Techno-economic analysis of four concepts for thermal decomposition of methane: Reduction of CO₂ emissions in natural gas combustion

This paper presents a techno-economic analysis of four concepts that apply the thermal decomposition of methane (TDM) with the aim of reducing carbon dioxide emissions in natural gas combustion. Different technical solutions are applied to convert methane in natural gas to gaseous hydrogen, which is combusted to produce electricity with a steam power cycle, and solid carbon, which is assumed to be sold as carbon black. The cost of electricity production and the potential to reduce CO₂ emissions in each concept were evaluated and compared to the reference case of direct methane combustion: With a moderate emission allowance price (20 €/t CO₂) and product carbon price (500 €/t carbon) the cost of electricity production in the concepts was 12–58% higher than in the reference case. However, the price of product carbon had a significant effect on the feasibility of the concepts. Thus, the methane burner, which showed the best performance, produced 17% less CO₂ emissions per MWhₑ and had a smaller cost of electricity production than the reference case already with the carbon price of 600–700 €/t carbon.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Chemistry and Bioengineering, Research group: Power Plant and Combustion Technology, ÅF-Consult Oy
Authors: Keipi, T., Hankalin, V., Nummelin, J., Raiko, R.
Pages: 1-12
Publication date: 2016
Peer-reviewed: Yes
Early online date: 1 Jan 2015

Publication information
Journal: Energy Conversion and Management
Volume: 110
ISSN (Print): 0196-8904
Ratings:
Scopus rating (2016): SJR 2.287 SNIP 2.065 CiteScore 6.04
Scopus rating (2015): SJR 2.09 SNIP 2.092 CiteScore 5.24
Scopus rating (2014): SJR 1.854 SNIP 2.835 CiteScore 5.35
Scopus rating (2013): SJR 1.669 SNIP 2.558 CiteScore 4.49
Scopus rating (2012): SJR 1.732 SNIP 2.277 CiteScore 3.72
Scopus rating (2011): SJR 1.292 SNIP 1.846 CiteScore 3.03
Scopus rating (2010): SJR 1.372 SNIP 1.75
Scopus rating (2009): SJR 1.339 SNIP 1.797
Scopus rating (2008): SJR 1.508 SNIP 1.905
Scopus rating (2007): SJR 1.196 SNIP 1.811
Scopus rating (2006): SJR 1.327 SNIP 1.816
Scopus rating (2005): SJR 1.577 SNIP 1.799
Scopus rating (2004): SJR 1.049 SNIP 1.466
Scopus rating (2003): SJR 0.903 SNIP 1.321
Scopus rating (2002): SJR 1.089 SNIP 1.463
Scopus rating (2001): SJR 0.81 SNIP 0.855
Scopus rating (2000): SJR 0.576 SNIP 0.688
Scopus rating (1999): SJR 0.515 SNIP 0.724
Original language: English
Keywords: Carbon capture, Natural gas, Carbon black, Methane decomposition, Techno-economic analysis, Carbon dioxide
DOIs:
10.1016/j.enconman.2015.11.057
Research output: Scientific - peer-review › Article