EFFECTIVE PLASMA DISCHARGE REFORMING OF METHANE USING WARM NON-EQUILIBRIUM DISCHARGES

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Non-thermal plasma conversion of methane to C_2 hydrocarbons has been studied over the years as a low temperature oxygen free alternative to thermal and partial combustion methods. Currently there is significant renewed interest in this area as society seeks alternative sources of liquid fuels. The conversion of methane to ethylene and acetylene is one of the most inefficient intermediate steps of this process. Study of various discharge techniques and parameters to achieve high selectivity and low energy cost shows that higher energy density systems lead to the most efficient C_2 yields. Most of these systems end up with coke as unwanted byproduct which in turn leads to unstable operation. With the aim of coke minimization and efficient conversion, we are investigating warm non-equilibrium discharge conditions ($T_{vib} > T_{trans}$ but still $T_{trans} \approx$ 500-1000K.)

Experiments are run with methane/hydrogen mixtures using various plasma source measuring both the plasma power and the power supply efficiency. The output gas composition analyzed with SRI 8610C Gas chromatograph consisting of calibrated TCD, HID detectors.

Adding hydrogen to the input methane feed gas is found to minimize carbon deposition and at above ~80% of hydrogen there is zero coke formation. However, hydrogen addition also causes a significant decrease in the conversion efficiency. Varying flow rates , input power, duty cycle that cover input methane specific energy range of 3 MJ/Kg to 43 MJ/Kg and different flow configurations in point to point type reactor (shown in figure 1 below) with flow of gas inside hollow electrodes are experimentally investigated. While lower flow rates and higher powers give the best results in terms of C_2 yields, coke deposition is prevented at higher flow rates and and lower input powers. Since residence time in addition to specific input power appears to affect coke formation, supersonic configurations are also being investigated.

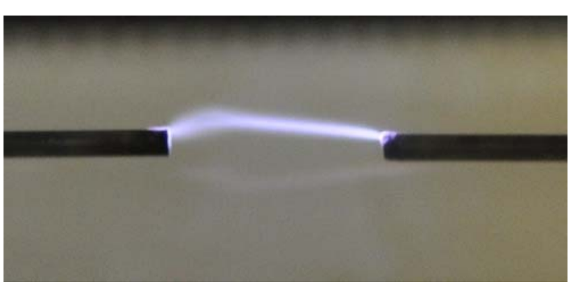

Figure 1 : Warm Non-Equilibrium Plasma Discharge