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Book Review

Kinetics of Coal Gasification—A Compilation of Research by the late Dr. James Lee Johnson, Wiley Interscience, New York, 1979, 324 pp., price £14.35.

This book presents a series of Dr. Johnson's publications, and sets out the development of coal gasification kinetics thus providing the reader with an excellent description of these processes in a single volume. There is a comprehensive first chapter dealing with Fundamentals of Coal Gasification. This publication in fact appears in the Chemistry of Coal Utilization, supplementary Vol. II. The other chapters are more specialized. Chapter 2 describes the kinetics of coal gasification in hydrogen during initial reaction stages and is adapted from a paper presented at the Joint U.S.–U.S.S.R. symposium on coal gasification/liquefaction at Moscow in 1976. The gasification of Montana lignite in hydrogen and helium during initial reaction stages is likewise adapted from a paper presented at the 170th National Meeting of the ASC/DFC, Chicago, in 1975 and forms the subject matter of Chapter 3. A short paper presented at the same meeting dealing with the relationship between gasification reactivities of coal char and physical and chemical properties of coal and coal tar becomes Chapter 4 in this book. Dr. Johnson must have been a very busy man at this conference, for Chapter 5 on the Use of Catalysts in Coal Gasification is also from a paper presented at this meeting in Chicago. The final chapter on the kinetics of bituminous coal char gasification with gases containing steam and hydrogen comes from the Advances in Chemistry Series, Number 131, 1974. Taken together these six chapters form a very impressive testimonial to the scientific accomplishments of Dr. Johnson.

The book provides the thermal analyst with some beautiful examples of the art. Dr. Johnson is able to show that rising temperature kinetics analysis can be applied to the subject and thereby emphasizes the point that the kinetic analysis is a theoretical exercise performed upon data such as fractional decomposition against temperature where the temperature noted is that obtained by a linear heating rate being imposed upon the system. Dr. Johnson notes that the subject of coal gasification covers the conversion of coals to light gases, condensable liquids and tars, and solid products in the presence of reactive gaseous atmospheres. Thus gasification is distinct from other forms of coal conversion such as pyrolysis or carbonization, which occur in inert-gas atmospheres, or liquefaction which occurs in liquid medium. He deals first with equilibrium conditions and their temperature dependence. Dr. Johnson compares the heat of reaction for various carbon gasification processes with carbonization heat effects obtained by differential scanning calorimetry or differential thermal analysis experiments. He goes on to deal with the physical processes which affect the gasification process and then considers the

textural changes taking place in the remaining solid phase during gasification, a factor often ignored in theoretical treatments of decomposing solid state systems. He develops a method of a "rising temperature kinetic analysis" based on constant residence time conversion functions which enables the Arrhenius parameters to be calculated. This is achieved by, for example, leaving the sample of coal in the thermobalance at a particular temperature for a residence time of say 60 minutes and simply using the balance to note the weight loss fraction. This basic data of weight loss fraction against temperature is then related at different atmospheres of hydrogen and the data utilized as indicated above to give the Arrhenius parameters. It is interesting in that although he considers a model of coal hydrogasification based on a first order reaction with a distribution of activation energies, he does not then proceed to demonstrate a compensation effect which might be expected as a result of such a model.

The thermobalance utilized in these studies is a specially constructed unit. It is capable of continuously weighing a coal sample which is undergoing reaction in a gaseous environment of desired composition at a constant pressure. The temperature can be kept constant or programmed at a constant rate. A transducer records the weight change. Gas analysis is by a mass spectrometer. A controlled gas flow is possible and the operating pressure range is very impressive.

This book is the result of a mastered and continued dedication to research in a single field which, taken with the dedicating statements at the beginning of the volume, allows one to perceive the determined character of Dr. Johnson as well as appreciate the sophistication of his scientific analysis and the care and planning which went into the experimental work.

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