UPGRADATION OF KUTCH LIGNITE : A STUDY

By

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CERTIFICATE

This is to certify that the thesis entitled "UPGRADATION OF KUTCH LIGNITE: A STUDY", being submitted by K. KESHAV to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of the bonafide research work carried out by him. Mr. K. KESHAV worked under my guidance for the submission of this thesis which to my knowledge has reached the requisite standards.

This thesis or any part thereof, has not been submitted to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

In view of the universal energy crisis, alternate sources of energy like biomass and lignites have been investigated for commercial usage.

Lignites are low ranking coals and their direct usage as fuel pose problems like pollution, low calorific out put, lumping etc. Therefore it was thought worthwhile to find means of upgrading lignites to a value added fuel like, synthetic oil, fuel oil, or even gasoline range liquid fuels.

The present work is restricted to Kutch lignites. The various routes for upgradation have been (i) desulphurization (ii) alkali degradation of the desulphurized lignite (iii) hydrogenation of the products of alkaline degradation.

Lignites in general including Kutch lignite are known to possess a high sulphur content varying from 2-7%. This hampers the smooth hydrogenation and creates pollution problems.

A simple and novel technique of solvent - vapour extraaction with simultaneous desulphurization has been developed. At a temperature of 300 - 350°C vapour extraction with donor solvent resulted in an extract along with some elemental sulphur. To better the yield of desulphurization a number of solvents with varying residence time and different catalyst were put to test. An enhancement in desulphurization was noted when

catalysts were used. The desulphurized lignite resulting from the optimized run was taken for the alkaline degradation reaction.

Alkali degradation has been explored with the idea of breaking down the lignite complex into simpler fragments of lower molecular weight. Since the main aim of lignite upgradation was to convert it to a value added liquid fuel which possessed a higher hydrogen to carbon ratio, hydrogenation seemed to be a necessary step. As has been established by researches so far, hydrogenation involves high pressure and high costs. By way of reducing the cost of hydrogenation, the lignite structure was broken down into smaller units, much less complex than the original lignite. Alkali degradation was the reaction of choice.

Alkali degradation reactions in different mediums have been tried out, such as in (i) aqueous phase (ii) donor solvents, and (iii) oxidizing agents. Studies of the infrared spectra's and the increase in solubility showed that there was a simplification of the structure.

As expected the alkali degraded lignite (having less molecular complexity) could be hydrogenated at a much lower pressure of 20-40 atmospheres as compared to reported conditions of 200-250 atmospheres and therefore at lower costs. Various catalysts used have shown an enhanced conversion capability of nearly 36%.

The calorific value of different lignites namely (a) original lignite (b) desulphurized lignite (c) alkali degraded lignite and (d) hydrogenated lignite residue and liquids, showed a steady increase from 4811 cal/g for original lignite to approximately 6000 cal/g for the hydrogenated liquid product, thereby showing a distinct upgradation.

The general conclusion based on this work is that lignite by desulphurization and structural simplification by alkali degradation, could be hydrogenated under less severe conditions of pressure and temperature to given an upgraded product. The process developed could be scaled up to prove economical.

CONTENT

Page No.