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Tar removal by combination of non-thermal plasma with catalyst

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Biomass is one of the most available renewable energy sources around the world. It can be used directly in combustion processes or transformed by gasification processes into biomass derived fuel gas (mixture of CO, H_2, CH_4, etc) often polluted with NOx, SOx and tar. Besides the environmental hazard, tar compounds have negative impacts on the human health, constrain the heating value of the fuel gas, cause operational problems due to aerosol and soot formation, and block particle filters and fuel lines. Thus, it is important to remove tar compounds as well as to investigate new processes to obtain higher removal efficiencies at low energy consumption. Non-thermal plasma processes combined with catalysts represent a promising method able to provide high chemical reactivity and catalytic selectivity, often utilized in numerous environmental applications (e.g. gas and water pollution control). In recent years various stand-alone catalytic and non-thermal plasma systems have been tested for tar removal [1, 2]. The objective of the study was tar removal by non-thermal plasma generated by atmospheric pressure discharges in combination with various metal catalysts. Naphthalene was used as a model tar compound because of its stability and difficulty of being decomposed. Dielectric barrier discharge of cylindrical geometry maintained in the streamer discharge mode, alone or in combination with catalytic pellets was used and the effects of gas mixture composition (N_2, ambient or synthetic air) and temperature (up to 100oC), applied voltage amplitude and frequency (up to 1 kHz) and type of catalyst (Al_2O_3, TiO_2, Pt) were investigated. Naphthalene decomposition and by-products formation was analyzed by means of the FT-IR spectrometry. The plasma chemical effects in two identical plasma reactors with/without catalytic pellets were studied and showed higher naphthalene removal efficiency when plasma catalytic system was used.

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[1] L. Devi, et al. . In Biomass and Bioenergy: New Research, Michael D. Brenes, editor, 249–274, Nova Science Publishers, Inc., (2006).
[2] A. J. M. Pemen et al., Plasma Polym., 8, 209–214 (2003)