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SUBJECT: CATALYTIC COAL HYDROGENATION USING ZINC SLIMES

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CATALYTIC COAL HYDROGENATION USING ZINC SLIMES

SYNOPSIS

The selection and utilization of South African raw materials as catalysts in coal conversion depend on the availability of catalysts. Equally important is the selectivity and activity of these materials for coal conversion.

We are now trying to establish which raw materials are the most promising candidates. For this purpose a method has been developed to screen catalysts in the process of dry hydrogenation (1). The test involves the reaction of pulverised coal (100 - 200 mesh) with hydrogen in a rotating autoclave at 470°C and 100 atm. cold pressure for 1 hour.

It has been discovered that zinc slimes give an 89,1% total conversion of coal with a 44% oil, 15% asphaltene and 30% gas yield. The coal used came from the Sigma colliery.

This is the highest conversion yet obtained in this system for this coal and is of considerable interest. For example, it offers a cheap catalyst in enormous quantities. Sigma coal is not generally considered to be a good candidate for direct hydrogenation because of its high mineral matter and inertinite content.

Extension of this study to other raw materials is planned.

INTRODUCTION

It is commonly known that zinc is one of the best coal hydrogenation catalysts available (2). This metal is also extensively mined in South, and South West Africa where it commonly occurs as sphalerite. This ore is primarily ZnS.

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In the processing of this ore, flotation upgrades the zinc to about fifty per cent. The gangue material discharged into slime dams contains residual zinc either in the sulphide, carbonate or silicate form.

Typically up to 3% metals (principally Zn, Pb, Cu) are discharged into slime dams, with the primary constituent being fine sand. One can therefore regard the quartz as a carrier or diluent of those metals.

In our studies on coal conversion by dry hydrogenation, mass transfer properties have proved to be in some cases at least as important as catalytic parameters. To improve the mass transfer characteristics, inert materials are added to coal to prevent agglomeration. One of these inerts that successfully has been employed in this laboratory is quartz sand (1). Therefore the slime naturally contains this diluent to improve mass transfer.

RESULTS AND DISCUSSION

27,1 grams of 100 - 200 mesh dry Sigma coal from the Sasol I area yielded on overall conversion of 89,1%. The percentage conversion is calculated from the following equation.

$$\% \text{ conversion} = 100 \quad 1 - \frac{(\text{Organic matter + catalyst in residue})}{(\text{Organic matter + catalyst in feed})}$$

A blank run was used to measure the mass loss incurred by the catalyst under the operating conditions.

7,77 grams of oil were obtained which is equivalent to a 44% oil yield on a d.a.f. basis.

2,7 grams of asphaltene were obtained, equivalent to 15% on a d.a.f. basis.

As comparison, 100 - 200 mesh Sigma coal without catalytic material gives an overall conversion of 46% with an oil and asphaltene yield of 11% and 4% respectively.

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This fourfold increase in oil and asphaltene and twofold increase in total conversion must be rated as significant.

CONCLUSIONS

The catalytic activity of zinc slimes for dry hydrogenation of coal is such, that this local waste product can be rated as the best catalyst screened so far in this laboratory under the conditions of this particular catalyst testing. The discovery warrants further investigation.

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