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Pyro-gasification of agri-crop residue for Hydrogen production: A pilot process demonstration

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Statement of the Problem: The demand for hydrogen is likely to increase in future, which is driven by stringent product specification in oil refineries in the near term and hydrogen becoming an energy carrier in the long term. With rising prices of fossil fuels and depleting natural gas reserves, gasification route is believed to gain more ground as an alternative process to conventional hydrogen production technologies. Here, a total steam gasification process has been developed and demonstrated at pilot scale (0.5- 1 kg/h biomass processing capacity).

Methodology: Any ligno-cellulosic biomass is understood as a polymeric structure containing C, H, N, O and few metals in different proportions. Typically, a conventional gasification process yields CO, CO_2 and H2; where a major portion of the carbon in the biomass is lost as CO_2. Here, a novel process was conceptualized on the basis of superheated steam aided enhanced-elemental extraction from biomass at high temperature. The biomass is treated purely by high temperature steam (~300-400oC) at elevated temperature (700- 750oC). The elemental analysis of biomass suggests a nearly equi-molar composition of C and O in biomass. More than 90% convertible portion of the biomass turns majorly into CO and H_2. CO_2 is formed marginally as there was no additional O2 or air supply. CO was then converted into H2 and CO2 by Water-Gas-Shift reaction in a fixed bed reactor.

Findings: The process was established at pilot scale (1 kg biomass/h) to achieve 90% conversion of ash free basis. Parametric optimization for hydrogen production from steam gasification of biomass has been done for operating parameters i.e. steam to biomass ratio, temperature and residence time. Salient feature in the process is control of biomass residence time and gas residence time in the reactor by adjusting rotating drive rpm and vacuum levels respectively.

Conclusion & Significance: This process exemplifies a robust approach for clean production of hydrogen from agri-residues and provides a potential and alternate way to produce hydrogen for petroleum refineries.

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