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SCIENCE

Research Opportunities in Fossil Fuels

The Syncrude project to produce oil from the Athabasca tar sands is an awesome sight. A 600-foot stack dominates the scene. A 260-megawatt power station will cogenerate process steam. Four mammoth electric-powered dragline scoops will retrieve tar sand from a 130- to 150-foot-thick bed lying some 50 feet beneath the surface. Two electric-powered conveyors 3 miles long and 6 feet wide will take the sand to what must be the world's largest washing machines, where tar and sand will be separated. The sand tailings will be initially stored in a large retention pond but ultimately returned to the diggings. The tar will be upgraded to a high-quality synthetic crude oil in a processing plant as big as a refinery. All this is being put in place in the northern climate of Mildred Lake, Alberta, Canada, 300 miles north of Edmonton. Syncrude will start up in 1978 and when fully operational, will average about 110,000 barrels per day of synthetic crude.

Over $2 billion will be spent at Mildred Lake before production begins. Even this is small when compared with the investment to recover oil and gas from the North Sea—that will be larger than the cost of Project Apollo. In different terms, the cost of the North Sea projects is currently $10,000 and more for each daily barrel of oil production capacity. Larger costs and corresponding research, development, and engineering will be involved in coal gasification and liquefaction, shale oil recovery, and deep drilling on the continental rise or the deep structures of the Gulf of Mexico. These are likely to be at least an order of magnitude more expensive than "conventional" oil production on shore.

Projects such as Syncrude and the North Sea are economically attractive only because of current and projected world energy prices. This situation carries over to solid hydrocarbons, where low-rank and high-sulfur coals may be gasified or liquefied before transportation and use, removing pollutants in the process. In the direct use of coal, complex and controlled combustion will be the rule—for example, fluid bed combustion to achieve acceptable flue gas quality.

The increasing costs of obtaining and using fossil fuels from low-quality or hard-to-get-at sources are impressive, but even more impressive is the opportunity provided for science and technology. Production, refining, and use of fossil fuels, already highly technology intensive, will continue to demand even more scientists and engineers. Chemistry is crucial, as are chemical, mechanical, and civil engineering. Catalysis, thermal chemical processing, and physical separation of chemical species have long been staples of petroleum refining. These same disciplines are involved in coal gasification and liquefaction. Technological improvements are needed to cut investment, to make conversion more energy efficient, and to improve the quality of products. This must be done with resource feeds of low quality, which will probably be high in contaminants such as sulfur, nitrogen, and heavy metals. New corrosion-resistant materials, improved designs, and better catalysts will be required. Computer control of complex chemical processes will be vital.

The coming years will see the creation of new industrial complexes based on fossil feeds. They will produce useful fuels and chemicals from a variety of inputs. The processes involved will be energy efficient, effluents will be reduced, and the toxicities of the products will be known and controlled. There are still many issues to be considered, such as the carbon dioxide greenhouse effect and the potential environmental damage of removing materials from the ground. Federal policies are a major uncertainty. Nevertheless, the opportunity for disciplined and creative minds is extraordinary.—EDWARD E. DAVID, JR., *President Elect, AAAS (1978), and President, EXXON Research and Engineering Company, Florham Park, New Jersey 07932*