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Catalytic Soot Gasification in Single and Mixed Atmospheres of CO2 and H2O in the Presence of CO and H2

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Abstract : LiFeO2 nano-powders were prepared via solution combustion synthesis (SCS) method and were used as carbon gasification catalyst in a reduced atmosphere. The gasification of soot with CO2 and H2O in the presence of CO and H2 (syngas atmosphere) were also investigated under atmospheric conditions using a fixed-bed micro-reactor placed in an electric, PID-regulated oven. The catalytic bed was composed of 150 mg of inert silica, 45 mg of carbon (Printex-U) and 5 mg of catalyst. The bed was prepared by ball milling the mixture at 240 rpm for 15 min to get an intimate contact between the catalyst and soot. A Gas Hourly Space Velocity (GHSV) of 38.000 h-1 was used for the tests campaign. The furnace was heated up to the desired temperature, a flow of 120 mL/min was sent into the system and at the same time the concentrations of CO, CO2 and H2 were recorded at the reactor outlet using an EMERSON X-STREAM XEGP analyzer. Catalytic and non-catalytic soot gasification reactions were studied in a temperature range of 120°C – 850°C with a heating rate of 5 °C/min (non-isothermal case) and at 650°C for 40 minutes (isothermal case). Experimental results show that the gasification of soot with H2O and CO2 are inhibited by the H2 and CO, respectively. The soot conversion at 650°C decreases from 70.2% to 31.6% when the CO is present in the feed. Besides, the soot conversion was 73.1% and 48.6% for H2O-soot and H2O-H2-soot gasification reactions, respectively. Also, it was observed that the carbon gasification in mixed atmosphere, i.e., when simultaneous carbon gasification with CO2 and steam take place, with H2 and CO as co-reagents; the gasification reaction is strongly inhibited by CO and H2, as well has been observed in single atmospheres for the isothermal and non-isothermal reactions. Further, it has been observed that when CO2 and H2O react with carbon at the same time, there is a passive cooperation of steam and carbon dioxide in the gasification reaction, this means that the two gases operate on separate active sites without influencing each other. Finally, despite the extreme reduced operating conditions, it has been demonstrated that the 32.9% of the initial carbon was gasified using LiFeO2-catalyst, while in the non-catalytic case only 8% of the soot was gasified at 650°C.

Keywords : soot gasification, nanostructured catalyst, reducing environment, syngas
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