

does contrive, and somehow manage, to effect a balance between principles and practice and does include the important topic of catalyst preparation eschewed in most other texts. Both academic and industrial researchers will therefore find much to interest them between the covers of this book.

Due to the lapse in time between the original publication and its translation, no references later than 1980 are quoted and this is regrettable. However, Chapter 9 does describe unpublished useful and current process information.

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Catalysis in Coal Liquefaction: New Directions for Research. By FRANK J. DERBYSHIRE. IEA Coal Research, London, United Kingdom, 1988. 69 pp. \$60.00 to member countries, \$180.00 to nonmember countries.

IEA Coal Research issues report on various aspects of coal science and technology. The author chosen to write on catalysis in coal liquefaction faced a formidable task. There is a plethora of published papers on this subject and separating the wheat from the chaff is difficult. Fortunately, the author has written an excellent manuscript that is a must for any worker in, and around, the field of direct coal liquefaction. This could have been accomplished only by someone whose vast experience in this area lends confidence to his judgment.

The "direct" liquefaction of coal connotes the conversion of coal to liquids (with some gases) by a route that does not proceed by means of the intermediate production of synthesis gas. The latter is termed "indirect" liquefaction and is exemplified by the Fischer-Tropsch process. The direct catalytic liquefaction of coal is usually carried out at about 400°C and 13–20 MPa of H₂. Covalent bonds are broken under these conditions; it is generally assumed that the radicals formed are capped by hydrogen atoms from H₂ or from hydroaromatic polynuclear compounds in the solvent used to slurry the coal into the reactor.

Coals differ greatly in carbon, oxygen, and sulfur contents as well as in the amounts and kinds of inorganic materials. The fact that coals are solids greatly

complicates processing. This volume, if studied carefully and the selected references read, will open the door a bit to the use of catalysts in direct coal liquefaction for those not familiar with the field. It has value as a guide for those not involved in this area of catalyst research; it furnishes a path through the foliage which precedes the dense woods that constitute direct coal liquefaction research. The way is not easy to follow and many workers in catalysis tend to avoid the subject.

Coal is a reactive macromolecular substance which may be "depolymerized" at comparatively low temperatures (100–250°C) with acid catalysts operating chiefly by ionic mechanisms. The catalyst should promote the cleavage of connecting linkages between clusters and also prevent retrogressive reactions of reactive intermediates. The difficulty lies in balancing the rather easily achieved depolymerization step with a high-temperature (400–450°C) hydrogenation (hydrogenolysis) step to produce quality distillate fuels while preventing the formation of high-molecular-weight substances. This is the heart of the problem in direct coal liquefaction and it is far from being solved. Evolutionary progress has been made; revolutionary solutions are called for. One apparent approach is to find factors which influence the introduction of catalysts to the coal in an active and highly dispersed form. Methods for quantifying the dispersion are needed. It is proposed that highly dispersed catalysts be used in a first stage, followed by a second upgrading step. Supported catalysts are generally used in this latter stage, but they are easily deactivated with high-boiling feeds. Perhaps research on catalyst-support interactions will be useful in this regard.

The author expresses surprise at how seldom optical and microscopic techniques have been used in the field of catalytic coal liquefaction. This is an area in which catalyst researchers can make significant contributions by introducing and modifying methods they commonly use. H₂S plays an important role in coal liquefaction although it is still unclear.

The bibliography is extensive but selective rather than comprehensive. This report could be of interest to catalyst researchers in general; workers in coal conversion would be well served to own this volume. However, the price of the report is a deterrent.

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