Hydrogen or Soot ?: Partial Oxidation of High-Boiling Hydrocarbon Wastes

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Hydrogen or soot ?: Partial oxidation of high-boiling hydrocarbon wastes

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An increased demand on hydrogen, which is essential for a deeper hydrorefining of petroleum oils to ensure better quality of motor fuels motivate research on partial oxidation (POX) of high-boiling hydrocarbons residues or alternative biomass waste. Process POX is based on reaction between raw material and oxygen in the presence of water vapor and its selectivity with regard both to composition of the exhaust gas and soot formation strongly depends on lambda parameter representing molar ratio of oxygen to carbon content in raw material fed to the POX reactor. Combination of thermal pyrolysis of raw material to hydrogen, soot, methane and oxidation or imperfect combustion of wastes to carbon dioxide, carbon monoxide, water are parallel reaction in the reaction space. The raw material is gassified in industrial plants at temperature above 1300 °C under pressure 3.5 MPa. The performance of the operating unit enables to produce (in the reaction space of 1 m^3) 1500 m^3/h of synthesis gas of a typical composition (% vol.):

$H_2 = 49.3$; $CO_2 = 6.8$; $CO = 46{,}0$; $CH_4 = 0.2$; $(N_2 + Ar) = 1.1$; $H_2S = 0{,}7$

An impact steam and oxygen ratio to the feed on the selectivity of the partial oxidation of high-boiling hydrocarbons with regard to the composition of the exhaust gas was detected in our previous studies[1,2]. Content of components in a gaseous product was in very good conformity with a synthesis gas composition produced by the plant unit of the UNIPETROL RPA Co., which opperates according to the license of the Shell Co. Significant formation of carbon black – soot - as a by-product of partial oxidation under the proces conditions has to be separated. Its production can be monitored by discharge of soot dispersion in water, which arises at product quench cooling by water after outlet from the POX reactor.

This paper is focussed to research of the influence of process parameters of partial oxidation like quality of hydrocarbon raw materials, which differed in their stock properties (especially the boiling point and viscosity), on the composition of output gas (selectivity of the process) and also on the formation extent of soot which can be used as an excellent and valued sorbent CHEZACARB(TM) and/or filler in rubber industry, e.g. for automotive tires. The effects of steam flow rate and oxygen to raw material feed rate ratio is discussed as well.

Process performance is compared with results of simulation by Aspen Plus program. Both chemical equilibrium and kinetic of pyrolysis and soot formation are taking into account. Also sensitivity of POX product composition depending on properties of different raw materials and reaction condition are analysed by mathematical modelling.

Literature

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