavy metal contents in AD and AAD were more or less the same and were below the upper limit recommended for non-sewage sludge application on agricultural soils. Short-term phytotoxicity tests showed that seed germination and root elongation of Chinese cabbage and ryegrass were severely inhibited at digestate concentrations of 60-100%. Germination index values were well below the score of 50% required to indicate the phytotoxic-free nature of compost. Long-term plant assays showed that AD and AAD, when supplemented with a base fertilizer, resulted in higher plant growth, and fresh weight and dry matter production than AD without base fertilizer. The results thus indicate that aerobic post-treatment did not have any significant beneficial effect on reducing phytotoxicity, and AD could be used as such on agricultural soils, especially with high P.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Jyväskylän yliopisto, Department of Biological and Environmental Science

Contributors: Kaparaju, P., Rintala, J., Oikari, A.

Number of pages: 10

Pages: 85-94

Publication date: 1 Jan 2012

Peer-reviewed: Yes

## Publication information

Journal: Environmental Technology

Volume: 33

Issue number: 1

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2012): CiteScore 1.9 SJR 0.663 SNIP 0.879

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Waste Management and Disposal, Water Science and Technology

Keywords: aerobic post-treatment, anaerobic digestate, orange waste, phytotoxicity, plant assays

DOIs:

10.1080/09593330.2011.551839

URLs:

<http://www.scopus.com/inward/record.url?scp=84857215694&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84857215694

Research output: Contribution to journal > Article > Scientific > peer-review

## Performance of ventilation filtration technologies on characteristic traffic related aerosol down to nanocluster size

Near traffic routes and urban areas, the outdoor air particle number concentration is typically dominated by ultrafine particles. These particles can enter into the nearby buildings affecting the human exposure on ultrafine particles indoors. In this study, we demonstrate an aerosol generation system which mimics the characteristic traffic related aerosol. The aerosol generation system was used to determine the size-resolved particle filtration efficiencies of five typical commercial filters in the particle diameter range of 1.3–240 nm. Two different HEPA filters were observed to be efficient in all particle sizes. A fibrous filter (F7) was efficient at small particle sizes representing the nucleation mode of traffic related aerosol, but its efficiency decreased down to 60% with the increasing particle size. In contrast, the filtration efficiency of an electrostatic precipitator (ESP) increased as a function of the particle size, being more efficient for the soot mode of traffic related aerosol than for the nucleation mode. An electret filter with a charger was relatively efficient (filtration efficiency >85%) at all the observed particle sizes. The HEPA, F7 and electret filters were found to practically remove the particles/nanoclusters smaller than 3 nm. All in all, the filtration efficiencies were observed to be strongly dependent on the particle size and significant differences were found between different filters. Based on these results, we suggest that the particulate filter test standards should be extended to cover the ultrafine particles, which dominate the particle concentrations in outdoor air and are hazardous for public health.

## General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, VTT Technical Research Centre of Finland

Contributors: Karjalainen, P., Saari, S., Kuuluvainen, H., Kalliohaka, T., Taipale, A., Rönkkö, T.

Number of pages: 11

Pages: 1398-1408

Publication date: 2017

Peer-reviewed: Yes

## Publication information

Journal: Aerosol Science and Technology

Volume: 51

Issue number: 12

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2017): CiteScore 3.6 SJR 0.875 SNIP 0.958

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Electronic versions:

ast\_v8\_04072017\_TUTCRIS. Embargo ended: 7/08/18

DOIs:

10.1080/02786826.2017.1356904

URLs:

<http://urn.fi/URN:NBN:fi:tyy-201712192401>. Embargo ended: 7/08/18

Source: Scopus

Source ID: 85027077005

Research output: Contribution to journal > Article > Scientific > peer-review

## Strategies To Diminish the Emissions of Particles and Secondary Aerosol Formation from Diesel Engines

Particle emissions and secondary aerosol formation from internal combustion engines deteriorate air quality and significantly affect human wellbeing and health. Both the direct particle emissions and the emissions of compounds contributing to secondary aerosol formation depend on choices made in selecting fuels, engine technologies, and exhaust aftertreatment (EAT). Here we study how catalytic EATs, particle filtration, and fuel choices affect these emissions concerning heavy-duty diesel engine. We observed that the most advanced EAT decreased the emissions of fresh exhaust particle mass as much as 98% (from 44.7 to 0.73 mg/kWh) and the formation of aged exhaust particle mass ~100% (from 106.2 to ~0 mg/kWh). The composition of emitted particles depended significantly on the EAT and oxidative aging. While black carbon typically dominated the composition of fresh exhaust particles, aged particles contained more sulfates and organics. The fuel choices had minor effects on the secondary aerosol formation, implicating that, in diesel engines, either the lubricant is a significant source of secondary aerosol precursors or the precursors are formed in the combustion process. Results indicate that the utilization of EAT in diesel engines would produce benefits with respect to exhaust burden on air quality, and thus their utilization should be promoted especially in geographical areas suffering from poor air quality.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research area: Aerosol Physics, Physics, Research group: Aerosol Synthesis, Atmospheric Composition Research, Finnish Meteorological Institute, AGCO Power Oy, Dinex Finland Oy

Contributors: Karjalainen, P., Rönkkö, T., Simonen, P., Ntziachristos, L., Juuti, P., Timonen, H., Teinilä, K., Saarikoski, S., Saveljeff, H., Lauren, M., Happonen, M., Matilainen, P., Maunula, T., Nuottimäki, J., Keskinen, J.

Number of pages: 9

Pages: 10408-10416

Publication date: 3 Sep 2019

Peer-reviewed: Yes

### Publication information

Journal: Environmental science & technology

Volume: 53

Issue number: 17

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2019): CiteScore 12.6 SJR 2.704 SNIP 2.06

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

Electronic versions:

acs.est.9b04073

DOIs:

10.1021/acs.est.9b04073

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201909193415>

### Bibliographical note

EXT="Happonen, Matti"

Source: Scopus

Source ID: 85071785150

Research output: Contribution to journal › Article › Scientific › peer-review

## Soft hydrazone crosslinked hyaluronan- and alginate-based hydrogels as 3D supportive matrices for human pluripotent stem cell-derived neuronal cells

Regenerative medicine, especially cell therapy combined with a supportive biomaterial scaffold, is considered to be a potential treatment for various deficits in humans. Here, we have produced and investigated the detailed properties of injectable hydrazone crosslinked hyaluronan-polyvinyl alcohol (HA-PVA) and alginate-polyvinyl alcohol (AL-PVA) hydrogels to be used as a supportive biomaterial for 3D neural cell cultures. To the best of our knowledge, this is the first time the polymerization and properties of hydrazone crosslinked AL-PVA hydrogel have been reported. The effect of the degree of substitution and molecular weight of the polymer components as well as the polymer concentration of the hydrogel on the swelling, degradation and mechanical properties of the hydrogels is reported. Furthermore, we studied the effect of the above parameters on the growth of human pluripotent stem cell-derived neuronal cells. The most neural cell supportive HA-PVA hydrogel was composed of high molecular weight HA component with brain-mimicking mechanical properties and decreased polymer concentration. AL-PVA hydrogel, with stiffness quite similar to brain tissue, was also shown to be similarly supportive. Neuronal spreading and 3D network formation was enhanced inside the softest hydrogels.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech Institute and Faculty of Medicine and Life Sciences

Contributors: Karvinen, J., Joki, T., Ylä-Outinen, L., Koivisto, J. T., Narkilahti, S., Kellomäki, M.

Number of pages: 11

Pages: 29-39

Publication date: 1 Mar 2018

Peer-reviewed: Yes

### Publication information

Journal: Reactive and Functional Polymers

Volume: 124

ISSN (Print): 1381-5148

Ratings:

Scopus rating (2018): CiteScore 4.9 SJR 0.712 SNIP 0.92

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry, Biochemistry, Chemical Engineering(all), Polymers and Plastics, Materials Chemistry

Keywords: 3D neuronal culture, Alginate, Hyaluronan, Hydrazone, Hydrogel

DOIs:

10.1016/j.reactfunctpolym.2017.12.019

URLs:

<http://www.scopus.com/inward/record.url?scp=85040229275&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 85040229275

Research output: Contribution to journal > Article > Scientific > peer-review

### Landfill methane oxidation in engineered soil columns at low temperature

Though engineered covers have been suggested for reducing landfill methane emissions via microbial methane oxidation, little is known about the covers' function at low temperature. This study aimed to determine the methane consumption rates of engineered soil columns at low temperature (4-12°C) and to identify soil characteristics that may enhance methane oxidation in the field. Engineered soils (30 cm thick) were mixtures of sewage sludge compost and de-inking waste, amended with sand (SDS soil) or bark chips (SDB soil). At 4-6°C, we achieved rates of 0.09 gCH<sub>4</sub> kgTS<sup>-1</sup> d<sup>-1</sup> (0.02 m<sup>3</sup> m<sup>-2</sup> d<sup>-1</sup>) and 0.06 gCH<sub>4</sub> kgTS<sup>-1</sup> d<sup>-1</sup> (0.009 m<sup>3</sup> m<sup>-2</sup> d<sup>-1</sup>) with SDS and SDB soils, respectively. With SDS, good movement and exchange of oxygen in porous soil moderated the slowdown of microbial activity so that the rate dropped only by half as temperature declined from 21-23°C to 4-6°C. In SDB, wet bark chips reduced the soil's air-filled porosity and intensified non-methanotrophic microbial activity, thus reducing the methane consumption rate at 4-6°C to one fourth of that at 21-23°C. In conclusion, soil characteristics such as air-filled porosity, water holding capacity, quantity and stabilization of organic amendments that affect the movement and exchange of oxygen are important variables in designing engineered covers for high methane oxidation at low temperature.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: University of Jyväskylä, Jyväskylän yliopisto, Tritonet Ltd.

Contributors: Kettunen, R. H., Einola, J. K. M., Rintala, J. A.

Number of pages: 22

Pages: 313-334

Publication date: Nov 2006

Peer-reviewed: Yes

### Publication information

Journal: Water Air and Soil Pollution

Volume: 177

Issue number: 1-4

ISSN (Print): 0049-6979

Ratings:

Scopus rating (2006): SJR 0.574 SNIP 0.916

Original language: English

ASJC Scopus subject areas: Atmospheric Science, Pollution, Environmental Science(all), Environmental Chemistry, Water Science and Technology, Earth-Surface Processes

Keywords: Landfill cover, Low temperature, Methane oxidation, Organic amendments, Soil

DOIs:

10.1007/s11270-006-9176-0

Source: Scopus

Source ID: 33845511153

Research output: Contribution to journal > Article > Scientific > peer-review

### Testing the near field/far field model performance for prediction of particulate matter emissions in a paint factory

A Near Field/Far Field (NF/FF) model is a well-accepted tool for precautionary exposure assessment but its capability to estimate particulate matter (PM) concentrations is not well studied. The main concern is related to emission source characterization which is not as well defined for PM emitters compared to e.g. for solvents. One way to characterize PM emission source strength is by using the material dustiness index which is scaled to correspond to industrial use by using modifying factors, such as handling energy factors. In this study we investigate how well the NF/FF model predicts PM concentration levels in a paint factory. PM concentration levels were measured during big bag and small bag powder pouring. Rotating drum dustiness indices were determined for the specific powders used and applied in the NF/FF model to predict mass concentrations. Modeled process specific concentration levels were adjusted to be similar to the measured concentration levels by adjusting the handling energy factor. The handling energy factors were found to vary considerably depending on the material and process even though they have the same values as modifying factors in the exposure models. This suggests that the PM source characteristics and process-specific handling energies should be studied in more detail to improve the model-based exposure assessment.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Danmarks Tekniske Universitet, DTU Informatik, Denmark Technical University DTU, National Research Centre for the Working Environment, Department of Micro and Nanotechnology

Contributors: Koivisto, A. J., Jensen, A. C. Ø., Levin, M., Kling, K. I., Maso, M. D., Nielsen, S. H., Jensen, K. A., Koponen, I. K.

Number of pages: 12

Pages: 62-73

Publication date: 1 Jan 2015

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Sciences: Processes and Impacts

Volume: 17

Issue number: 1

ISSN (Print): 2050-7887

Ratings:

Scopus rating (2015): CiteScore 4.3 SJR 0.998 SNIP 0.923

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Public Health, Environmental and Occupational Health, Management, Monitoring, Policy and Law, Medicine(all)

DOIs:

10.1039/c4em00532e

URLs:

<http://www.scopus.com/inward/record.url?scp=84920000979&partnerID=8YFLogxK> (Link to publication in Scopus)

#### Bibliographical note

EXT="Koivisto, A. J."

Source: Scopus

Source ID: 84920000979

Research output: Contribution to journal > Article > Scientific > peer-review

### Applicability of optical and diffusion charging-based particulate matter sensors to urban air quality measurements

High spatial resolution particulate matter measurements are necessary to accurately characterize urban air quality issues. This study investigates how sensors can be used in an urban area to complement existing air quality measurements. A measurement campaign was conducted during winter in Helsinki, Finland, where the performance of a custom-built optical instrument—the Prototype Aerosol Sensor (PAS; uses Shinyei PPD60PV and PPD42NS sensor modules)—and three commercial diffusion charging-based sensors (Pegasor AQ Urban, DiSCmini and Partector) was evaluated against reference instruments. The results showed that the PAS was able to measure the coarse ( $PM_{2.5-10}$ ; range:  $0-400 \mu g m^{-3}$ ) and fine ( $PM_{2.5}$ ; range:  $0-50 \mu g m^{-3}$ ) fractions with reasonably high correlations ( $R^2 = 0.87$  and  $0.77$ ) when compared to a gravimetric monitor. Likewise, the lung deposited surface area (LDSA) concentrations delivered by the three diffusion charging sensors indicated good performance ( $R^2 = 0.92-0.97$ ) when compared to LDSA concentrations calculated from the size distribution data of the differential mobility particle sizer. A clear correlation ( $R^2 = 0.77$ ) between the black carbon and Pegasor-measured LDSA concentrations, as well as similar diurnal cycles, was observed, suggesting a common source. The optical sensors were useful for measuring the mass concentrations of coarse local particles. By contrast, the

diffusion charging sensors were applicable in urban environments, where ultrafine particles from traffic or other local combustion sources affect air quality.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research area: Aerosol Physics, Finnish Meteorological Institute, Helsinki Region Environmental Services Authority (HSY), Pegasor Oyj

Contributors: Kuula, J., Kuuluvainen, H., Rönkkö, T., Niemi, J. V., Saukko, E., Portin, H., Aurela, M., Saarikoski, S., Rostedt, A., Hillamo, R., Timonen, H.

Number of pages: 16

Pages: 1024-1039

Publication date: 1 May 2019

Peer-reviewed: Yes

#### Publication information

Journal: Aerosol and Air Quality Research

Volume: 19

Issue number: 5

ISSN (Print): 1680-8584

Ratings:

Scopus rating (2019): CiteScore 5.4 SJR 0.965 SNIP 0.966

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

Keywords: Diffusion charging, Low-cost sensor, Optical, PM, Urban air quality

DOIs:

10.4209/aaqr.2018.04.0143

#### Bibliographical note

EXT="Saukko, Erkka"

Source: Scopus

Source ID: 85068919113

Research output: Contribution to journal > Article > Scientific > peer-review

#### Triboelectric charging of fungal spores during resuspension and rebound

The triboelectric charging of fungal spores was experimentally characterized during rebound and resuspension. A fungal spore source strength tester (FSSST) was used as a primary aerosol generator for spores of three fungal species and two powders (silicon carbide and silver). The critical velocity of rebound was determined using a variable nozzle area impactor (VNAI), and the charging state of particles after resuspension and rebound was measured using the FSSST, different impactor setups, electrometers, and optical particle counters. In the impactor setups and the FSSST, five different surface materials relevant for indoor environments were used (steel, glass, polystyrene, paper, and polytetrafluoroethylene). The critical velocity of rebound was determined to be 0.57 m/s for fungal spores, which is relatively low compared to silicon carbide and previous results for micron-sized aerosol particles. Based on the rebound impactor measurements, we were able to define the crucial parameters of charge transfer for different particle-surface material pairs. A contact charge parameter, which describes the triboelectric charging during rebound, was found to have a negative correlation with the charging state of the particles after the resuspension from an impactor. This connects the triboelectric charging during rebound and resuspension to each other. Based on the contact charge parameter values, quantified triboelectric series could be formed. The results of this work show that fungal spores can be charged both positively and negatively during rebound and resuspension depending on the fungal species and surface material.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research area: Aerosol Physics, Research area: Optics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, University of Eastern Finland, University of Cincinnati

Contributors: Kuuluvainen, H., Saari, S., Mensah-Attipoe, J., Arffman, A., Pasanen, P., Reponen, T., Keskinen, J.

Number of pages: 11

Pages: 187-197

Publication date: 1 Feb 2016

Peer-reviewed: Yes

#### Publication information

Journal: Aerosol Science and Technology

Volume: 50

Issue number: 2

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2016): CiteScore 3.7 SJR 0.992 SNIP 0.901

Original language: English

ASJC Scopus subject areas: Materials Science(all), Environmental Chemistry, Pollution

DOIs:

10.1080/02786826.2016.1141164

Source: Scopus

Source ID: 84958163401

Research output: Contribution to journal › Article › Scientific › peer-review

## Editorial

### General information

Publication status: Published

MoE publication type: B1 Article in a scientific magazine

Organisations: Civil Engineering

Contributors: Länsivaara, T.

Number of pages: 1

Publication date: 17 Dec 2018

Peer-reviewed: No

### Publication information

Journal: Environmental Geotechnics

Volume: 5

Issue number: 6

ISSN (Print): 2051-803X

Ratings:

Scopus rating (2018): CiteScore 3.4 SJR 0.602 SNIP 0.899

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Water Science and Technology, Geotechnical Engineering and Engineering Geology, Waste Management and Disposal, Geochemistry and Petrology, Nature and Landscape Conservation, Management, Monitoring, Policy and Law

DOIs:

10.1680/jenge.2018.5.6.309

Source: Scopus

Source ID: 85059019429

Research output: Contribution to journal › Editorial › Scientific

### Recovering Nitrogen as a Solid without Chemical Dosing: Bio-Electroconcentration for Recovery of Nutrients from Urine

This letter presents the proof of concept of a novel bio-electroconcentration system (BEC), a hybrid microbial electrolysis/electrodialysis cell specifically designed to recover nitrogen (as ammonia  $\text{NH}_4\text{-N}$ ), phosphorus (as phosphate  $\text{PO}_4\text{-P}$ ), and potassium (as  $\text{K}^+$ ) from urine. Using a synthetic urine medium, the BECs could reach high current densities of up to  $37.6 \text{ A m}^{-2}$  at  $E_{\text{we}}$  values of 0.0 versus the standard hydrogen electrode (SHE) and  $50 \text{ A m}^{-2}$  at 0.2 V versus SHE, which in turn drove the removal and recovery of N, P, and K at rates of  $7.18 \text{ kg of NH}_4\text{-N m}^{-3} \text{ day}^{-1}$ ,  $0.52 \text{ kg of PO}_4\text{-P m}^{-3} \text{ day}^{-1}$ , and  $1.62 \text{ kg of K}^+ \text{ m}^{-3} \text{ day}^{-1}$  into a concentrate stream (containing  $1.87 \text{ M NH}_4\text{-N}$ ,  $0.29 \text{ M PO}_4\text{-P}$ , and  $0.18 \text{ M K}^+$ ). Finally, this communication demonstrates the recovery of a nitrogen-rich solid from the synthetic urine (in the form of pure  $\text{NH}_4\text{HCO}_3$  crystals with 17% N content) without any chemical additions via the flash-cooling of the produced nutrient-rich concentrate to  $4 \text{ }^\circ\text{C}$ . These two new products may help facilitate the reuse of urine nutrients in the fertilizer or protein production industries of the future.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, University of Queensland

Contributors: Ledezma, P., Jermakka, J., Keller, J., Freguia, S.

Number of pages: 6

Pages: 119-124

Publication date: 14 Mar 2017

Peer-reviewed: Yes

### Publication information

Journal: Environmental Science and Technology Letters

Volume: 4

Issue number: 3  
ISSN (Print): 2328-8930  
Ratings:

Scopus rating (2017): SNIP 1.767  
Original language: English

ASJC Scopus subject areas: Ecology, Environmental Chemistry, Health, Toxicology and Mutagenesis, Pollution, Waste Management and Disposal, Water Science and Technology

DOIs:

10.1021/acs.estlett.7b00024

Source: Scopus

Source ID: 85017618476

Research output: Contribution to journal > Article > Scientific > peer-review

### **Detection of gaseous species during KCl-induced high-temperature corrosion by the means of CPFAAS and CI-API-TOF**

Two different analytical approaches—collinear photofragmentation and atomic absorption spectroscopy (CPFAAS) and chemical ionization atmospheric pressure interface time-of-flight mass spectrometer (CI-API-TOF)—were applied to detect and identify the online gaseous KOH and HCl formed in the addressed high-temperature reactions. Samples of pure KCl, KCl+Cr, KCl+Fe, and KCl+316 L were studied at 550°C under dry and humid conditions with varying oxygen concentrations. The goal was to shed more light on the gas-phase chemistry during KCl-induced corrosion under conditions relevant to biomass combustion. CI-API-TOF proved to be a valuable tool for high-temperature corrosion studies: HCl was identified to have formed during the reactions under humid conditions. On the contrary, despite the known sensitivity of CPFAAS, the formation of KOH could not be verified in any of the performed measurements.

#### **General information**

Publication status: E-pub ahead of print

MoE publication type: A1 Journal article-refereed

Organisations: Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Physics, Research group: Applied Optics, Åbo Akademi University

Contributors: Lehmusto, J., Olin, M., Viljanen, J., Kalliokoski, J., Mylläri, F., Toivonen, J., Dal Maso, M., Hupa, L.

Number of pages: 10

Publication date: 30 Aug 2019

Peer-reviewed: Yes

#### **Publication information**

Journal: Materials and Corrosion

ISSN (Print): 0947-5117

Ratings:

Scopus rating (2019): CiteScore 2.4 SJR 0.433 SNIP 0.878

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Mechanics of Materials, Mechanical Engineering, Surfaces, Coatings and Films, Metals and Alloys, Materials Chemistry

Keywords: CI-API-TOF, CPFAAS, gaseous KCl, HCl formation, high-temperature corrosion

DOIs:

10.1002/maco.201910964

Source: Scopus

Source ID: 85071360769

Research output: Contribution to journal > Article > Scientific > peer-review

### **Indoor thermal environment, air exchange rates, and carbon dioxide concentrations before and after energy retro fits in Finnish and Lithuanian multi-family buildings**

Impacts of energy retrofits on indoor thermal environment, i.e. temperature (T) and relative humidity (RH), as well as ventilation rates and carbon dioxide (CO<sub>2</sub>) concentrations, were assessed in 46 Finnish and 20 Lithuanian multi-family buildings, including 39 retrofitted case buildings in Finland and 15 in Lithuania (the remaining buildings were control buildings with no retrofits). In the Finnish buildings, high indoor T along with low RH levels was commonly observed both before and after the retrofits. Ventilation rates (l/s per person) were higher after the retrofits in buildings with mechanical exhaust ventilation than the corresponding values before the retrofits. Measured CO<sub>2</sub> levels were low in vast majority of buildings. In Lithuania, average indoor T levels were low before the retrofits and there was a significant increase in the average T after the retrofits. In addition, average ventilation rate was lower and CO<sub>2</sub> levels were higher after the retrofits in the case buildings (N = 15), both in apartments with natural and mixed ventilation. Based on the results, assessment of thermal conditions and ventilation rates after energy retrofits is crucial for optimal indoor environmental quality and energy use.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Kaunas University of Technology, National Public Health Institute

Contributors: Leivo, V., Prasauskas, T., Du, L., Turunen, M., Kiviste, M., Aaltonen, A., Martuzevicius, D., Haverinen-Shaughnessy, U.

Number of pages: 9

Pages: 398-406

Publication date: 2017

Peer-reviewed: Yes

### Publication information

Journal: Science of the Total Environment

Volume: 621

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2017): CiteScore 7.5 SJR 1.546 SNIP 1.68

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Air exchange rate, CO concentration, Energy retrofit, Multi-family buildings, Thermal environment

Electronic versions:

STOTEN\_FINAL\_revision. Embargo ended: 27/11/19

DOIs:

10.1016/j.scitotenv.2017.11.227

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201911196077>. Embargo ended: 27/11/19

Source: Scopus

Source ID: 85034947532

Research output: Contribution to journal › Article › Scientific › peer-review

### Measurement of the human respiratory tract deposited surface area of particles with an electrical low pressure impactor

Particle deposition in the human respiratory tract is considered to have negative effects on human health. The lung deposited surface area (LDSA) is an important metric developed to assess the negative health effects of particles deposited in the alveolar region of the human respiratory tract. The measurement of the LDSA is frequently based on the detection of the electrical current carried by diffusion charged particles. Various conversion factors can be used to convert the electric current into LDSA concentration with relatively good accuracy up to the size about 300-600 nm. In this study, we introduce stage-specific LDSA conversion factors for electrical low pressure impactor (ELPI+) data, which enable accurate and real time LDSA concentration and LDSA size distribution measurements in the particle size range from 6 nm to 10  $\mu\text{m}$ . This wide size range covers most of the alveolar deposition of particles, which has not been possible previously by electrical methods. Also, the conversion factors for tracheobronchial and head airways particle surface area deposition were determined, and the stage-specific conversion factors were compared with the single-factor data conversion method. Furthermore, the stage-specific calibration was tested against real-world particle size distributions by simulations and against laboratory-generated aerosols. Particles larger than 300 nm were observed to significantly affect the total LDSA concentration. Stage-specific conversion factors are especially required while measuring aerosols containing larger particles or when considering the surface area deposition in the tracheobronchial region and head airways. The method and the conversion factors introduced in this study can be used to monitor LDSA concentrations reliably in various environments containing particles in different size ranges.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research group: Aerosol Synthesis, Tampere University, Dekati Ltd

Contributors: Lepistö, T., Kuuluvainen, H., Juuti, P., Järvinen, A., Arffman, A., Rönkkö, T.

Number of pages: 15

Pages: 958-971

Publication date: 2020

Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology

Volume: 54

Issue number: 8

ISSN (Print): 0278-6826

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Pramod Kulkarni  
DOIs:  
10.1080/02786826.2020.1745141

#### **Bibliographical note**

INT=phys,"Lepistö, Teemu"  
EXT="Arffman, Anssi"

Source: Scopus

Source ID: 85084367755

Research output: Contribution to journal › Article › Scientific › peer-review

#### **Screening for potential fermentative hydrogen production from black water and kitchen waste in on-site UASB reactor at 20°C**

The potential of black water and a mixture of black water and kitchen waste as substrates for on-site dark fermentative hydrogen production was screened in upflow anaerobic sludge blanket reactors at 20°C. Three different inocula were used with and without heat treatment. With glucose, the highest specific hydrogenogenic activity was 69 ml H<sub>2</sub> g volatile solids<sup>-1</sup> d<sup>-1</sup> in batch assays and the highest hydrogen yield 0.44 mol H<sub>2</sub> mol glucose<sup>-1</sup> in upflow anaerobic sludge bed reactors. The mixture of black water and kitchen waste degraded readily into volatile fatty acids in the reactors, thus showing potential for hydrogen production. In the conditions applied, however, the highest end product was propionate and no hydrogen was produced. Black water alone apparently contained too little readily soluble carbohydrates for hydrogen producing bacteria, and little VFA and no hydrogen was produced.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: MTT Agrifood Research Finland, Jyväskylän yliopisto, University of Jyväskylä

Contributors: Luostarinen, S., Pakarinen, O., Rintala, J.

Number of pages: 9

Pages: 691-699

Publication date: Jun 2008

Peer-reviewed: Yes

#### **Publication information**

Journal: Environmental Technology

Volume: 29

Issue number: 6

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2008): SJR 0.424 SNIP 0.563

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Anaerobic treatment, Heat treatment, On-site, Renewable energy

DOIs:

10.1080/09593330801987038

Source: Scopus

Source ID: 45849103521

Research output: Contribution to journal › Article › Scientific › peer-review

#### **Assessing urban population vulnerability and environmental risks across an urban area during heatwaves – Implications for health protection**

Heatwaves can lead to a range of adverse impacts including increased risk of illness and mortality; the heatwave in August 2003 has been associated with ~ 70,000 deaths across Europe. Due to climate change, heatwaves are likely to become more intense, more frequent and last longer in the future. A number of factors may influence risks associated with heat exposure, such as population age, housing type, and location within the Urban Heat Island, and such factors may not be evenly distributed spatially across a region. We simulated and analysed two major heatwaves in the UK, in August 2003 and July 2006, to assess spatial vulnerability to heat exposure across the West Midlands, an area containing ~ 5 million people, and how ambient temperature varies in relation to factors that influence heat-related health effects, through weighting of ambient temperatures according to distributions of these factors across an urban area. Additionally we present quantification of how particular centres such as hospitals are exposed to the UHI, by comparing temperatures at these locations with average temperatures across the region, and presenting these results for both day and night times. We find that UHI intensity was substantial during both heatwaves, reaching a maximum of + 9.6 °C in Birmingham in July 2006. Previous work has shown some housing types, such as flats and terraced houses, are associated with increased risk of overheating, and our results show that these housing types are generally located within the warmest parts of the city. Older age groups are more susceptible to the effects of heat. Our analysis of distribution of population based on age group showed there is only small spatial variation in ambient temperature that different age groups are exposed to.

Analysis of relative deprivation across the region indicates more deprived populations are located in the warmest parts of the city.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Public Health England, London School of Hygiene and Tropical Medicine, University of Birmingham, University College London, Institute of Occupational Medicine

Contributors: Macintyre, H. L., Heaviside, C., Taylor, J., Picetti, R., Symonds, P., Cai, X. M., Vardoulakis, S.

Number of pages: 13

Pages: 678-690

Publication date: 1 Jan 2018

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 610-611

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2018): CiteScore 7.4 SJR 1.536 SNIP 1.84

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Health effects, Heat waves, Spatial vulnerability, Urban Heat Island

DOIs:

10.1016/j.scitotenv.2017.08.062

URLs:

<http://www.scopus.com/inward/record.url?scp=85027502140&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 85027502140

Research output: Contribution to journal > Article > Scientific > peer-review

#### Occurrence and removal of organic pollutants in sewages and landfill leachates

Sewages of different composition and the effluents of four sewage treatment plants (STPs), plus sewage sludges were analysed for semivolatile organic priority pollutants. Furthermore, 11 landfill leachates were analysed to evaluate their contribution to sewage pollutants when co-treated. Bis(2-ethylhexyl) phthalate (DEHP) was the pollutant occurring at highest concentrations (up to 122 µg/l) and it was present in all sewages and leachates; concentrations of other phthalates were usually below 17 µg/l. Some polycyclic aromatic hydrocarbons (PAH) (<1 µg/l) and 2,6-dinitrotoluene (≤5.9 µg/l) were also present in many of the sewages and leachates. Phthalates were present in STP effluents in low concentrations (<8 µg/l), while PAHs were usually not present. DEHP concentrations were at the same level in the sewage consisting of household wastewater and stormwater runoff and the sewages also including industrial discharges and landfill leachates, while PAHs were present in sewages containing industrial discharges. Leachate contribution to the total pollutant load to the STP was less than 1%. Sorption of DEHP to different particle size fractions in sewage was studied by serial membrane filtration. Most of the DEHP (71-84%) was attached to the particles 0.1-41 µm in size, and approximately 10-27% of the DEHP was sorbed on particles larger than 41 µm. Less than 6% of the DEHP was in the fraction below 0.1 µm and readily available for microbial degradation.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, Tritonet Ltd., Department of Biological Science

Contributors: Marttinen, S. K., Kettunen, R. H., Rintala, J. A.

Number of pages: 12

Pages: 1-12

Publication date: 1 Jan 2003

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 301

Issue number: 1-3

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2003): SJR 1.156 SNIP 1.324

Original language: English  
ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all)  
Keywords: DEHP, Leachate, Organic compounds, Particle size distribution, Sewage, Treatment  
Source: Scopus  
Source ID: 2242462211  
Research output: Contribution to journal > Article > Scientific > peer-review

### **Screening of physical-chemical methods for removal of organic material, nitrogen and toxicity from low strength landfill leachates**

Physical-chemical methods have been suggested for the treatment of low strength municipal landfill leachates. Therefore, applicability of nanofiltration and air stripping were screened in laboratory-scale for the removal of organic matter, ammonia, and toxicity from low strength leachates ( $\text{NH}_4\text{-N}$  74-220 mg/l, chemical oxygen demand (COD) 190-920 mg  $\text{O}_2$  /l,  $\text{EC}_{50}$  = 2-17% for *Raphidocelis subcapitata*). Ozonation was studied as well, but with the emphasis on enhancing biodegradability of leachates. Nanofiltration (25 °C) removed 52-66% of COD and 27-50% of ammonia, the latter indicating that ammonia may in part have been present as ammonium salt complexes. Biological pretreatment enhanced the overall COD removal. Air stripping (24 h at pH 11) resulted in 89% and 64% ammonia removal at 20 and 6 °C, respectively, the stripping rate remaining below 10 mg N/lh. COD removals of 4-21% were obtained in stripping. Ozonation (20 °C) increased the concentration of rapidly biodegradable COD (RBCOD), but the proportion of RBCOD of total COD was still below 20%, indicating poor biological treatability. The effect of the different treatments on leachate toxicity was assessed with the *Daphnia* acute toxicity test (*Daphnia magna*) and algal growth inhibition test (*Raphidocelis subcapitata*). None of the methods was effective in toxicity removal. By way of comparison, treatment in a full-scale biological plant decreased leachate toxicity to half of the initial value. Although leachate toxicity significantly correlated with COD and ammonia in untreated and treated leachate, in some stripping and ozonation experiments toxicity was increased in spite of COD and ammonia removals.

#### **General information**

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Jyväskylän yliopisto, Tritonet Ltd., Biomark, University of Jyväskylä  
Contributors: Marttinen, S. K., Kettunen, R. H., Sormunen, K. M., Soimasuo, R. M., Rintala, J. A.  
Number of pages: 8  
Pages: 851-858  
Publication date: 2002  
Peer-reviewed: Yes

#### **Publication information**

Journal: Chemosphere  
Volume: 46  
Issue number: 6  
ISSN (Print): 0045-6535  
Ratings:  
Scopus rating (2002): SJR 0.911 SNIP 1.053  
Original language: English  
ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all)  
Keywords: Leachate treatment, Nanofiltration, Ozonation, Stripping, Toxicity  
DOIs:  
10.1016/S0045-6535(01)00150-3  
Source: Scopus  
Source ID: 0036170223  
Research output: Contribution to journal > Article > Scientific > peer-review

### **Removal of DEHP in composting and aeration of sewage sludge**

The potential of composting and aeration to remove bis(2-ethylhexyl) phthalate (DEHP) from municipal sewage sludge was studied with two dewatered sludges: raw sludge and anaerobically digested sludge. Composting removed 58% of the DEHP content of the raw sludge and 34% of that of the anaerobically digested sludge during 85 days stabilisation in compost bins. A similar removal for the anaerobically digested sludge was achieved in a rotary drum in 28 days. Less than 1% of DEHP was removed with the compost leachate. Although DEHP removal was greater from raw sludge compost than anaerobically digested sludge compost, the total and volatile solids removals were on the same level in the two composts. In the aeration of raw sludge at 20 °C the DEHP removals were 33-41% and 50-62% in 7 and 28 days, respectively. Both composting and aeration are concluded to have the potential to reduce the DEHP contents typically found in sewage sludges to levels acceptable for agricultural use.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed  
Organisations: Jyväskylän yliopisto, University of Jyväskylä  
Contributors: Marttinen, S. K., Hänninen, K., Rintala, J. A.  
Number of pages: 8  
Pages: 265-272  
Publication date: Jan 2004  
Peer-reviewed: Yes

#### Publication information

Journal: Chemosphere  
Volume: 54  
Issue number: 3  
ISSN (Print): 0045-6535  
Ratings:

Scopus rating (2004): SJR 1.627 SNIP 1.471

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all)

Keywords: Aeration, Bis(2-ethylhexyl) phthalate, Composting, Sewage sludge, Stabilisation

DOIs:

10.1016/S0045-6535(03)00661-1

Source: Scopus

Source ID: 0347415694

Research output: Contribution to journal > Article > Scientific > peer-review

#### Release and characteristics of fungal fragments in various conditions

Intact spores and submicrometer size fragments are released from moldy building materials during growth and sporulation. It is unclear whether all fragments originate from fungal growth or if small pieces of building materials are also aerosolized as a result of microbial decomposition. In addition, particles may be formed through nucleation from secondary metabolites of fungi, such as microbial volatile organic compounds (MVOCs). In this study, we used the elemental composition of particles to characterize the origin of submicrometer fragments released from materials contaminated by fungi. Particles from three fungal species (*Aspergillus versicolor*, *Cladosporium cladosporioides* and *Penicillium brevicompactum*), grown on agar, wood and gypsum board were aerosolized using the Fungal Spore Source Strength Tester (FSSST) at three air velocities (5, 16 and 27 m/s). Released spores (optical size,  $d_p \geq 0.8 \mu\text{m}$ ) and fragments ( $d_p \leq 0.8 \mu\text{m}$ ) were counted using direct-reading optical aerosol instruments. Particles were also collected on filters, and their morphology and elemental composition analyzed using scanning electron microscopes (SEMs) coupled with an Energy-Dispersive X-ray spectroscopy (EDX). Among the studied factors, air velocity resulted in the most consistent trends in the release of fungal particles. Total concentrations of both fragments and spores increased with an increase in air velocity for all species whereas fragment-spore (F/S) ratios decreased. EDX analysis showed common elements, such as C, O, Mg and Ca, for blank material samples and fungal growth. However, N and P were exclusive to the fungal growth, and therefore were used to differentiate biological fragments from non-biological ones. Our results indicated that majority of fragments contained N and P. Because we observed increased release of fragments with increased air velocities, nucleation of MVOCs was likely not a relevant process in the formation of fungal fragments. Based on elemental composition, most fragments originated from fungi, but also fragments from growth material were detected.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research area: Aerosol Physics, Research area: Optics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Department of Environmental Science, University of Eastern Finland, Itä-Suomen yliopisto, SIB Labs, Department of Environmental Health, University of Cincinnati

Contributors: Mensah-Attipoe, J., Saari, S., Veijalainen, A. M., Pasanen, P., Keskinen, J., Leskinen, J. T. T., Reponen, T.

Number of pages: 10  
Pages: 234-243

Publication date: 15 Mar 2016  
Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 547

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2016): CiteScore 6.9 SJR 1.652 SNIP 1.869

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution, Waste Management and Disposal, Environmental Engineering

Keywords: Air velocity, Elemental analysis, Energy Dispersive X-ray spectroscopy, Fragments, Scanning electron microscope

DOIs:

10.1016/j.scitotenv.2015.12.095

Source: Scopus

Source ID: 84953924447

Research output: Contribution to journal > Article > Scientific > peer-review

### **Hierarchical Self-Assembly of Halogen-Bonded Block Copolymer Complexes into Upright Cylindrical Domains**

Self-assembly of block copolymers into well-defined, ordered arrangements of chemically distinct domains is a reliable strategy for preparing tailored nanostructures. Microphase separation results from the system, minimizing repulsive interactions between dissimilar blocks and maximizing attractive interactions between similar blocks. Supramolecular methods have also achieved this separation by introducing small-molecule additives binding specifically to one block by noncovalent interactions. Here, we use halogen bonding as a supramolecular tool that directs the hierarchical self-assembly of low-molecular-weight perfluorinated molecules and diblock copolymers. Microphase separation results in a lamellar-within-cylindrical arrangement and promotes upright cylindrical alignment in films upon rapid casting and without further annealing. Such cylindrical domains with internal lamellar self-assemblies can be cleaved by solvent treatment of bulk films, resulting in separated and segmented cylindrical micelles stabilized by halogen-bond-based supramolecular crosslinks. These features, alongside the reversible nature of halogen bonding, provide a robust modular approach for nanofabrication.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Supramolecular photochemistry, VTT Technical Research Centre of Finland, Aalto University, Politecnico di Milano, Italian Institute of Technology, Università del Salento

Contributors: Milani, R., Houbenov, N., Fernandez-Palacio, F., Cavallo, G., Luzio, A., Haataja, J., Giancane, G., Saccone, M., Priimägi, A., Metrangolo, P., Ikkala, O.

Number of pages: 10

Pages: 417-426

Publication date: 9 Mar 2017

Peer-reviewed: Yes

#### **Publication information**

Journal: CheM

Volume: 2

Issue number: 3

ISSN (Print): 2451-9294

Ratings:

Scopus rating (2017): CiteScore 6.7 SJR 5.295 SNIP 2.265

Original language: English

ASJC Scopus subject areas: Chemistry(all), Chemical Engineering(all), Biochemistry, Environmental Chemistry, Materials Chemistry, Biochemistry, medical

Keywords: block copolymers, halogen bond, hierarchical self-assembly, nanofabrication, supramolecular complexes

Electronic versions:

Hierarchical Self-Assembly of Halogen-Bonded Block Copolymer Complexes into Upright Cylindrical Domains

DOIs:

10.1016/j.chempr.2017.02.003

URLs:

<http://urn.fi/URN:NBN:fi:tty-201703281227>

Source: Scopus

Source ID: 85014778403

Research output: Contribution to journal > Article > Scientific > peer-review

### **Influence of electron acceptor availability and microbial community structure on sedimentary methane oxidation in a boreal estuary**

Methane is produced microbially in vast quantities in sediments throughout the world's oceans. However, anaerobic oxidation of methane (AOM) provides a near-quantitative sink for the produced methane and is primarily responsible for preventing methane emissions from the oceans to the atmosphere. AOM is a complex microbial process that involves several different microbial groups and metabolic pathways. The role of different electron acceptors in AOM has been studied for decades, yet large uncertainties remain, especially in terms of understanding the processes in natural settings. This study reports whole-core incubation methane oxidation rates along an estuarine gradient ranging from near fresh water to brackish conditions, and investigates the potential role of different electron acceptors in AOM. Microbial community structure involved in different methane processes is also studied in the same estuarine system using high throughput sequencing tools. Methane oxidation in the sediments was active in three distinct depth layers throughout the

studied transect, with total oxidation rates increasing seawards. We find extensive evidence of non-sulphate AOM throughout the transect. The highest absolute AOM rates were observed below the sulphate-methane transition zone (SMTZ), strongly implicating the role of alternative electron acceptors (most likely iron and manganese oxides). However, oxidation rates were ultimately limited by methane availability. ANME-2a/b were the most abundant microbial phyla associated with AOM throughout the study sites, followed by ANME-2d in much lower abundances. Similarly to oxidation rates, highest abundances of microbial groups commonly associated with AOM were found well below the SMTZ, further reinforcing the importance of non-sulphate AOM in this system.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, University of Helsinki

Contributors: Myllykangas, J. P., Rissanen, A. J., Hietanen, S., Jilbert, T.

Number of pages: 19

Pages: 291-309

Publication date: 2020

Peer-reviewed: Yes

#### Publication information

Journal: BIOGEOCHEMISTRY

Volume: 148

Issue number: 3

ISSN (Print): 0168-2563

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Water Science and Technology, Earth-Surface Processes

Keywords: 16S rRNA gene, Baltic sea, High throughput sequencing, Methanotrophy, Radiotracer incubation

Electronic versions:

Influence of electron acceptor availability 2020

DOIs:

10.1007/s10533-020-00660-z

URLs:

<http://urn.fi/URN:NBN:fi:tuni-202006256222>

Source: Scopus

Source ID: 85083359457

Research output: Contribution to journal > Article > Scientific > peer-review

#### Stable carbon isotopic composition of peat columns, subsoil and vegetation on natural and forestry-drained boreal peatlands

We studied natural and forestry-drained peatlands to examine the effect of over 34 years lowered water table on the  $\delta^{13}\text{C}$  values of vegetation, bulk peat and subsoil. In the seven studied sites,  $\delta^{13}\text{C}$  in the basal peat layer was 1.1 and 1.2 ‰ lower than that of the middle-layer and surface layer, respectively. Furthermore, there was a positive correlation between the  $\delta^{13}\text{C}$  values of the basal and surface peat layers, possibly due to carbon (C) recycling within the peat column. In the same mire complex, natural fen peat  $\delta^{13}\text{C}$  values were lower than those of the nearby bog, possibly due to the dominance of vascular plants on fen and the generally larger share of recycled C in the fens than in the bogs. Furthermore, natural and 51 years previously drained fen and bog, on the opposite sides of a ditch on the same mire complex, showed no significant differences in  $\delta^{13}\text{C}$  values. Plant  $\delta^{13}\text{C}$  values were lower, while  $\delta^{13}\text{C}$  values of subsoil were higher in the drained than in the natural site of the fen.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, University of Eastern Finland, University of Jyväskylä

Contributors: Nykänen, H., Mpamah, P. A., Rissanen, A. J.

Publication date: 2018

Peer-reviewed: Yes

Early online date: 2018

#### Publication information

Journal: Isotopes in Environmental and Health Studies

Volume: 54

Issue number: 6

ISSN (Print): 1025-6016

Ratings:

Scopus rating (2018): CiteScore 2.9 SJR 0.666 SNIP 0.804

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all), Inorganic Chemistry

Keywords: Biogeochemistry, bog, carbon cycle, carbon dioxide, carbon-13, diagenesis, drainage, fen, isotope ecology, Sphagnum, Suess effect

Electronic versions:

stable\_carbon\_isotopic\_composition\_2018

DOIs:

10.1080/10256016.2018.1523158

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201910234043>

Source: Scopus

Source ID: 85053893057

Research output: Contribution to journal > Article > Scientific > peer-review

### **High-solids anaerobic digestion requires a trade-off between total solids, inoculum-to-substrate ratio and ammonia inhibition**

Increasing total solids in anaerobic digestion can reduce the methane yield by highly complex bio-physical-chemical mechanisms. Therefore, understanding those mechanisms and their main drivers becomes crucial to optimize this waste treatment biotechnology. In this study, seven batch experiments were conducted to investigate the effects of increasing the initial total solids in high-solids anaerobic digestion of the organic fraction of municipal solid waste. With inoculum-to-substrate ratio = 1.5 g VS/g VS and maximum total solids  $\leq$  19.6%, mono-digestion of the organic fraction of municipal solid waste showed a methane yield = 174–236 NmL CH<sub>4</sub>/g VS. With inoculum-to-substrate ratio  $\leq$  1.0 g VS/g VS and maximum total solids  $\geq$  24.0%, mono-digestion experiments acidified. Co-digestion of the organic fraction of municipal solid waste and beech sawdust permitted to reduce the inoculum-to-substrate ratio to 0.16 g VS/g VS while increasing total solids up to 30.2%, though achieving a lower methane yield (117–156 NmL CH<sub>4</sub>/g VS). At each inoculum-to-substrate ratio, higher total solids corresponded to higher ammonia and volatile fatty acid accumulation. Thus, a 40% lower methane yield for mono-digestion was observed at a NH<sub>3</sub> concentration  $\geq$  2.3 g N-NH<sub>3</sub>/kg reactor content and total solids = 15.0%. Meanwhile, co-digestion lowered the nitrogen content, being the risk of acidification exacerbated only at total solids  $\geq$  20.0%. Therefore, the biodegradability of the substrate, as well as the operational total solids and inoculum-to-substrate ratio, are closely interrelated parameters determining the success of methanogenesis, but also the risk of ammonia inhibition in high-solids anaerobic digestion.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Department of Civil and Mechanical Engineering, University of Cassino and Southern Lazio, LBE, INRA, ENEA/CREATE/Università Degli Studi Napoli Federico II

Contributors: Pastor-Poquet, V., Papirio, S., Trably, E., Rintala, J., Escudié, R., Esposito, G.

Publication date: 2019

Peer-reviewed: Yes

#### **Publication information**

Journal: INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND TECHNOLOGY

ISSN (Print): 1735-1472

Ratings:

Scopus rating (2019): CiteScore 2.9 SJR 0.518 SNIP 1.016

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Agricultural and Biological Sciences(all)

Keywords: Batch experiments, Co-digestion, High-solids anaerobic digestion, Methane yield, Organic fraction of municipal solid waste, Thermophilic, Volatile fatty acids

DOIs:

10.1007/s13762-019-02264-z

Source: Scopus

Source ID: 85061488051

Research output: Contribution to journal > Article > Scientific > peer-review

### **Improving the signal-to-noise ratio of Faraday cup aerosol electrometer based aerosol instrument calibrations**

This study introduces a new bipolar measurement routine for particle number concentration calibrations. In the new routine, singly-charged particles of opposite polarities are measured sequentially with a Faraday cup aerosol electrometer (FCAE). We compared the bipolar routine to the traditional FCAE routine, where particle signal and electrometer offset are measured in turns, by calibrating a single CPC on a wide particle number concentration range (from 1000 to 77,000 cm<sup>-3</sup>) with both routines. By increasing the signal-to-noise ratio, the bipolar routine decreases the type A uncertainty of the calibration especially at low particle concentrations. In practice, the new routine enables shortening the measurement times by 80% at the lowest particle concentrations which, in practice, corresponds to hours.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Physics, Research area: Aerosol Physics, Aerosol Physics Laboratory  
Contributors: Pihlava, K., Keskinen, J., Yli-Ojanperä, J.  
Number of pages: 7  
Pages: 373-379  
Publication date: 2 Apr 2016  
Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology  
Volume: 50  
Issue number: 4  
ISSN (Print): 0278-6826  
Ratings:  
Scopus rating (2016): CiteScore 3.7 SJR 0.992 SNIP 0.901  
Original language: English  
ASJC Scopus subject areas: Materials Science(all), Environmental Chemistry, Pollution  
DOIs:  
10.1080/02786826.2016.1153035  
Source: Scopus  
Source ID: 84962883045  
Research output: Contribution to journal > Article > Scientific > peer-review

### Effects of fresh lubricant oils on particle emissions emitted by a modern gasoline direct injection passenger car

Particle emissions from a modern turbocharged gasoline direct injection passenger car equipped with a three-way catalyst and an exhaust gas recirculation system were studied while the vehicle was running on low-sulfur gasoline and, consecutively, with five different lubrication oils. Exhaust particle number concentration, size distribution, and volatility were determined both at laboratory and on-road conditions. The results indicated that the choice of lubricant affected particle emissions both during the cold start and warm driving cycles. However, the contribution of engine oil depended on driving conditions being higher during acceleration and steady state driving than during deceleration. The highest emission factors were found with two oils that had the highest metal content. The results indicate that a 10% decrease in the Zn content of engine oils is linked with an 11-13% decrease to the nonvolatile particle number emissions in steady driving conditions and a 5% decrease over the New European Driving Cycle. The effect of lubricant on volatile particles was even higher, on the order of 20%.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Physics, Research area: Aerosol Physics, Urban circular bioeconomy (UrCirBio), Helsinki University, Aristotle University of Thessaloniki, Department of Informatics, Metropolia University of Applied Sciences, Laboratory of Applied Thermodynamics, Neste Oil Oyj  
Contributors: Pirjola, L., Karjalainen, P., Heikkilä, J., Saari, S., Tzamkiozis, T., Ntziachristos, L., Kulmala, K., Keskinen, J., Rönkkö, T.  
Number of pages: 9  
Pages: 3644-3652  
Publication date: 17 Mar 2015  
Peer-reviewed: Yes

### Publication information

Journal: Environmental Science and Technology  
Volume: 49  
Issue number: 6  
ISSN (Print): 0013-936X  
Ratings:  
Scopus rating (2015): CiteScore 9.5 SJR 2.546 SNIP 1.835  
Original language: English  
ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry  
DOIs:  
10.1021/es505109u  
URLs:  
<http://www.scopus.com/inward/record.url?scp=84924939595&partnerID=8YFLogxK> (Link to publication in Scopus)

### Bibliographical note

EXT="Ntziachristos, Leonidas"

Source: Scopus

Source ID: 84924939595

Research output: Contribution to journal › Article › Scientific › peer-review

### Physical and Chemical Characterization of Real-World Particle Number and Mass Emissions from City Buses in Finland

Exhaust emissions of 23 individual city buses at Euro III, Euro IV and EEV (Enhanced Environmentally Friendly Vehicle) emission levels were measured by the chasing method under real-world conditions at a depot area and on the normal route of bus line 24 in Helsinki. The buses represented different technologies from the viewpoint of engines, exhaust after-treatment systems (ATS) and fuels. Some of the EEV buses were fueled by diesel, diesel-electric, ethanol (RED95) and compressed natural gas (CNG). At the depot area the emission factors were in the range of  $0.3\text{--}21 \times 10^{14} \text{ # (kg fuel)}^{-1}$ ,  $6\text{--}40 \text{ g (kg fuel)}^{-1}$ ,  $0.004\text{--}0.88 \text{ g (kg fuel)}^{-1}$ ,  $0.004\text{--}0.56 \text{ g (kg fuel)}^{-1}$ ,  $0.01\text{--}1.2 \text{ g (kg fuel)}^{-1}$ , for particle number ( $EF_N$ ), nitrogen oxides ( $EF_{NO_x}$ ), black carbon ( $EF_{BC}$ ), organics ( $EF_{Org}$ ), and particle mass ( $EF_{PM_{10}}$ ), respectively. The highest particulate emissions were observed from the Euro III and Euro IV buses and the lowest from the ethanol and CNG-fueled buses, which emitted BC only during acceleration. The organics emitted from the CNG-fueled buses were clearly less oxidized compared to the other bus types. The bus line experiments showed that lowest emissions were obtained from the ethanol-fueled buses whereas large variation existed between individual buses of the same type indicating that the operating conditions by drivers had large effect on the emissions.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, University of Helsinki, Univerzita v Liberci, Finnish Meteorological Institute, Aerosol Physics Laboratory, Helsinki Region Environmental Services Authority (HSY)

Contributors: Pirjola, L., Dittrich, A., Niemi, J. V., Saarikoski, S., Timonen, H., Kuuluvainen, H., Järvinen, A., Kousa, A., Rönkkö, T., Hillamo, R.

Number of pages: 11

Pages: 294-304

Publication date: 5 Jan 2016

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 50

Issue number: 1

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2016): CiteScore 10.6 SJR 2.559 SNIP 1.923

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

DOIs:

10.1021/acs.est.5b04105

Source: Scopus

Source ID: 84953432299

Research output: Contribution to journal › Article › Scientific › peer-review

### Nanocluster Aerosol Emissions of a 3D Printer

Many studies exist that characterize the aerosol emissions from fused filament fabrication three-dimensional (3D) printers. However, nanocluster aerosol (NCA) particles, that is particles in a size range under 3 nm, are rarely studied. The purpose of this study was to characterize the NCA emissions and the contribution of NCA to the total particle number emissions from a 3D printer. We used a particle size magnifier and a scanning mobility particle sizer to measure the time evolution of particle size distribution, which was used to calculate the average NCA emission rates during a printer operation in a chamber. The NCA emission rates ranged from  $1.4 \times 10^6$  to  $7.3 \times 10^9 \text{ s}^{-1}$  depending on the applied combination of filament material and nozzle temperature, showing increasing emission with increasing temperature. The NCA emissions constitute from 9 to 48% of the total emissions, that is, almost half of the particle emissions may have been previously neglected. Therefore, it is essential to include the low NCA size range in, for example, future 3D-printer-testing protocols, emission measurement standards, and risk management measures.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics, Tampere University, Aerosol Physics Laboratory

Contributors: Poikkimäki, M., Koljonen, V., Leskinen, N., Närhi, M., Kangasniemi, O., Kausiala, O., Dal Maso, M.

Number of pages: 11  
Pages: 13618–13628  
Publication date: 7 Nov 2019  
Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 53

Issue number: 23

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2019): CiteScore 12.6 SJR 2.704 SNIP 2.06

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

Electronic versions:

Nanocluster Aerosol Emissions of a 3D Printer 2019. Embargo ended: 7/11/20

DOIs:

10.1021/acs.est.9b05317

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201912317151>. Embargo ended: 7/11/20

#### Bibliographical note

INT=phys,"Leskinen, Niko"

INT=phys,"Kausiala, Oskari"

Source: Scopus

Source ID: 85075430658

Research output: Contribution to journal › Article › Scientific › peer-review

#### Breaking dormancy: An energy-efficient means of recovering astaxanthin from microalgae

*Haematococcus pluvialis*, in the dormant aplanospore (cyst) status after 30 d of cultivation, accumulates high levels of a superpotent antioxidant, astaxanthin, which has been demonstrated to have enormous therapeutic benefits. However, owing to the robust structure of its trilayered cell wall, the recovery of astaxanthin from the cyst cells remains an energy-intensive process. In the present study, a novel strategy utilizing a short-period germination based on the natural life cycle of *H. pluvialis* was developed as an energy-efficient pretreatment for the extraction of astaxanthin using ionic liquids (ILs) as green solvents. The germination resulted in damage and deconstruction of the cyst cell wall, and thereby facilitated the extraction of astaxanthin by ILs at room temperature. By this natural pretreatment with 1-ethyl-3-methylimidazolium ethylsulfate for a very short reaction time of 1 min, a high astaxanthin yield of 19.5 pg per cell was obtained, which was about 82% of a conventional volatile organic solvent extraction by strong, 30 000 psi French-pressure-cell homogenization. The maximal astaxanthin-extraction yield from *H. pluvialis* cells was observed for 12–18 h germination. The germination rate furthermore could be improved by manipulating the nutritional composition (especially the nitrate concentration) of the culture medium. In light of these results, it can be posited that natural germination following the principles of green chemistry can be a uniquely simple method of robust microalgal cyst cell pretreatment and extraction of astaxanthin with room-temperature ILs.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), Biomass and Waste Energy Laboratory, Korea Institute of Energy Research (KIER), Korea Institute of Energy Research

Contributors: Ramasamy, P., Lee, K., Lee, J., Oh, Y. K.

Number of pages: 9

Pages: 1226–1234

Publication date: 1 Feb 2015

Peer-reviewed: Yes

#### Publication information

Journal: Green Chemistry

Volume: 17

Issue number: 2

ISSN (Print): 1463-9262

Ratings:

Scopus rating (2015): CiteScore 12.8 SJR 2.452 SNIP 1.901

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

DOIs:

10.1039/c4gc01413h

URLs:

<http://www.scopus.com/inward/record.url?scp=84922794041&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84922794041

Research output: Contribution to journal › Article › Scientific › peer-review

### Flow rate-independent electrical aerosol sensor

A new diffusion charging-based aerosol instrument design is presented, intended to be a starting point for a low-cost particle concentration sensor. The aim in the design is to minimize instrument response dependence on the sample flow rate. The operation principle, response functions of the components, and performance of a prototype instrument are reported. Based on the performance evaluation, the instrument response remained constant within  $\pm 15\%$  over a wide sample flow rate range of 3 to 10 lpm. While in the design some sensitivity is sacrificed to minimize flow rate dependency, the detection limit is still sufficient for a practical sensor application.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research area: Aerosol Physics, Physics

Contributors: Rostedt, A., Keskinen, J.

Pages: 1283-1292

Publication date: 2018

Peer-reviewed: Yes

Early online date: 2018

### Publication information

Journal: Aerosol Science and Technology

Volume: 52

Issue number: 11

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2018): CiteScore 3.8 SJR 0.786 SNIP 0.995

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Jingkun Jiang

Electronic versions:

[flow\\_rate\\_independent\\_electrical\\_aerosol\\_2018](#)

DOIs:

[10.1080/02786826.2018.1498586](https://doi.org/10.1080/02786826.2018.1498586)

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201910234052>

Source: Scopus

Source ID: 85052286150

Research output: Contribution to journal › Article › Scientific › peer-review

### Seasonal and diurnal variations of fluorescent bioaerosol concentration and size distribution in the urban environment

A recently introduced fluorescence based real-time bioaerosol instrument, BioScout, and an ultraviolet aerodynamic particle sizer (UVAPS) were used to study fluorescent bioaerosol particles (FBAP) in the Helsinki metropolitan area, Finland, during winter and summer. Two FBAP modes at 0.5–1.5  $\mu\text{m}$  (fine) and 1.5–5  $\mu\text{m}$  (coarse) were detected during the summer, whereas the fine mode dominated in the winter. The concentration and proportion of the coarse FBAP was high in summer ( $0.028 \text{ \#}/\text{cm}^3$ , 23%) and low in winter ( $0.010 \text{ \#}/\text{cm}^3$ , 6%). Snow cover and low biological activity were assumed to be the main reasons for the low coarse FBAP concentration in the wintertime. Both the fine and the coarse FBAP fraction typically increased at nighttime during the summer. Correlations between the BioScout and the UVAPS were high with the coarse ( $R = 0.83$ ) and fine ( $R = 0.92$ ) FBAP. The BioScout showed 2.6 and 9.7 times higher detection efficiencies for the coarse and fine FBAP, respectively, compared to the UVAPS. A long-range transport episode of particles from Eastern Europe increased the fine FBAP concentration by over two orders of magnitude compared to the clean period in the winter, but these FBAP probably also included fluorescent non-biological particles. Correlation analysis indicates that local combustion sources did not generate fluorescent non-biological particles that can disturb fine FBAP counting. The results provide information that can be used to estimate health risks and climatic relevance of bioaerosols in the urban environment.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Urban circular bioeconomy (UrCirBio), Helsinki University, Helsinki Region Environmental Services Authority (HSY), Department of Environmental Sciences, Metropolia University of Applied Science, Atmospheric Composition Research, Finnish Meteorological Institute

Contributors: Saari, S., Niemi, J. V., Rönkkö, T., Kuuluvainen, H., Järvinen, A., Pirjola, L., Aurela, M., Hillamo, R., Keskinen, J.

Number of pages: 10

Pages: 572-581

Publication date: 2015

Peer-reviewed: Yes

### Publication information

Journal: Aerosol and Air Quality Research

Volume: 15

Issue number: 2

ISSN (Print): 1680-8584

Ratings:

Scopus rating (2015): CiteScore 3.9 SJR 1.002 SNIP 1.143

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

Keywords: Bacteria, BioScout, Fluorescence, Fungal spores, UVAPS

DOIs:

10.4209/aaqr.2014.10.0258

URLs:

<http://www.scopus.com/inward/record.url?scp=84925957527&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84925957527

Research output: Contribution to journal › Article › Scientific › peer-review

### Identification of single microbial particles using electro-dynamic balance assisted laser-induced breakdown and fluorescence spectroscopy

Online characterization of fungal and bacterial spores is important in various applications due to their health and climatic relevance. The aim of this study was to demonstrate the capability of the combination of electro-dynamic balance assisted laser-induced breakdown spectroscopy (LIBS) and laser-induced fluorescence (LIF) techniques for the online detection of single fungal spores (*Aspergillus versicolor* and *Penicillium brevicompactum*) and bacteria (*Bacillus aureus*). The method enabled sensitive and repeatable LIBS analysis of common elemental components (Ca, Na, and K) from single microbial particles for the first time. Significant differences in the concentrations of these elements were observed between the species, e.g., bacterial spores had over three orders of magnitude higher Ca concentration ( $2 \times 10^{-12}$  g/particle) compared to fungal spores ( $3-5 \times 10^{-16}$  g/particle). The LIF analysis has previously been used to distinguish bioaerosols from other aerosols due to their fluorescence ability. This study showed that combination of LIF and LIBS analysis is a promising tool for identification of different bioaerosol particle types.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Physics, Research area: Aerosol Physics, Research area: Optics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Department of Environmental Science, Ita-Suomen yliopisto, Department of Environmental Health, University of Cincinnati

Contributors: Saari, S., Järvinen, S., Reponen, T., Mensah-Attipoe, J., Pasanen, P., Toivonen, J., Keskinen, J.

Number of pages: 7

Pages: 126-132

Publication date: 1 Feb 2016

Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology

Volume: 50

Issue number: 2

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2016): CiteScore 3.7 SJR 0.992 SNIP 0.901

Original language: English

ASJC Scopus subject areas: Materials Science(all), Environmental Chemistry, Pollution

DOIs:

10.1080/02786826.2015.1134764

Source: Scopus

Source ID: 84958169635

Research output: Contribution to journal › Article › Scientific › peer-review

### Performance evaluation of the HR-ELPI + inversion

Data inversion methods used in aerosol measurement instruments have significant influence on the resolution and quality of the result. A freshly launched new electrical low pressure impactor (ELPI) instrument version, high resolution ELPI+ (HR-ELPI+, Dekati Ltd.), uses an iterative inversion calculation method to improve particle size resolution, concentration, and data analysis quality. In this article, the performance of the HR-ELPI + is critically analyzed by simulations and experiments in laboratory and field conditions, and the results are compared with a conventional inversion data analysis method (cut-point diameter concept) and with common reference instruments (e.g., SMPS and EEPS). The results showed that the HR-ELPI + inversion has limited performance at the lower and upper limits of the instrument's size range, and can suffer if the raw currents have signal dependent noise more than 50% or electric noise more than 1%. However, the HR-ELPI + clearly provide remarkably better resolution and quality with low oscillation risk compared to the conventional cut-point diameter concept of the ELPI. The HR-ELPI + also showed generally very similar size distributions and number concentrations compared to the reference instruments.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics

Contributors: Saari, S., Arffman, A., Harra, J., Rönkkö, T., Keskinen, J.

Number of pages: 11

Pages: 1037-1047

Publication date: 2 Sep 2018

Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology

Volume: 52

Issue number: 9

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2018): CiteScore 3.8 SJR 0.786 SNIP 0.995

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

Keywords: Pramod Kulkarni

DOIs:

10.1080/02786826.2018.1500679

Source: Scopus

Source ID: 85052142628

Research output: Contribution to journal › Article › Scientific › peer-review

### Assessment of pitting corrosion in bare and passivated (wet scCO<sub>2</sub>-induced patination and chemical passivation) hot-dip galvanized steel samples with SVET, FTIR, and SEM (EDS)

In this study, the local electrochemical activity of untreated and passivated (natural or chemical passivation) zinc specimens was observed during immersion in a 0.1-M NaCl solution. The localized anodic activity during the exposure, measured with the scanning vibrating electrode technique, was linked to zinc dissolution by the pitting corrosion mechanism. It was correlated to specific corrosion products characterized by Fourier transmission infrared (FTIR) microscopy. FTIR molecule maps were produced from individual pitting corrosion sites (100–200 μm in width). With argon ion beam milling and latest energy-dispersive X-ray spectroscopy (EDS) technology, element maps with a high spatial resolution (<<100 nm) were recorded from abrasion- and beam-sensitive corrosion products, showing a residual layer structure. This study demonstrates the capability of FTIR mapping, cross-section polishing, and state-of-the-art scanning electron microscopy imaging, and EDS element mapping to produce high-resolution elemental, molecular, and visual information about pitting corrosion mechanisms on a hot-dip galvanized steel sample.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Research group: Ceramic materials, Top Analytica Oy, Swerim AB, RISE, SSAB

Contributors: Saarimaa, V., Fuertes, N., Persson, D., Zavalis, T., Kaleva, A., Nikkanen, J., Levänen, E., Heydari, G.

Number of pages: 10

Publication date: 2020

Peer-reviewed: Yes

### Publication information

Journal: Materials and Corrosion

ISSN (Print): 0947-5117

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Mechanics of Materials, Mechanical Engineering, Surfaces, Coatings and Films, Metals and Alloys, Materials Chemistry

Keywords: anodic dissolution, FTIR microscopy, passivation, pitting corrosion, scanning electron microscopy, zinc  
DOIs:

10.1002/maco.202011653

Source: Scopus

Source ID: 85084611702

Research output: Contribution to journal > Article > Scientific > peer-review

### Towards bioproduction of poly- $\alpha$ -olefins from lignocellulose

Bioprocesses involving more than one species can alleviate restrictions posed by limited substrate range of single species. Coupled, multistage cultures can be useful when heterogeneous substrates, such as lignocellulosic biomass, are exploited. Here, microbial production of  $\alpha$ -olefins (C11) from lignocellulosic substrates, namely cellulose and technical lignin, was investigated. A two-stage culture with cellulose fermentation to organic acids by *Clostridium cellulolyticum* and subsequent upgrading of the organic acids to 1-undecene by engineered *Acinetobacter baylyi* ADP1 was established. As a result, *A. baylyi* ADP1 synthesised 107  $\mu\text{g L}^{-1}$  of 1-undecene from cellulose. Additionally, ligninolytic effects by *A. baylyi* ADP1 on softwood were confirmed and downstream processing for continuous 1-undecene collection was introduced. In addition, the synthesis of poly- $\alpha$ -olefin trimers (C33) by the oligomerization of 1-undecene was demonstrated. This study demonstrates the potential of integrated multistage processes in treating challenging substrates.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Research group: Bio- and Circular Economy

Contributors: Salmela, M., Lehtinen, T., Efimova, E., Santala, S., Santala, V.

Number of pages: 10

Pages: 5067-5076

Publication date: 2020

Peer-reviewed: Yes

### Publication information

Journal: Green Chemistry

Volume: 22

Issue number: 15

ISSN (Print): 1463-9262

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

Electronic versions:

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DOIs:

10.1039/d0gc01617a

URLs:

<http://urn.fi/URN:NBN:fi:tuni-202008316780>

Source: Scopus

Source ID: 85089692039

Research output: Contribution to journal > Article > Scientific > peer-review

### Anaerobic digestion of poultry slaughtering wastes

The feasibility of anaerobic digestion of poultry slaughterhouse wastes combined with wastes from a food packing plant was studied using semi-continuously fed, laboratory-scale, continuously-stirred digesters at 35°C and 55°C. Furthermore, factors affecting anaerobic digestion were studied using batch assays with digested material from the digesters. In the mesophilic digester, inoculated with mesophilic digester sewage sludge, and with a loading of up to 4.6 g volatile solids (VS)  $\text{l}^{-1} \text{d}^{-1}$  (a hydraulic retention time (HRT) of 18 days), the specific methane yield was 330  $\text{ml g}^{-1}$  VS(added). Nitrogen in the feed was organic nitrogen with a slight amount of ammonium present, while ammonium nitrogen in the digested material accounted for 50 to 70% (up to 3.9  $\text{g l}^{-1}$ ) of total nitrogen. The total solids and VS removals were 58 and 68%, respectively. With the highest loading, however, methane production was apparently curtailed at the end of the study period, and sustainability of a long-term operation of the process remains to be proven. In contrast, under similar conditions the digesters inoculated with mesophilic and thermophilic granular sludge both failed after 40 to 50 days of

operation, their failure being due apparently to inhibition (unadapted inocula or overloading). The results show that up to 100 m<sup>3</sup> of methane can be produced from ton (wet weight) of the waste mixture studied. The process may be inhibited by ammonium nitrogen and some other inhibitory compounds, most likely long-chain fatty acids.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: University of Jyväskylä, Jyväskylän yliopisto  
Contributors: Salminen, E. A., Rintala, J. A.  
Number of pages: 8  
Pages: 21-28  
Publication date: 1999  
Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology  
Volume: 20  
Issue number: 1  
ISSN (Print): 0959-3330  
Ratings:  
Scopus rating (1999): SJR 0.624 SNIP 0.754  
Original language: English  
ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry  
Keywords: Ammonium nitrogen, Anaerobic digestion, Inhibition, Long-chain fatty acids, Poultry slaughtering waste  
URLs:  
<http://www.scopus.com/inward/record.url?scp=0033045309&partnerID=8YFLogxK> (Link to publication in Scopus)  
Source: Scopus  
Source ID: 0033045309  
Research output: Contribution to journal > Article > Scientific > peer-review

#### The methane production of poultry slaughtering residues and effects of pre-treatments on the methane production of poultry feather

The biological methane production rate and yield of different poultry slaughtering residues were studied. Poultry offal, blood, and bonemeal were rich in proteins and lipids and showed high methane yields, 0.7-0.9, 0.5, and 0.6-0.7 m<sup>3</sup> kg<sup>-1</sup> volatile solids<sub>added</sub>, respectively (270-340, 100, and 150-170 m<sup>3</sup> ton<sup>-1</sup> wet weight). Blood and bonemeal produced methane rapidly, whereas the methane production of offal was more delayed probably due to long-chain fatty acid inhibition. The length of delay dependent on the source and concentration of inoculum and incubation temperature, sewage sludge at 35 °C having the shortest delay of a few days, while granular sludge did not produce methane within 94 days of incubation. Feather showed a somewhat lower methane yield, 0.21 m<sup>3</sup> kg<sup>-1</sup> volatile solids<sub>added</sub> (50 m<sup>3</sup> ton<sup>-1</sup> wet weight). Combined thermal (120 °C, 5 min) and enzymatic (commercial alkaline endopeptidase, 2-10 g l<sup>-1</sup>) pre-treatments increased its methane yield by 37 to 51%. Thermal (70-120 °C, 5-60 min), chemical (NaOH 2-10 g l<sup>-1</sup>, 2-24 h), and enzymatic pre-treatments were less effective, with methane yield increasing by 5 to 32%. Based on the present results, anaerobic digestion of the studied of these residues (8 to 14% N of total solids), whereas pre-treatments were shown to improve the methane production of feather.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: University of Jyväskylä, Jyväskylän yliopisto  
Contributors: Salminen, E., Einola, J., Rintala, J.  
Number of pages: 8  
Pages: 1079-1086  
Publication date: 2003  
Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology  
Volume: 24  
Issue number: 9  
ISSN (Print): 0959-3330  
Ratings:  
Scopus rating (2003): SJR 0.545 SNIP 0.657  
Original language: English  
ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry  
Keywords: Anaerobic digestion, Feather, Methane production, Poultry slaughtering residues, Pre-treatment

DOIs:

10.1080/09593330309385648

Source: Scopus

Source ID: 0242694014

Research output: Contribution to journal › Article › Scientific › peer-review

### **Characterisation and anaerobic batch degradation of materials accumulating in anaerobic digesters treating poultry slaughterhouse waste**

We characterised materials accumulating in two failed mesophilic semi-continuous anaerobic digesters treating poultry slaughterhouse waste and, for reference, materials in the two well-performing digesters, to find the anaerobic degradability of these materials and the factors affecting their degradation. We also studied materials accumulating and stratifying in various layers in one of the two well-performing digesters. The material from the most severely failed digesters produced methane sluggishly and did not improve appreciably even with 33 percent dilution suggesting that the recovery of failed process is slow. The methane production was apparently affected by the accumulated long-chain fatty acids, totalling  $8.1 \text{ g l}^{-1}$ , which degraded slowly. However, the material produced methane in the end, which shows that the failure was reversible. In the well-performing digester, considerable amounts of long-chain fatty acids already floated on top of the digester after 20 hours without mixing, a phenomenon which may have affected their bioavailability and toxicity. However, materials from the top, middle, and bottom layers of the digester were readily and largely methanised by the microbial populations present in them and additional inocula did not markedly enhance the methanation. The results indicate that long-chain fatty acids are apparently the main factor affecting both the failure and recovery of a poultry slaughterhouse waste digester. Thus excessive feeding of lipids into the digester should be avoided.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: University of Jyväskylä, Jyväskylän yliopisto

Contributors: Salminen, E., Einola, J., Rintala, J.

Number of pages: 9

Pages: 577-585

Publication date: 2001

Peer-reviewed: Yes

#### **Publication information**

Journal: Environmental Technology

Volume: 22

Issue number: 5

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2001): SJR 0.579 SNIP 0.94

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Anaerobic degradation, Inhibition, Layer formation, Long-chain fatty acids, Poultry slaughterhouse waste

Source: Scopus

Source ID: 0034990767

Research output: Contribution to journal › Article › Scientific › peer-review

### **Emission measurements with gravimetric impactors and electrical devices: An aerosol instrument comparison**

Particulate matter in the atmosphere is known to affect Earth's climate and to be harmful to human health. Accurately measuring particles from emission sources is important, as the results are used to inform policies and climate models. This study compares the results of two ELPI+ devices, two PM10 cascade impactors and an eFilter, in combustion emission measurements. The comparison of the instruments in a realistic setting shows what types of challenges arise from measuring an emission aerosol with unknown particle morphologies and densities, different particle concentrations and high temperature. Our results show that the PM10 cascade impactors have very good intercorrelation when the collected mass is greater than  $150 \mu\text{g}$ , but below that, the uncertainty of the results increases with decreasing mass. The raw signals of two ELPI+ devices were nearly identical in most samples, as well as the particle number concentrations and size distributions calculated from raw signals; however, transforming the current distributions into mass distributions showed variation in the mass concentration of particles larger than  $1 \mu\text{m}$ . The real-time time signal measured by eFilter was similar to the total current measured by ELPI+. The eFilter and PM10 cascade impactors showed similar particle mass concentrations, whereas ELPI+ showed clearly higher ones in most cases. We concluded that the difference is at least partially due to volatile components being measured by ELPI+, but not by the mass collection measurements.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics, Estonian Environmental Research Centre, Dekati Ltd, Tallinn University of Technology, Finnish Meteorological Institute

Contributors: Salo, L., Mylläri, F., Maasikmets, M., Niemelä, V., Konist, A., Vainumäe, K., Kupri, H. L., Titova, R., Simonen, P., Aurela, M., Bloss, M., Keskinen, J., Timonen, H., Rönkkö, T.

Number of pages: 14

Pages: 526-539

Publication date: 1 Mar 2019

Peer-reviewed: Yes

### Publication information

Journal: Aerosol Science and Technology

Volume: 53

Issue number: 5

ISSN (Print): 0278-6826

Ratings:

Scopus rating (2019): CiteScore 4.4 SJR 0.811 SNIP 1.01

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Materials Science(all), Pollution

DOIs:

10.1080/02786826.2019.1578858

URLs:

<http://www.scopus.com/inward/record.url?scp=85062494308&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 85062494308

Research output: Contribution to journal › Article › Scientific › peer-review

### Why social sustainability counts: The impact of corporate social sustainability culture on financial success

Awareness is growing in European companies of the importance of managing all aspects of sustainability. However, the elusive social aspect of sustainability and its influence on successful business has been under-investigated in corporate culture literature so far. The aim of this paper is to examine whether a correlation can be found between corporate social sustainability culture (expressed as explicit "items" of corporate values and practices emphasizing employee and societal well-being) and the financial success of a company. This is examined through a multiple regression analysis of two contrasting European polls, examining items indicating corporate social sustainability culture, and financial outcomes. The empirical results show that four specific success-related social sustainability dimensions of corporate culture are predictors of a company being classified as financially successful. These are: Sustainability strategy and leadership; Mission, communication and learning; Social care and work life; and Loyalty and identification. The paper contributes to the understanding of how to manage corporate social sustainability culture whilst supporting companies' financial performance, and provides evidence-grounded recommendations to business managers and stakeholders aiming to manage social sustainability proactively by undertaking cultural change and development initiatives.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Mechanical Engineering and Industrial Systems, Deep White GmbH, Chalmers University of Technology, Politecnico di Milano, Festo AG & Co. KG, Panepistimion Patron

Contributors: Schönborn, G., Berlin, C., Pinzone, M., Hanisch, C., Georgoulas, K., Lanz, M.

Number of pages: 10

Pages: 1-10

Publication date: 1 Jan 2019

Peer-reviewed: Yes

### Publication information

Journal: Sustainable Production and Consumption

Volume: 17

ISSN (Print): 2352-5509

Ratings:

Scopus rating (2019): CiteScore 5.1 SJR 0.973 SNIP 1.307

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Renewable Energy, Sustainability and the Environment, Industrial and Manufacturing Engineering

Keywords: Corporate culture, Corporate sustainability, Financial performance, Social sustainability, Success factors, Sustainability

DOIs:

10.1016/j.spc.2018.08.008

Source: Scopus

Source ID: 85053411172

Research output: Contribution to journal › Article › Scientific › peer-review

### Tri-functionality of Fe<sub>3</sub>O<sub>4</sub>-embedded carbon microparticles in microalgae harvesting

Microalgae have received significant attention as promising resources for biodiesel. However, the downstream processes for the production of biodiesel, which range from cultivation, harvesting, dewatering, and lipid extraction to oil upgrading, are economically impracticable and can be improved. Therefore, efficient microalgal harvesting and integrated technologies are required to realize microalgae-based biodiesel. Herein, tri-functional (cationic, magnetic, and lipophilic) carbon microparticles filled with magnetite (Fe<sub>3</sub>O<sub>4</sub>) are synthesized through one-step aerosol spray pyrolysis and applied in microalgal harvesting and serial microalgal lipid entrapment. Carbon microparticles are tri-functional in the following respects: (i) the cationic carbon microparticles facilitate flocculation with anionic microalgae due to electrostatic attractions; (ii) the magnetic properties of the carbon microparticles, owing to embedded magnetites, enable the separation of microalgal flocs from low concentration cultures (~2g L<sup>-1</sup>) with a separation efficiency of 99%; and (iii) the lipophilicity enables the recovery of lipid droplets extracted from oleaginous microalgae. Microalgal lipids are directly separated through adsorption onto magnetic carbon microparticles from concentrated microalgal slurries after harvesting. The tri-functionality may facilitate the integrated use of magnetic carbon microparticles in microalgal biorefineries and the tri-functional microparticles could potentially be applied in various areas such as biomedicine, catalysis, magnetism, energy materials, and environmental remediation.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Urban circular bioeconomy (UrCirBio), KAIST, Korea Institute of Energy Research

Contributors: Seo, J. Y., Lee, K., Ramasamy, P., Kim, B., Lee, S. Y., Oh, Y. K., Park, S. B.

Number of pages: 9

Pages: 206-214

Publication date: 5 Nov 2015

Peer-reviewed: Yes

#### Publication information

Journal: Chemical Engineering Journal

Volume: 280

ISSN (Print): 1385-8947

Ratings:

Scopus rating (2015): CiteScore 8.6 SJR 1.676 SNIP 1.912

Original language: English

ASJC Scopus subject areas: Chemical Engineering(all), Chemistry(all), Industrial and Manufacturing Engineering, Environmental Chemistry

Keywords: Aerosol spray pyrolysis, Cationic functionality, Lipophilicity, Magnetic materials, Microalgae harvesting

DOIs:

10.1016/j.cej.2015.05.122

URLs:

<http://www.scopus.com/inward/record.url?scp=84933567826&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84933567826

Research output: Contribution to journal › Article › Scientific › peer-review

### Downstream integration of microalgae harvesting and cell disruption by means of cationic surfactant-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles

Microalgal biofuel, albeit an exciting potential fossil-fuel-replacement candidate, still requires the development of more advanced downstream processing technology for its price competitiveness. The major challenge in a microalgae-based biorefinery is the efficient separation of microalgae from low-concentration culture broth. The post-harvesting cell-disruption step necessary to render microalgae suitable for lipid extraction, moreover, further raises energy consumption and cost. For the mitigation of biorefinery complexity and costs, we suggest herein a new scheme that integrates the critical downstream processes (harvesting and cell disruption) by means of cationic surfactant-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles. The cationic surfactants' quaternary ammonium heads play an important role in not only flocculating negatively charged microalgae but also weakening thick cell walls. In the present study, the harvesting efficiency and cell-damaging effects of three cationic surfactants - cetyltrimethylammonium bromide (CTAB), cetylpyridinium chloride (CPC), and cetylpyridinium bromide (CPB) - were evaluated. The CTAB-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles, which were found to be the most effective, achieved a 96.6% microalgae harvesting efficiency at a dosage of 0.46 g particle per g cell. Next, for the purposes of magnetic nanoparticle recycling and high-purity microalgal biomass obtainment, microalgae detachment from microalgae-Fe<sub>3</sub>O<sub>4</sub> flocs was performed by addition of an anionic surfactant, sodium dodecyl sulfate (SDS). The detached CTAB-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles showed a steady reuse efficiency of about 80%. Furthermore, microalgae harvesting by CTAB-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles could contribute to a great improvement in the total extracted lipid

content and greener wet extraction without the additional energy-intensive cell-disruption step, thus demonstrating the cell-disruption ability of CTAB-decorated Fe<sub>3</sub>O<sub>4</sub> nanoparticles.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, National NanoFab Center, Korea Institute of Energy Research, Korea Advanced Institute of Science and Technology (KAIST), Chungnam National University

Contributors: Seo, J. Y., Ramasamy, P., Kim, B., Seo, J. C., Park, J. Y., Na, J. G., Jeon, S. G., Park, S. B., Lee, K., Oh, Y. K.

Number of pages: 9

Pages: 3981-3989

Publication date: 2016

Peer-reviewed: Yes

#### Publication information

Journal: Green Chemistry

Volume: 18

Issue number: 14

ISSN (Print): 1463-9262

Ratings:

Scopus rating (2016): CiteScore 13.8 SJR 2.598 SNIP 2.029

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

DOIs:

10.1039/c6gc00904b

Source: Scopus

Source ID: 84978832811

Research output: Contribution to journal > Article > Scientific > peer-review

#### Mutation spectra of the drinking water mutagen 3-chloro-4-methyl-5-hydroxy-2(5H)-furanone (MCF) in Salmonella TA100 and TA104: Comparison to MX

The chlorinated drinking water mutagen 3-chloro-4-methyl-5-hydroxy-2(5H)-furanone (MCF) occurs at concentrations similar to or greater than that of the related furanone 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX). MCF and MX differ structurally only by replacement of a 3-methyl in MCF with a 3-dichloromethyl in MX; yet, MCF is significantly less mutagenic than MX and produces different adducts when reacted with nucleosides or DNA. To explore further the effects that these structural differences might have on the biological activity of MCF and MX, we determined the mutation spectra of MCF in Salmonella strains TA100 and TA 104 and of MX in strain TA104; the spectrum of MX in TA100 had been determined previously. In TA100, which presents only GC targets for mutagenesis, MCF induced primarily (75%) GC → TA transversions, with most of the remaining revertants (20%) being GC → AT transitions. This spectrum was not significantly different from that of MX in TA100 ( $P = 0.07$ ). In TA104, which presents both GC and AT targets, MCF induced a lower percentage (57%) of GC → TA transversions, with most of the remaining revertants (33%) being AT → TA transversions. In contrast, MX induced almost only (98%) GC → TA transversions in TA104, with the remaining revertants (2%) being AT → TA transversions. Thus, almost all (98%) of the MX mutations were targeted at GC sites in TA104, whereas only 63% of the MCF mutations were so targeted. These results are consistent with the published findings that MX: (1) forms an adduct on guanosine when reacted with guanosine, (2) induces apurinic sites in DNA, and (3) forms a minor adduct on adenosine when reacted with adenosine or DNA. The results are also consistent with evidence that MCF forms adenosine adducts when reacted with adenosine. Our results show that the replacement of the 4-methyl in MCF with a 4-dichloromethyl to form MX not only increases dramatically the mutagenic potency but also shifts significantly the mutagenic specificity from almost equal targeting of GC and AT sites by MCF to almost exclusive targeting of GC sites by MX.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Abo Akad Univ, Abo Akademi University, Dept Phys, Dept. of Environ. Sci. and Eng., University of North Carolina at Charlotte, Computer Science Department, Dept. of Food and Nutrition Science, Åbo Akademi University, Kyoto Women's University, Environ. Carcinogenesis Division, U.S. Environmental Protection Agency, Department of Organic Chemistry, University of Helsinki

Contributors: Shaughnessy, D. T., Ohe, T., Landi, S., Warren, S. H., Richard, A. M., Munter, T., Franzén, R., Kronberg, L., DeMarini, D. M.

Number of pages: 8

Pages: 106-113

Publication date: 2000

Peer-reviewed: Yes

### Publication information

Journal: Environmental and Molecular Mutagenesis

Volume: 35

Issue number: 2

ISSN (Print): 0893-6692

Ratings:

Scopus rating (2000): SJR 0.778 SNIP 0.977

Original language: English

ASJC Scopus subject areas: Genetics, Environmental Science(all), Environmental Chemistry, Health, Toxicology and Mutagenesis, Genetics(clinical), Toxicology

Keywords: MCF, Mutation spectra, MX, Salmonella

DOIs:

10.1002/(SICI)1098-2280(2000)35:2<106::AID-EM5>3.0.CO;2-U

URLs:

<http://www.scopus.com/inward/record.url?scp=0034023630&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 0034023630

Research output: Contribution to journal › Article › Scientific › peer-review

### Anaerobic treatment of LCFA-containing synthetic dairy wastewater at 20°C: Process performance and microbial community dynamics

Facilitating anaerobic degradation of long-chain fatty acids (LCFA) is key for tapping the high methane production potential of the fats, oil and grease (FOG) content of dairy wastewaters. In this study, the feasibility of using high-rate granular sludge reactors for the treatment of mixed LCFA-containing synthetic dairy wastewater (SDW) was assessed at 20 °C. The effects of the LCFA concentration (33–45% of COD) and organic loading rates (2–3 gCOD/L·d) were determined using three parallel expanded granular sludge bed reactors. For the first time, long term anaerobic treatment of LCFA-containing feed at 20 °C was shown to be feasible and was linked to the microbial community dynamics in high-rate reactors. During a two-month operation, a soluble COD removal of 84–91% and COD to methane conversion of 44–51% was obtained. However, granular sludge flotation and washout occurred after two months in all reactors without volatile fatty acids (VFA) accumulation, emphasizing the need for sludge retention for long-term granular sludge reactor operation with LCFA-containing feed at low ambient temperatures. The temporal shifts in microbial community structure were studied in the high-rate treatment of SDW, and the process disturbances (elevated LCFA loading, LCFA accumulation, and batch operation) were found to decrease the microbial community diversity. The relative abundance of Methanosaeta increased with higher LCFA accumulation in the settled and flotation layer granules in the three reactors, therefore, acetoclastic methanogenesis was found to be crucial for the high-rate treatment of SDW at 20 °C. This study provides an initial understanding of the continuous anaerobic treatment of LCFA-containing industrial wastewaters at low ambient temperatures.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Materials Science and Environmental Engineering, Tampere Water, Hydraulic and Environmental Engineering (IHE) Inst. for Water Education, Natl. University of Ireland, Galway

Contributors: Singh, S., Rinta-Kanto, J. M., Kettunen, R., Tolvanen, H., Lens, P., Collins, G., Kokko, M., Rintala, J.

Number of pages: 9

Pages: 960-968

Publication date: 15 Nov 2019

Peer-reviewed: Yes

### Publication information

Journal: Science of the Total Environment

Volume: 691

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2019): CiteScore 8.6 SJR 1.661 SNIP 1.977

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Dairy wastewater, Expanded granular sludge bed (EGSB), Granule disintegration, Long chain fatty acids (LCFA), Methanogenesis pathway, Microbial community dynamics

DOIs:

10.1016/j.scitotenv.2019.07.136

Source: Scopus

Source ID: 85069487981

Research output: Contribution to journal › Article › Scientific › peer-review

### **Weathering of gasification and grate bottom ash in anaerobic conditions**

The effect of anaerobic conditions on weathering of gasification and grate bottom ash were studied in laboratory lysimeters. The two parallel lysimeters containing the same ash were run in anaerobic conditions for 322 days, after which one was aerated for 132 days. The lysimeters were watered throughout the study and the quality of leachates and changes in the binding of elements into ash were observed. The results show that organic carbon content and initial moisture of ashes are the key parameters affecting the weathering of ashes. In the grate ash the biodegradation of organic carbon produced enough CO<sub>2</sub> to regulate pH. In contrast the dry gasification ash, containing little organic carbon, was not carbonated under anaerobic conditions and the pH decreased only after aeration was started. During the aeration the CO<sub>2</sub> absorption capacity was not reached, indicating that intense aeration would be needed to fully carbonate gasification ash. The results indicate that in common weathering practice the main emissions-reducing processes are leaching and carbonation due to CO<sub>2</sub> from biodegradation. The results of the aeration study suggest that the role of atmospheric CO<sub>2</sub> in the weathering process was insignificant.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Sivula, L., Ilander, A., Väisänen, A., Rintala, J.

Number of pages: 8

Pages: 344-351

Publication date: 15 Feb 2010

Peer-reviewed: Yes

#### **Publication information**

Journal: Journal of Hazardous Materials

Volume: 174

Issue number: 1-3

ISSN (Print): 0304-3894

Ratings:

Scopus rating (2010): SJR 1.677 SNIP 1.706

Original language: English

ASJC Scopus subject areas: Health, Toxicology and Mutagenesis, Pollution, Waste Management and Disposal, Environmental Chemistry, Environmental Engineering

Keywords: Aeration, Anaerobic, Carbonation, Gasification ash, Weathering

DOIs:

10.1016/j.jhazmat.2009.09.056

Source: Scopus

Source ID: 71849087952

Research output: Contribution to journal › Article › Scientific › peer-review

### **Stabilisation of MSWI bottom ash with sulphide-rich anaerobic effluent**

Effluent of an anaerobic sulphate-reducing wastewater treatment process was used to stabilise bottom ash. The effect of stabilisation on the concentration and binding of Ca, P, S, Cu, Pb, Zn, As, Cr, and Mo were studied by comparing results of sequential extraction from fresh and stabilised bottom ash. The stabilisation treatment improved the retention of Ca, Cu, Pb, S, and Zn in bottom ash compared to a treatment with ion-exchanged water. In addition to retention, Cu, S, and Zn were accumulated from the anaerobic effluent in the bottom ash. Concentrations of As, Cr, and Mo remained on the same level, whereas leaching of P increased compared to control treatment with ion-exchanged water. Improved retention and accumulation were the result of increased binding to less soluble fractions. The highest increases were in the sulphide and organic carbon bound fraction and in the carbonate fraction. Enhanced carbonation was probably due to CO<sub>2</sub> deriving from the degradation of organic carbon. Flushing of stabilised bottom ash with ion-exchanged water ensured that the observed changes were not easily reversed. Most of the sulphide in the anaerobic effluent was removed when it was passed through bottom ash. The objective was to study the feasibility of sulphide-rich anaerobic effluent in bottom ash stabilisation and changes in the binding of the elements during stabilisation. In addition, the ability of the process to remove sulphide from the effluent was observed.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Sivula, L., Väisänen, A., Rintala, J.

Number of pages: 9  
Pages: 1-9  
Publication date: Mar 2008  
Peer-reviewed: Yes

#### Publication information

Journal: Chemosphere  
Volume: 71  
Issue number: 1  
ISSN (Print): 0045-6535  
Ratings:

Scopus rating (2008): SJR 1.658 SNIP 1.572

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Environmental Science(all)

Keywords: Heavy metals, Incineration, Landfilling, Sulphate reduction, Utilisation

DOIs:

10.1016/j.chemosphere.2007.10.060

Source: Scopus

Source ID: 39149109938

Research output: Contribution to journal › Article › Scientific › peer-review

#### Occurrence of some chlorinated enol lactones and cyclopentene-1,3-diones in chlorine-treated waters

Enol lactones (5-dichloromethylene-2-furanones) and 2,2-dichlorocyclopentene-1,3-diones, a total of six compounds, were synthesized and subsequently qualitatively and quantitatively determined in a sample of chlorination stage liquor from the bleaching of softwood kraft pulp (CBL), in chlorine-treated natural humic water (HW), and in three samples of drinking water treated with various disinfectants (DW1-3). All the compounds could be observed in the samples, in concentrations ranging from 2 to 170 µg/L in CBL, from 7 to 65 ng/L in HW, and at most a few nanograms per liter in DW1-3. The compounds were found to be weakly mutagenic in the Ames assay (strain TA100 without metabolic activation). The contribution of the compounds to the total mutagenicity in the studied samples was negligible. The compounds were unstable in aqueous solutions at pH 7.0, and under these conditions they were in part converted to 5-(dichloromethyl)-5-hydroxy-2-furanones. In acidified methanol, the enol lactones were partially converted to 5-(dichloromethyl)-5-methoxy-2-furanones.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Abo Akad Univ, Abo Akademi University, Dept Phys, Abo Akademi University, Åbo Akademi, Department of Organic Chemistry

Contributors: Smeds, A., Franzen, R., Kronberg, L.

Number of pages: 6

Pages: 1839-1844

Publication date: 1995

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 29

Issue number: 7

ISSN (Print): 0013-936X

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry, Environmental Engineering

DOIs:

10.1021/es00007a022

URLs:

<http://www.scopus.com/inward/record.url?scp=0029071371&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 0029071371

Research output: Contribution to journal › Article › Scientific › peer-review

#### London Hybrid Exposure Model: Improving Human Exposure Estimates to NO<sub>2</sub> and PM<sub>2.5</sub> in an Urban Setting

Here we describe the development of the London Hybrid Exposure Model (LHEM), which calculates exposure of the Greater London population to outdoor air pollution sources, in-buildings, in-vehicles, and outdoors, using survey data of when and where people spend their time. For comparison and to estimate exposure misclassification we compared Londoners LHEM exposure with exposure at the residential address, a commonly used exposure metric in epidemiological research. In 2011, the mean annual LHEM exposure to outdoor sources was estimated to be 37% lower for PM<sub>2.5</sub> and

63% lower for NO<sub>2</sub> than at the residential address. These decreased estimates reflect the effects of reduced exposure indoors, the amount of time spent indoors (~95%), and the mode and duration of travel in London. We find that an individual's exposure to PM<sub>2.5</sub> and NO<sub>2</sub> outside their residential address is highly correlated (Pearson's R of 0.9). In contrast, LHEM exposure estimates for PM<sub>2.5</sub> and NO<sub>2</sub> suggest that the degree of correlation is influenced by their exposure in different transport modes. Further development of the LHEM has the potential to increase the understanding of exposure error and bias in time-series and cohort studies and thus better distinguish the independent effects of NO<sub>2</sub> and PM<sub>2.5</sub>.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: King's College London, University College London, University of London

Contributors: Smith, J. D., Mitsakou, C., Kitwiroon, N., Barratt, B. M., Walton, H. A., Taylor, J. G., Anderson, H. R., Kelly, F. J., Beevers, S. D.

Number of pages: 9

Pages: 11760-11768

Publication date: 1 Nov 2016

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Science and Technology

Volume: 50

Issue number: 21

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2016): CiteScore 10.6 SJR 2.559 SNIP 1.923

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

DOIs:

10.1021/acs.est.6b01817

URLs:

<http://www.scopus.com/inward/record.url?scp=84993990169&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84993990169

Research output: Contribution to journal › Article › Scientific › peer-review

#### Are there environmental or agricultural benefits in using forest residue biochar in boreal agricultural clay soil?

Short-term agronomic and environmental benefits are fundamental factors in encouraging farmers to use biochar on a broad scale. The short-term impacts of forest residue biochar (BC) on the productivity and carbon (C) storage of arable boreal clay soil were studied in a field experiment. In addition, rain simulations and aggregate stability tests were carried out to investigate the potential of BC to reduce nutrient export to surface waters. A BC addition of 30 t ha<sup>-1</sup> increased soil test phosphorus and decreased bulk density in the surface soil but did not significantly change pH or water retention properties, and most importantly, did not increase the yield. There were no changes in the bacterial or fungal communities, or biomasses. Soil basal respiration was higher in BC-amended plots in the spring, but no differences in respiration rates were detected in the fall two years after the application. Rain simulation experiments did not support the use of BC in reducing erosion or the export of nutrients from the field. Of the C added, on average 80% was discovered in the 0–45 cm soil layer one year after the application. Amendment of boreal clay soil with a high rate of BC characterized by a moderately alkaline pH, low surface functionalities, and a recalcitrant nature, did not induce such positive impacts that would unambiguously motivate farmers to invest in BC. BC use seems unviable from the farmer's perspective but could play a role in climate change mitigation, as it will likely serve as long-term C storage.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research group: Computational Biophysics and Imaging Group, BioMediTech, Natural Resources Institute Finland (Luke), HAMK University of Applied Sciences

Contributors: Soenne, H., Keskinen, R., Heikkinen, J., Hyväluoma, J., Uusitalo, R., Peltoniemi, K., Velmala, S., Pennanen, T., Fritze, H., Kaseva, J., Hannula, M., Rasa, K.

Publication date: 20 Aug 2020

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 731

Article number: 138955

ISSN (Print): 0048-9697

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Biochar, Carbon sequestration, Microbial community, Nutrient leaching, Soil productivity, Soil quality

Electronic versions:

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Research output: Contribution to journal > Article > Scientific > peer-review

### **Internal leachate quality in a municipal solid waste landfill: Vertical, horizontal and temporal variation and impacts of leachate recirculation**

The aim of this study was to monitor and characterise internal leachate quality at a Finnish municipal solid waste landfill (Lahti, Kujala, in operation for approximately 50 years) to provide information about its horizontal and vertical variation as well as effects of leachate recirculation on leachate quality. The study area (approximately 4 h) of the landfill had 14 monitoring wells for leachate quality monitoring over a 2-year period. The leachate was monitored for COD, BOD, TKN,  $\text{NH}_4\text{-N}$ , Cl, pH and electric conductivity. The results showed high horizontal and vertical variability in leachate quality between monitoring wells, indicating that age and properties of waste, local conditions (e.g., water table) and degradation and dilution processes have a marked effect on local leachate quality. The mean COD values (642-8037 mg/l) and mean BOD/COD ratios (0.08-0.17) from the different monitoring wells were typical of landfills in the methanogenic phase of degradation. The leachate in the monitoring wells was notably more concentrated than the leachate effluent used for leachate recirculation. In the landfill as a whole the effects of the leachate recirculation on leachate quality, although difficult to distinguish from those caused by other factors, appeared to be minor during the study period.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, Matti Ettala Ltd., University of Jyväskylä

Contributors: Sormunen, K., Ettala, M., Rintala, J.

Number of pages: 7

Pages: 601-607

Publication date: 30 Dec 2008

Peer-reviewed: Yes

#### **Publication information**

Journal: Journal of Hazardous Materials

Volume: 160

Issue number: 2-3

ISSN (Print): 0304-3894

Ratings:

Scopus rating (2008): SJR 1.25 SNIP 1.522

Original language: English

ASJC Scopus subject areas: Health, Toxicology and Mutagenesis, Pollution, Waste Management and Disposal, Environmental Chemistry, Environmental Engineering

Keywords: Landfill, Leachate, Nitrogen, Organic matter, Sampling

DOIs:

10.1016/j.jhazmat.2008.03.081

Source: Scopus

Source ID: 54549090158

Research output: Contribution to journal > Article > Scientific > peer-review

### **Bio-electrochemical conversion of industrial wastewater-COD combined with downstream methanol synthesis-an economic and life cycle assessment**

Herein, a techno-economic and environmental performance evaluation (i.e. Life Cycle Assessment (LCA)) of a 45 kW Microbial Electrolysis Cell (MEC) system is presented in the context of industrial wastewater remediation. This system produces  $\text{H}_2$  and  $\text{CO}_2$ -suitable for downstream  $\text{CH}_3\text{OH}$  synthesis-based on the bio-electrochemical conversion of chemical industry wastewater with an organic content of  $3.9 \text{ g(COD) L}^{-1}$ . A cost-benefit analysis indicates that the MEC system hardware costs, share of  $\text{CO}_2$  captured from the MEC and MEC operating current density (i.e.  $1.0 \text{ mA cm}^{-2}$ ) are crucial parameters influencing the total cost and represent areas for potential cost reductions. It was established based on the present study that MEC system operation with renewable electricity leads to  $\text{H}_2$  production costs of  $4\text{-}5.7\text{€ kg(H}_2\text{)}^{-1}$

(comparable to H<sub>2</sub>O electrolysis) and CH<sub>3</sub>OH production costs of 900€ t(CH<sub>3</sub>OH)<sup>-1</sup>. At the current CH<sub>3</sub>OH market prices, however, the production is currently not profitable. In turn, the cost-efficient construction of the MEC system and the use of less expensive materials could lead to improved CH<sub>3</sub>OH production economics based on this route. Our results indicate that the use of low-cost materials has greater potential with regard to cost reduction compared to reducing the internal resistance and polarization losses via the use of expensive high-performance materials in MEC construction. A complementary LCA of the proposed system, based on a "cradle-to-gate" definition, indicates that waste-based is superior to fossil-based CH<sub>3</sub>OH production with respect to global warming potential and cumulated fossil energy demand, provided the system is operated with 100% renewable electricity and CO<sub>2</sub> sourced only from the MEC. However, with regard to the impact categories Metal Depletion and Freshwater Eutrophication Potential, the system was found to perform less satisfactorily (i.e. in comparison with fossil-based CH<sub>3</sub>OH production).

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Fraunhofer Institute for Solar Energy Systems ISE, Albert-Ludwig-University of Freiburg, Karlsruhe Institute of Technology, Institute for Technical Physics, Germany, University of Freiburg, Laboratory for MEMS Applications, University of Bremen

Contributors: Streeck, J., Hank, C., Neuner, M., Gil-Carrera, L., Kokko, M., Pauliuk, S., Schaadt, A., Kerzenmacher, S., White, R. J.

Number of pages: 21

Pages: 2742-2762

Publication date: 2018

Peer-reviewed: Yes

#### Publication information

Journal: Green Chemistry

Volume: 20

Issue number: 12

ISSN (Print): 1463-9262

Ratings:

Scopus rating (2018): CiteScore 15.7 SJR 2.517 SNIP 1.84

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Pollution

DOIs:

10.1039/c8gc00543e

Source: Scopus

Source ID: 85048986666

Research output: Contribution to journal › Article › Scientific › peer-review

#### Biomass characterization of laboratory-scale thermophilic-mesophilic wastewater treatment processes

Two thermophilic-mesophilic wastewater treatment processes, one as the combination of the thermophilic activated sludge process (ASP), followed by the mesophilic ASP and the other as thermophilic suspended carrier biofilm process (SCBP), followed by the mesophilic ASP, were used to study sludge characteristics and floc formation. Thermophilic bacteria in both ASP and SCBP were able to form flocs, which were <50 µm in size and had a weak structure and irregular shape. Flocs in both the mesophilic ASPs were larger in size (50-500 µm) and had more compact structures. Filamentous bacteria played an important role in both the thermophilic and mesophilic processes by forming bridges between small flocs. Both thermophilic processes showed a high density of dispersed particles, such as free bacteria. When hydraulic retention time (HRT) was decreased the biofilm was retained in the thermophilic SCBP better than the flocs in the thermophilic ASP. The mesophilic ASPs efficiently removed dispersed particles originating from the thermophilic processes.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Watrec Ltd, Jyväskylän yliopisto, University of Jyväskylä

Contributors: Suvilampi, J., Lehtomäki, A., Rintala, J.

Number of pages: 11

Pages: 41-51

Publication date: Jan 2006

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology

Volume: 27

Issue number: 1

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2006): SJR 0.477 SNIP 0.545

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Aerobic, Filamentous bacteria, Floc size, Thermophilic, Wastewater

DOIs:

10.1080/09593332708618620

Source: Scopus

Source ID: 33144471120

Research output: Contribution to journal > Article > Scientific > peer-review

### Comparison of activated sludge processes at different temperatures: 35°C, 2-55°C, and 55°C

The performance of mesophilic (35°C; referred to as R1) and thermophilic (55°C; R3) laboratory activated sludge processes (ASPs) as well as ASP with a fluctuating temperature (27-56°C; R2) was compared. During the 124-day runs, in R1 and R3 hydraulic retention time was gradually reduced from 18 h to 3 h, corresponding to an increase in volumetric loading rate from 2 to 10 kg soluble COD m<sup>-3</sup>d<sup>-1</sup>; in R2 hydraulic retention time was reduced from 18 to 4.5 h, corresponding to an increase in volumetric loading rate from 2 to 7.5 kg soluble COD m<sup>-3</sup>d<sup>-1</sup>. R1 removed on average 85% of soluble COD (GF50-filtered) that was approximately 10% more than R3. In R2 SCOD removal was dependent on the operating temperature, being comparable to R1 and R3 at respective temperature. However, the COD for 0.45 µm-filtered (bacteria-free) effluent samples was lower for R3 than for R1, indicating the role of free bacteria on effluent quality. Furthermore, 24 h post-aeration of R3 effluent at 35°C decreased SCOD (GF50-filtrated) markedly (43% removal), whereas at 55°C no SCOD removal occurred, which suggest mesophilic post-treatment ability to remove thermophilically recalcitrant matter or, more probably, the ability of free bacteria to aggregate more efficiently under lower temperatures. The results indicate that temperature may not be as crucial a factor in high temperature biological wastewater treatment as previously believed. On the other hand, in thermophilic ASP the importance of solids separation is emphasized.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Suvilampi, J., Rintala, J.

Number of pages: 7

Pages: 1127-1133

Publication date: 2002

Peer-reviewed: Yes

### Publication information

Journal: Environmental Technology

Volume: 23

Issue number: 10

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2002): SJR 0.68 SNIP 0.724

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Activated sludge process, Effluent quality, Mesophilic, Thermophilic, Varying temperature

Source: Scopus

Source ID: 0036441176

Research output: Contribution to journal > Article > Scientific > peer-review

### MicroEnv: A microsimulation model for quantifying the impacts of environmental policies on population health and health inequalities

The Sustainable Development Goals (SDGs) recognise the critical need to improve population health and environmental sustainability. This paper describes the development of a microsimulation model, MicroEnv, aimed at quantifying the impact of environmental exposures on health as an aid to selecting policies likely to have greatest benefit. Its methods allow the integration of morbidity and mortality outcomes and the generation of results at high spatial resolution. We illustrate its application to the assessment of the impact of air pollution on health in London. Simulations are performed at Lower Layer Super Output Area (LSOA), the smallest geographic unit (population of around 1500 inhabitants) for which detailed socio-demographic data are routinely available in the UK. The health of each individual in these LSOAs is simulated year-by-year using a health-state-transition model, where transition probabilities from one state to another are based on published statistics modified by relative risks that reflect the effect of environmental exposures. This is done through linkage of the simulated population in each LSOA with 1 × 1 km annual average PM<sub>2.5</sub> concentrations and area-based deprivation indices. Air pollution is a leading cause of mortality and morbidity globally, and improving air quality is critical to the SDGs for Health (Goal 3) and Cities (Goal 11). The evidence of MicroEnv is aimed at providing better

understanding of the benefits for population health and health inequalities of policy actions that affect exposure such as air quality, and thus to help shape policy decisions. Future work will extend the model to integrate other environmental determinants of health.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: University College London, London School of Hygiene and Tropical Medicine

Contributors: Symonds, P., Hutchinson, E., Ibbetson, A., Taylor, J., Milner, J., Chalabi, Z., Davies, M., Wilkinson, P.

Publication date: 20 Dec 2019

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 697

Article number: 134105

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2019): CiteScore 8.6 SJR 1.661 SNIP 1.977

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Air pollution, Deprivation, Environmental risks, Health modelling, Microsimulation, SDGs

DOIs:

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Source: Scopus

Source ID: 85071636750

Research output: Contribution to journal > Article > Scientific > peer-review

#### HPLC-SEC: a new approach to characterise complex wastewater effluents

This work investigates the use of HPLC-SEC to characterise dissolved organic matter (DOM) of complex wastewater effluents. A silica-based column, sodium acetate eluent and multiple detections were employed: UV-254 absorbance for humic-type, and tryptophan-like ( $Ex/Em = 270/355$ ) and tyrosine-like ( $Ex/Em = 270/310$ ) fluorescence for protein type compounds. Effects of eluent pH, eluent ionic strength and injection volume on separation efficiency were tested. Humic-type and protein-type fractions were clearly differentiated and eluted within and out of calibration range. Eluent ionic strength had the greatest influence on global resolution; the lowest eluent concentration of 0.01 M produced the best separation for all wastewater effluents tested at any detection. UV-254 absorbance was higher at neutral and basic eluent pH while tryptophan-like fluorescence depended on the sample composition rather than on the eluent pH or ionic strength. Tyrosine-like fluorescence decreased significantly with the increase of eluent ionic strength. Accurate molecular weight measurements could not be done, the separation being influenced by secondary interactions, but could be approximated using separate calibrations with sodium salts of polystyrene-sulfonates and protein standards. The results show that this method is suitable for determining DOM in wastewater at low eluent concentrations (up to 0.03 M), at neutral or slightly basic pH.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Degree Programme in Energy and Environmental Engineering, Tampere University of Applied Sciences, Department of Biological and Environmental Science, University of Jyväskylä

Contributors: Szabo, H. M., Lepistö, R., Tuhkanen, T.

Number of pages: 14

Pages: 257-270

Publication date: 19 Feb 2016

Peer-reviewed: Yes

#### Publication information

Journal: International Journal of Environmental Analytical Chemistry

Volume: 96

Issue number: 3

ISSN (Print): 0306-7319

Ratings:

Scopus rating (2016): CiteScore 2.5 SJR 0.368 SNIP 0.501

Original language: English

ASJC Scopus subject areas: Analytical Chemistry, Environmental Chemistry, Soil Science, Health, Toxicology and Mutagenesis, Pollution, Waste Management and Disposal, Water Science and Technology, Public Health, Environmental and Occupational Health

Keywords: DOM, Fluorescence, greywater, humic, ionic strength, proteins, tryptophan, UV-254

DOIs:

10.1080/03067319.2016.1150463

### Bibliographical note

EXT="Tuhkanen, Tuula"

Source: Scopus

Source ID: 84961206778

Research output: Contribution to journal > Article > Scientific > peer-review

### Biological treatment of selenium-laden wastewater containing nitrate and sulfate in an upflow anaerobic sludge bed reactor at pH 5.0

This study investigated the removal of selenate ( $\text{SeO}_4^{2-}$ ), sulfate ( $\text{SO}_4^{2-}$ ) and nitrate ( $\text{NO}_3^-$ ) at different influent pH values ranging from 7.0 to 5.0 and 20 °C in an upflow anaerobic sludge blanket (UASB) reactor using lactate as an electron donor. At pH 5.0, the UASB reactor showed a 20–30% decrease in reactor performance compared to operation at pH 5.5 to 7.0, reaching removal efficiencies of 79%, 15%, 43% and 61% for  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{Se}_{\text{total}}$  and  $\text{Se}_{\text{diss}}$ , respectively. However, the reactor stability was an issue upon lowering the pH to 5.0 and further experiments are recommended. The sludge formed during low pH operation had a fluffy, floc-like appearance with filamentous structure, possibly due to the low polysaccharide (PS) to protein (PN) ratio (0.01 PS/PN) in the soluble extracellular polymeric substances (EPS) matrix of the biomass. Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) analysis of the sludge confirmed Se oxyanion reduction and deposition of  $\text{Se}^0$  particles inside the biomass. Microbial community analysis using Illumina MiSeq sequencing revealed that the families of Campylobacteraceae and Desulfomicrobiaceae were the dominant phylotypes throughout the reactor operation at approximately 23% and 10% relative abundance, respectively. Furthermore, approximately 10% relative abundance of both Geobacteraceae and Spirochaetaceae was observed in the granular sludge during the pH 5.0 operation. Overall, this study demonstrated the feasibility of UASB operation at pH values ranging from 7.0 to 5.0 for removing Se and other oxyanions from wastewaters.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Bhabha Atomic Research Centre, Montana State University (MSU), Hydraulic and Environmental Engineering (IHE) Inst. for Water Education

Contributors: Tan, L. C., Nancharaiah, Y. V., Lu, S., van Hullebusch, E. D., Gerlach, R., Lens, P. N.

Number of pages: 10

Pages: 684-693

Publication date: 1 Nov 2018

Peer-reviewed: Yes

### Publication information

Journal: Chemosphere

Volume: 211

ISSN (Print): 0045-6535

Ratings:

Scopus rating (2018): CiteScore 7.4 SJR 1.448 SNIP 1.57

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Chemistry(all), Pollution, Health, Toxicology and Mutagenesis

Keywords: Acid mine drainage, Anaerobic granular sludge, Microbial diversity, Selenate bioreduction, UASB reactor

DOIs:

10.1016/j.chemosphere.2018.07.079

Source: Scopus

Source ID: 85053212365

Research output: Contribution to journal > Article > Scientific > peer-review

### Low concentration of zeolite to enhance microalgal growth and ammonium removal efficiency in a membrane photobioreactor

The aim of this work was to study the growth and nutrient removal efficiency of a mixed microalgal culture with and without the addition of low concentrations (0.5, 1, and 5 g L<sup>-1</sup> of total liquid volume in the reactor) of natural zeolite. A control test in which only zeolite was added into a similar membrane photobioreactor was also conducted. The addition of 0.5 g L<sup>-1</sup> zeolite to a continuously-fed membrane photobioreactor increased the microalgal biomass concentration from 0.50 to 0.90–1.17 g particulate organic carbon per L while the average ammonium removal efficiency increased from 14% to 30%.

Upon microscopic inspection, microalgal cells were observed growing on the surface of zeolite particles, which indicates that zeolite can support attached microalgal growth. With higher zeolite doses (1 and 5 g L<sup>-1</sup>) inside the reactor, however, the breaking apart of added zeolite particles into finer particles dramatically increased solution turbidity, which likely was not beneficial for microalgal growth and ammonium removal due to reduced light penetration. This work shows that low doses of zeolite can be used as microcarriers to enhance microalgal biomass concentration and ammonium removal efficiency, while minimizing zeolite dose would likely reduce the turbidity effects.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research group: Bio- and Circular Economy, Materials Science and Environmental Engineering, University of South Florida Tampa, UNESCO-IHE Institute for Water Education, Delft, Institut de Physique du Globe de Paris

Contributors: Tao, R., Bair, R., Pickett, M., Calabria, J. L., Lakaniemi, A., van Hullebusch, E. D., Rintala, J. A., Yeh, D. H.

Number of pages: 15

Publication date: 2020

Peer-reviewed: Yes

#### Publication information

Journal: Environmental Technology

ISSN (Print): 0959-3330

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Water Science and Technology, Waste Management and Disposal

Keywords: membrane photobioreactor, Microalgal growth, nutrient removal, turbidity, wastewater treatment

DOIs:

10.1080/09593330.2020.1752813

Source: Scopus

Source ID: 85084252299

Research output: Contribution to journal › Article › Scientific › peer-review

#### Application of an indoor air pollution metamodel to a spatially-distributed housing stock

Estimates of population air pollution exposure typically rely on the outdoor component only, and rarely account for populations spending the majority of their time indoors. Housing is an important modifier of air pollution exposure due to outdoor pollution infiltrating indoors, and the removal of indoor-sourced pollution through active or passive ventilation. Here, we describe the application of an indoor air pollution modelling tool to a spatially distributed housing stock model for England and Wales, developed from Energy Performance Certificate (EPC) data and containing information for approximately 11.5 million dwellings. First, we estimate indoor/outdoor (I/O) ratios and total indoor concentrations of outdoor air pollution for PM<sub>2.5</sub> and NO<sub>2</sub> for all EPC dwellings in London. The potential to estimate concentration from both indoor and outdoor sources is then demonstrated by modelling indoor background CO levels for England and Wales pre- and post-energy efficient adaptation, including heating, cooking, and smoking as internal sources. In London, we predict a median I/O ratio of 0.60 (99% CIs; 0.53–0.73) for outdoor PM<sub>2.5</sub> and 0.41 (99% CIs; 0.34–0.59) for outdoor NO<sub>2</sub>; Pearson correlation analysis indicates a greater spatial modification of PM<sub>2.5</sub> exposure by housing ( $\rho = 0.81$ ) than NO<sub>2</sub> ( $\rho = 0.88$ ). For the demonstrative CO model, concentrations ranged from 0.4–9.9 ppm (99% CIs)(median = 3.0 ppm) in kitchens and 0.3–25.6 ppm (median = 6.4 ppm) in living rooms. Clusters of elevated indoor concentration are found in urban areas due to higher outdoor concentrations and smaller dwellings with reduced ventilation potential, with an estimated 17.6% increase in the number of living rooms and 63% increase in the number of kitchens exceeding recommended exposure levels following retrofit without additional ventilation. The model has the potential to rapidly calculate indoor pollution exposure across large housing stocks and estimate changes to exposure under different pollution or housing policy scenarios.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: University College London, University of Edinburgh

Contributors: Taylor, J., Shrubsole, C., Symonds, P., Mackenzie, I., Davies, M.

Number of pages: 10

Pages: 390-399

Publication date: 1 Jun 2019

Peer-reviewed: Yes

#### Publication information

Journal: Science of the Total Environment

Volume: 667

ISSN (Print): 0048-9697

Ratings:

Scopus rating (2019): CiteScore 8.6 SJR 1.661 SNIP 1.977

Original language: English

ASJC Scopus subject areas: Environmental Engineering, Environmental Chemistry, Waste Management and Disposal, Pollution

Keywords: Air pollution, Building physics, I/O ratios, NO, PM

DOIs:

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URLs:

<http://www.scopus.com/inward/record.url?scp=85062229013&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 85062229013

Research output: Contribution to journal > Article > Scientific > peer-review

### **Sulphate-reducing laboratory-scale high-rate anaerobic reactors for treatment of metal-and sulphate-containing mine wastewater**

Upflow anaerobic sludge blanket (UASB) reactors were used in this study to evaluate the feasibility of the sulphate-reducing, anaerobic high-rate process to treat metal- and sulphate-containing mining wastewater (MWW). Four simultaneous reactors, inoculated with different inocula (mesophilic granular sludge from two UASB reactors, one treating sugar refinery wastewater and the other board mill wastewater) and operated with different loadings, were for 95 days fed with synthetic feed consisting of glucose and sulphate. In all reactors, 23 - 72% of sulphate and 12 - 93% of COD were removed. Subsequently, two reactors were fed with diluted MWW (zinc as the main metal) for 77 days with hydraulic retention times down to 8 hours. At the onset of the runs (until day 48), over 99.9% of zinc was removed in both reactors, after which removals fell to less than 30 - 80%. At the end of the runs, the highest zinc content (44 mg g<sup>-1</sup> TS) in the reactor sludges was 21 times higher than that in the inoculum. It cannot be concluded definitively that sulphide precipitation was the only mechanism of metal removal, for biosorption may have had a role to play in the process.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Jyväskylän yliopisto, University of Jyväskylä

Contributors: Tuppurainen, K. O., Väisänen, A. O., Rintala, J. A.

Number of pages: 10

Pages: 599-608

Publication date: 2002

Peer-reviewed: Yes

#### **Publication information**

Journal: Environmental Technology

Volume: 23

Issue number: 6

ISSN (Print): 0959-3330

Ratings:

Scopus rating (2002): SJR 0.68 SNIP 0.724

Original language: English

ASJC Scopus subject areas: Environmental Science(all), Environmental Chemistry

Keywords: Biological metal removal, Mining wastewater, Sulphate reduction, UASB-reactor, Zinc removal

DOIs:

10.1080/09593332308618382

Source: Scopus

Source ID: 0035986692

Research output: Contribution to journal > Article > Scientific > peer-review

### **Optimised selection of new protective coatings for biofuel boiler applications**

Using biofuels in power and CHP boilers can pose a challenge for materials performance. Formation of deposits containing e.g. potassium, sulphur, calcium, sodium, and chlorine can result in severe corrosion of conventional steels and alloys at relatively modest temperatures. Given suitable component design and fabrication facilities, coatings may be considered to protect the fireside surfaces. This paper aims to present a systematic approach to the design and selection criteria for protective coatings of boilers. The approach includes modelling of the process and surface conditions, optimisation of the coating process and structure, and performance validation in the laboratory and plant scales. The applied examples have included iron and nickel based HVOF and arc sprayed coatings subjected to verification field testing in boiler testing under aggressive biofuel conditions. The coatings have shown good corrosion resistance in both laboratory tests and long-term harsh field tests. The paper discusses the used approach for finding a suitable and cost effective coating for biofuel boiler applications. The paper gives test results from microstructural, corrosion resistance and field testing experience for the selected coatings.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Engineering materials science and solutions (EMASS), VTT Technical Research Centre of Finland

Contributors: Tuurna, S., Varis, T., Penttilä, K., Ruusuvuori, K., Holmström, S., Yli-Olli, S.

Number of pages: 8

Pages: 642-649

Publication date: Jul 2011

Peer-reviewed: Yes

### Publication information

Journal: Materials and Corrosion-Werkstoffe und Korrosion

Volume: 62

Issue number: 7

ISSN (Print): 0947-5117

Ratings:

Scopus rating (2011): CiteScore 1.7 SJR 0.603 SNIP 1.109

Original language: English

ASJC Scopus subject areas: Environmental Chemistry, Mechanics of Materials, Mechanical Engineering, Surfaces, Coatings and Films, Metals and Alloys, Materials Chemistry

Keywords: biofuel boiler, coating performance, life extension, protection

DOIs:

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Source: Scopus

Source ID: 79960241231

Research output: Contribution to journal > Article > Scientific > peer-review

### High Nitrogen Removal in a Constructed Wetland Receiving Treated Wastewater in a Cold Climate

Constructed wetlands provide cost-efficient nutrient removal, with minimal input of human labor and energy, and their number is globally increasing. However, in northern latitudes, wetlands are rarely utilized, because their nutrient removal efficiency has been questioned due to the cold climate. Here, we studied nutrient retention and nitrogen removal in a boreal constructed wetland (4-ha) receiving treated nitrogen-rich wastewater. On a yearly basis, most of the inorganic nutrients were retained by the wetland. The highest retention efficiency was found during the ice-free period, being 79% for ammonium-nitrogen (NH<sub>4</sub><sup>+</sup>-N), 71% for nitrate-nitrogen (NO<sub>3</sub><sup>-</sup>-N), and 88% for phosphate-phosphorus (PO<sub>4</sub><sup>3-</sup>-P). Wetland also acted as a buffer zone during the disturbed nitrification process of the wastewater treatment plant. Denitrification varied between 106 and 252 mg N m<sup>-2</sup> d<sup>-1</sup> during the ice-free period. During the ice-cover period, total gaseous nitrogen removal was 147 mg N m<sup>-2</sup> d<sup>-1</sup>, from which 66% was removed as N<sub>2</sub>, 28.5% as N<sub>2</sub>O through denitrification, and 5.5% as N<sub>2</sub> through anammox. Nearly 2600 kg N y<sup>-1</sup> was estimated to be removed through microbial gaseous N-production which equaled 72% of NO<sub>3</sub><sup>-</sup>-N and 60% of TN yearly retention in the wetland. The wetland retained nutrients even in winter, when good oxygen conditions prevailed under ice. The results suggest that constructed wetlands are an efficient option for wastewater nitrogen removal and nutrient retention also in cold climates.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, University of Helsinki, Jyväskylän yliopisto, University of Eastern Finland

Contributors: Uusheimo, S., Huotari, J., Tulonen, T., Aalto, S. L., Rissanen, A. J., Arvola, L.

Number of pages: 8

Pages: 13343-13350

Publication date: 20 Nov 2018

Peer-reviewed: Yes

### Publication information

Journal: Environmental science & technology

Volume: 52

Issue number: 22

ISSN (Print): 0013-936X

Ratings:

Scopus rating (2018): CiteScore 11.9 SJR 2.514 SNIP 1.99

Original language: English

ASJC Scopus subject areas: Chemistry(all), Environmental Chemistry

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### **The effects of nutrients on natural organic matter (NOM) removal in biological activated carbon (BAC) filtration**

Effective biodegradation of organic compounds is one of the major objectives while optimizing biological drinking water treatment processes. Enhancing the biological activated carbon (BAC) filter performance with nutrient addition was studied using chemically pre-treated and ozonated lake water. Three parallel pilot-scale biofilters were operated: one with phosphorus addition, one with a mixture of inorganic nutrients addition, and one as a reference. The addition of nutrients has no statistically significant influence on the natural organic matter (NOM) removal when monitored by total organic carbon (TOC), UV absorbance, and assimilable organic carbon (AOC). However, the addition of nutrients significantly increased the heterotrophic plate count (HPC) bacteria of the filter effluent, while the adenosine triphosphate (ATP) analysis of the attached bacteria did not show any increase in BAC filters. It seemed that in BAC filters the bacterial growth was limited by phosphorus, but the increased bacteria could not attach themselves during the relatively short acclimatization period.

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Contributors: Vahala, R., Moramarco, V., Niemi, R. M., Rintala, J., Laukkanen, R.

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### **The evaluation of drinking water treatment performed with HPSEC**

Characterization of natural organic matter (NOM) removal in the drinking-water treatment train can give valuable information, while optimizing the treatment process. In this study, high-performance size-exclusion chromatography (HPSEC) was applied to evaluate the relative changes of molecular size distribution (MSD) of NOM in different treatment steps. The full-scale treatment train consisting of coagulation, flocculation, sedimentation, sand filtration, and ozonation was studied in Pitkakoski water treatment plant, Helsinki, Finland. Furthermore, in a pilot-scale process, the effect of the subsequent two-step granular activated carbon (GAC) filtration on MSD was evaluated. Chemical treatment followed by sand filtration decreased NOM efficiently. The fraction of the largest molecules disappeared completely, and the next two fractions were reduced by 92% and 85%, respectively. No significant changes in the smallest molecular fractions were observed. Ozonation shifted MSD slightly towards smaller molecules, depending on the applied ozone dose. However, the increase of assimilable organic carbon (AOC) could not be related to the certain fraction of NOM. On the contrary, MSD did not change considerably during two-step GAC-filtration, except in the fresh GAC columns, where the adsorption of large molecules was slower than with smaller ones. Conversely, the smallest molecules seemed to escape from the exhausted GAC filter. Finally, significant correlations were established between HPSEC results,  $\text{KMnO}_4$  number, UV absorbance (254 nm), chlorine demand, and TOC results.

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Contributors: Vuorio, E., Vahala, R., Rintala, J., Laukkanen, R.  
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#### Photo-oxidation of Aromatic Hydrocarbons Produces Low-Volatility Organic Compounds

To better understand the role of aromatic hydrocarbons in new-particle formation, we measured the particle-phase abundance and volatility of oxidation products following the reaction of aromatic hydrocarbons with OH radicals. For this we used thermal desorption in an iodide-adduct Time-of-Flight Chemical-Ionization Mass Spectrometer equipped with a Filter Inlet for Gases and AEROSols (FIGAERO-ToF-CIMS). The particle-phase volatility measurements confirm that oxidation products of toluene and naphthalene can contribute to the initial growth of newly formed particles. Toluene-derived (C7) oxidation products have a similar volatility distribution to that of  $\alpha$ -pinene-derived (C10) oxidation products, while naphthalene-derived (C10) oxidation products are much less volatile than those from toluene or  $\alpha$ -pinene; they are thus stronger contributors to growth. Rapid progression through multiple generations of oxidation is more pronounced in toluene and naphthalene than in  $\alpha$ -pinene, resulting in more oxidation but also favoring functional groups with much lower volatility per added oxygen atom, such as hydroxyl and carboxylic groups instead of hydroperoxide groups. Under conditions typical of polluted urban settings, naphthalene may well contribute to nucleation and the growth of the smallest particles, whereas the more abundant alkyl benzenes may overtake naphthalene once the particles have grown beyond the point where the Kelvin effect strongly influences the condensation driving force.

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Contributors: Wang, M., Chen, D., Xiao, M., Ye, Q., Stolzenburg, D., Hofbauer, V., Ye, P., Vogel, A. L., Mauldin, R. L., Amorim, A., Baccarini, A., Baumgartner, B., Brilke, S., Dada, L., Dias, A., Duplissy, J., Finkenzeller, H., Garmash, O., He, X. C., Hoyle, C. R., Kim, C., Kvashnin, A., Lehtipalo, K., Fischer, L., Molteni, U., Petäjä, T., Pospisilova, V., Quéléver, L. L., Rissanen, M., Simon, M., Tauber, C., Tomé, A., Wagner, A. C., Weitz, L., Volkamer, R., Winkler, P. M., Kirkby, J., Worsnop, D. R., Kulmala, M., Baltensperger, U., Dommen, J., El-Haddad, I., Donahue, N. M.  
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### **Molecular Composition and Volatility of Nucleated Particles from $\alpha$ -Pinene Oxidation between -50 °C and +25 °C**

We use a real-time temperature-programmed desorption chemical-ionization mass spectrometer (FIGAERO-CIMS) to measure particle-phase composition and volatility of nucleated particles, studying pure  $\alpha$ -pinene oxidation over a wide temperature range (-50 °C to +25 °C) in the CLOUD chamber at CERN. Highly oxygenated organic molecules are much more abundant in particles formed at higher temperatures, shifting the compounds toward higher O/C and lower intrinsic (300 K) volatility. We find that pure biogenic nucleation and growth depends only weakly on temperature. This is because the positive temperature dependence of degree of oxidation (and polarity) and the negative temperature dependence of volatility counteract each other. Unlike prior work that relied on estimated volatility, we directly measure volatility via calibrated temperature-programmed desorption. Our particle-phase measurements are consistent with gas-phase results and indicate that during new-particle formation from  $\alpha$ -pinene oxidation, gas-phase chemistry directly determines the properties of materials in the condensed phase. We now have consistency between measured gas-phase product concentrations, product volatility, measured and modeled growth rates, and the particle composition over most temperatures found in the troposphere.

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Contributors: Ye, Q., Wang, M., Hofbauer, V., Stolzenburg, D., Chen, D., Schervish, M., Vogel, A., Mauldin, R. L., Baalbaki, R., Brilke, S., Dada, L., Dias, A., Duplissy, J., El Haddad, I., Finkenzeller, H., Fischer, L., He, X., Kim, C., Kürten, A., Lamkaddam, H., Lee, C. P., Lehtipalo, K., Leiminger, M., Manninen, H. E., Marten, R., Mentler, B., Partoll, E., Petäjä, T., Rissanen, M., Schobesberger, S., Schuchmann, S., Simon, M., Tham, Y. J., Vazquez-Pufleau, M., Wagner, A. C., Wang, Y., Wu, Y., Xiao, M., Baltensperger, U., Curtius, J., Flagan, R., Kirkby, J., Kulmala, M., Volkamer, R., Winkler, P. M., Worsnop, D., Donahue, N. M.

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