VAPOUR EXTRACTION AND DEVOLATILIZATION OF ASSAM COAL

BY

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ABSTRACT

The present thesis reports the results of an exploratory research with an aim to seek an alternative route for progressive atmospheric pressure liquefaction of coal under the conditions of Low temperature carbonization. A comprehensive literature survey on the reported liquefaction processes have been made. It was proposed that subjecting coal to a devolatilization process in presence of solvent vapours could enhance the yield of liquid products in a normal carbonization type process; if a chemical reaction could be superimposed on the devolatilization reaction, polymerization of coal fragments leading to coke formation could be prevented thereby enhancing further yield of liquid products through decomposition of stabilized coal fragments. This way, coal could be progressively liquefied through cracking, chemical reaction and vapour extraction.

Following the above logic a detailed study on vapour extraction of coal was made using a number of liquid vapours (some gases as well). An attempt was made to conduct alkylation type of chemical reactions under some selected condition of vapour extraction. A kinetic study of steam extraction and a thermogravimetric study of the coal devolatilization were also made.

A series of vapour extraction experiments were conducted on Assam coal with a small laboratory scale experimental set-up employing a silica reactor assembly. A small sample of coal (about 5 gms.) was subjected to various solvents, gases and in combination of them under a temperature condition varying between 430-620°C. The results were

evaluated on the basis of loss in weight of coal on extraction, and carbon-hydrogen and ash analysis of the residue. The extraction yield was found to vary from 21 to 36 % in the temperature range 430-620°C and remained unaffected by the type of vapours used. Analysis of the residue by Infra Red spectra indicated minor structural changes due to the effect of different solvent vapours.

The process of vapour extraction was also studied with superimposition of alkylation type of chemical reaction. A strong possibility of having enhanced yield of liquid products was indicated by the results.

In order to understand the mechanism of coal decomposition in the devolatilization process, a rate study was conducted on vapour extraction with steam as the extractant under isothermal conditions. At five different temperatures (400, 420, 460, 480 and 510°C), extraction was studied under varying lengths of time. The analysis of the data indicated that the devolatilization process could not be explained by the same reaction mechanism at all the temperatures. Testing of experimental data with solid-gas reaction models showed that the devolatilization process seemed to be chemical reaction rate controlled only in the temperature range of 460-480°C. The activation energy in this region was found to be 50.6 Kcal/mole. The process at higher temperature appeared to be diffusion controlled. In the lower temperature region the process could be controlled by both diffusion and external mass transfer.

The process of devolatilization was also studied under inert atmosphere by using thermogravinetric analysis (TGA) technique. It was apparent from the non-isothermal analysis of the data at different heating rates (2, 5, 10, 20, 30, 50 and 100°C/min.) that the process of devolatilization could be chemical reaction rate controlled in the temperature range of 450-500°C. This was supported by the value (53 Kcal/mole) of activation energy and also by the value observed in the study of steam extraction.

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