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Application of Thermal Plasma in hydrogen production

Hydrogen is one of the best alternatives to traditional fuels for developing carbon-less energy resources. However, the hydrogen containing resources are utilized to generate hydrogen. Traditionally, methane (CH4) is used in industries to generate hydrogen while acetylene (C2H2) is used to form carbon black. A popular method to generate hydrogen from methane is steam methane reforming (SMR) [1]. However, SMR generates CO2 which is released in atmosphere. Hence, a challenge remains to develop a method which will not emit carbon products. One such method is pyrolysis of methane by thermal plasma [2]. Now, thermal plasma has high temperature which is essential to dissociate molecules into their constituents.

In this study, different hydrocarbons like CH4, C2H2 was used as source of hydrogen. The DC-arc thermal plasma reactor was used to pyrolyze these hydrocarbons. The product gas was collected and analyzed by GC-MS while the carbon products were analyzed using XRD, Raman spectroscopy and electron microscopy.

The systematic efforts have been undertaken to understand the effect of different plasma plume gases on the hydrogen production efficiency and carbon morphology. Further, the hydrocarbon gases have been flowed through different temperature regions. This variation has also been checked for hydrogen efficiency and carbon products formed.

The hydrogen efficiency is found in range of 60-90% while the carbon products differ from amorphous to crystalline as well as their morphology changes depending on the various factors. Further, carbon products are tested for energy applications like supercapacitor.

References:

[1] Dash, Santanu Kumar, et.al. “A brief review of hydrogen production methods and their challenges.” Energies 16.3 (2023): 1141.

[2] Fulcheri, Laurent, et al. “An energy-efficient plasma methane pyrolysis process for high yields of carbon black and hydrogen.” International journal of hydrogen energy 48.8 (2023): 2920-2928.

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