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Tars removal by non-thermal plasma and plasma catalysis

Cimerman R, Račková D, Hensel K

Faculty of Mathematics, Physics and Informatics, Comenius University,

842 48 Bratislava, Slovakia

E-mail: cimerman@fmph.uniba.sk

Gasification of a fuel or biomass is an industrial process utilized for synthesis gas (syngas) production. The syngas can be used to generate electricity, however after gasification is often polluted with tars and various other pollutants and therefore, syngas clean-up before its further use is necessary [1, 2]. The objective of this study is to investigate the potential of tars removal by non-thermal plasma generated by atmospheric pressure dielectric barrier discharge in combination with various reactor packing materials. Naphthalene was used as a model polyaromatic tar compound. The effects of discharge power (up to 990 J/L), carrier gas (N₂, O₂, ambient air) and packing material (TiO₂, Pt/γ-Al₂O₃, γ-Al₂O₃, glass beads) on naphthalene removal was investigated and gaseous and solid by-products were analysed by means of the FTIR spectrometry. Experiments were performed with initial naphthalene concentration of 5000 ppm at relatively low temperature of 100°C. Naphthalene removal efficiency of 88% and 40% for 320 J/L in air with and without the catalyst was achieved, respectively. The maximum efficiency of almost 100% was observed with TiO₂ catalyst and with oxygen carrier gas. Among the products CO, CO₂, H₂O and HCOOH were positively identified, as well as more complex compounds including 1,4-naphthoquinone and phthalic anhydride and traces of maleic anhydride, 1,4-benzoquinone and phthalaldehyde. The results proved, that combination of the non-thermal plasma with catalysis is very efficient method for tars removal that allow better efficiency compared to the only catalytic [3] or non-thermal plasma [2, 4] alone treatments.

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