

# Kinetics of Short Contact Time Coal Liquefaction

## Part I: Effect of Operating Variables

The liquefaction kinetics of Pockhams No. 5 subbit coal (Pittsburgh Seam) in the presence of SRC-II recycle solvent at short contact times (<10 min) and temperature and pressure ranges of 673–723 K and 10.5–13.6 MPa is examined in a well-mixed reactor. In the initial stages of liquefaction, while overall coal conversion (tetrahydronaphthalene solubles) increases with temperature, oil (pentane solubles) is lost with an increase in temperature. An increase in solvent-to-coal ratio results in an increase of conversion. The initial coal particle size distribution, total pressure, and nature of gas phase (nitrogen or hydrogen) have no significant effect on the production of any of the product of liquefaction for contact times up to 10 min. A lumped kinetic model is presented to describe the product distribution.

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### SCOPE

The primary reactions in conversion of coal to liquid fuels in any coal-oil slurry liquefaction process are pyrolytic in nature and require high temperature to overcome the distribution of activation energies involved in the rupture of bond linkages in the macromolecular network of coal. It is known that when coal is contacted with a hydrogen-donor solvent, at elevated temperatures (693–723 K), much of the coal conversion to soluble products takes place in the initial 2–5 min. Hence, the preheater in the coal liquefaction process is a critical component, as it behaves as a short contact time reactor. Usually, there has been a considerable interest in the development of a short contact

time two-stage process. This paper presents a short contact time (<10 min) coal liquefaction kinetic study which is carried out in a well-mixed, 1-L stainless autoclave reactor. The experimental data are obtained for Pockhams No. 5 subbit coal at various practical ranges of temperatures, pressures, solvent-to-coal ratio, and initial coal particle size. Both nitrogen and hydrogen was used as the gas phase. The data are correlated by a lumped kinetic model which would be useful in predicting the performance of a preheater or a short contact time coal liquefaction reactor.

### CONCLUSIONS AND SIGNIFICANCE

The kinetics of coal liquefaction at short residence times (under 10 min) has been studied. The products of liquefaction were characterized as:

Preasphaltenes	{ Soluble in Tetrahydrofuran Insoluble in Toluene
Asphaltenes	
	{ Soluble in Toluene Insoluble in Pentane
	Oil Solubles in Pentane

It is shown that initially there is an effective loss of oil, whereas the preasphaltenes and asphaltenes are rapidly formed indicating a fast dissolution of coal in the initial stages. A statistical analysis of the experiments shows that the temperature has a significant negative influence on oil concentration with a

minimum at around 2–4 min of reaction time. This result indicates the occurrence of an additive reaction between coal and oil leading to some intermediate products which in turn react to give oils. The production of toluene and tetrahydrofuran solubles is shown to be positively influenced by temperature. The solvent-to-coal ratio also significantly influences the product distribution.

An investigation of the influence of gas phase (nitrogen and hydrogen), particle size, and total pressure, at short-time liquefaction show no statistically significant effect in the range of variables studied. From a kinetic standpoint, it appears that there is no need to add hydrogen to the first stage of the short contact time two-stage processes or the preheater or other processes; however, hydrogen may be needed to prevent coke formation. A kinetic model is developed to predict the product distribution over the entire range of operating variables studied. This model should be useful in predicting the product distribution coming out of a preheater or a short contact time coal liquefaction reactor.

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# Kinetics Of Short Time Coal Liquefaction

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## **Kinetics Of Short Time Coal Liquefaction:**

*Kinetics of Short Contact Time Coal Liquefaction* Jeevan Sahib Abichandani, 1984      *Fossil Energy Update*, 1977

**Engineering Kinetics of Short Residence Time Coal Liquefaction Processes** R. K. Traeger, 1978      **Energy Research Abstracts**, 1993 Semiannual with semiannual and annual indexes References to all scientific and technical literature coming from DOE its laboratories energy centers and contractors Includes all works deriving from DOE other related government sponsored information and foreign nonnuclear information Arranged under 39 categories e g Biomedical sciences basic studies Biomedical sciences applied studies Health and safety and Fusion energy Entry gives bibliographical information and abstract Corporate author subject report number indexes      Energy Research Abstracts, 1983 Semiannual with semiannual and annual indexes References to all scientific and technical literature coming from DOE its laboratories energy centers and contractors Includes all works deriving from DOE other related government sponsored information and foreign nonnuclear information Arranged under 39 categories e g Biomedical sciences basic studies Biomedical sciences applied studies Health and safety and Fusion energy Entry gives bibliographical information and abstract Corporate author subject report number indexes      Energy, 1984      *ERDA Energy Research Abstracts* United States. Energy Research and Development Administration, 1977      **Energy: a Continuing Bibliography with Indexes**, 1981      **ERDA Energy Research Abstracts**, 1983      **Scientific and Technical Aerospace Reports**, 1983-10      *Proceedings*, 1983      **Fossil Energy Research and Development Program of the U.S. Department of Energy** United States. Department of Energy. Office of Energy Technology, 1978      Theoretical Chemical Engineering Abstracts, 1984      *ERDA Energy Research Abstracts* United States. Energy Research and Development Administration. Technical Information Center, 1977      *Papers and Discussions Presented Before the [Coal] Division* American Institute of Mining, Metallurgical, and Petroleum Engineers, 1985      **Coal Abstracts**, 1992      **Applied Science & Technology Index**, 1985      Comprehensive Dissertation Index, 1989      **Energy and Fuel Systems Integration** Yatish T. Shah, 2015-10-15 Energy and Fuel Systems Integration explains how growing energy and fuel demands paired with the need for environmental preservation require different sources of energy and fuel to cooperate and integrate with each other rather than simply compete Providing numerous examples of energy and fuel systems integration success stories this book Discusses the use of different mixtures of fuels for combustion gasification liquefaction pyrolysis and anaerobic digestion processes Describes the use of hybrid nuclear and renewable energy systems for power and heat cogenerations with nonelectrical applications Details the holistic integration of renewable nuclear and fossil energy systems by gas heat and smart electrical grids Energy and Fuel Systems Integration emphasizes the many advantages of these integrated systems including sustainability flexibility for optimization and scale up and more efficient use of storage transportation and delivery infrastructures      Chemical Engineering Abstracts, 1988

## Embracing the Track of Phrase: An Emotional Symphony within **Kinetics Of Short Time Coal Liquefaction**

In a global taken by displays and the ceaseless chatter of quick conversation, the melodic beauty and psychological symphony created by the written word frequently disappear into the backdrop, eclipsed by the relentless noise and interruptions that permeate our lives. However, nestled within the pages of **Kinetics Of Short Time Coal Liquefaction** a marvelous fictional value full of organic feelings, lies an immersive symphony waiting to be embraced. Crafted by an outstanding musician of language, this charming masterpiece conducts visitors on an emotional trip, well unraveling the concealed melodies and profound impact resonating within each cautiously constructed phrase. Within the depths of this poignant analysis, we will explore the book is main harmonies, analyze its enthralling writing design, and surrender ourselves to the profound resonance that echoes in the depths of readers souls.

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