Can Physicists Clean Up Coal's Act?

American Physical Society panel urges a national coal sample bank, facilities for testing models of processes, and lots of research

Despite the suspected environmental consequences of digging and burning the stuff, coal figures prominently in most studies of how to provide the United States with energy in the next few decades. Generating electricity by burning coal directly in power plants is scheduled to become even more common than now, and a much-debated effort to create a synthetic fuels industry based on turning coal into gases and liquids began during the Carter Administration. Now the physicists want a piece of the action. A report released last week by the American Physical Society asserts that physicists and their research techniques can play a significant role in making coal technology a more scientific and thereby more economical endeavor.*

The report, the outcome of a 14-month study by a 17-member panel headed by Bernard Cooper of West Virginia University, is the latest in a series emanating from the society's Panel on Public Affairs. Earlier studies included one on nuclear reactor safety which called attention to some flaws in the famed Rasmussen report, which the nuclear industry had been using to support its claims of safety. The coal report's recommendations are not intended to affect the choice of near-term advanced coal or synthetic fuels technologies. The idea is that a solid research base will provide the information, now lacking, to make second and later generation processes economically efficient and environmentally more benign. However, the heavy emphasis on research could serve to support the Reagan Administration's recent decision to shift spending away from pilot and demonstration plants to more basic studies.

Cooper explained that the study panel took as its starting point a presumed U.S. decision to expand the use of coal. The goal was to find out what physicists could do to help out. However, the study panel did come in with two major "institutional" recommendations addressed to funding agencies and to the coal and synthetic fuels industry. The first was a strongly worded statement of support for a recently proposed national sample bank. The bank would be a repository for well-characterized, preserved "standard" samples that would be made available to researchers. Coal is such a variable material that findings from different samples of even the same type of coal may not be comparable. The sample bank would help to alleviate this problem. Storing coal is not simply a matter of setting lumps of the material on shelves in a cupboard. The main storage methods now involve preserving samples in a relatively inert environment at a low temperature. The proposed sample bank would also seek new methods.

The second major recommendation was to initiate "a program to gain fundamental understanding of processes for coal utilization and synthetic fuel production." The panel members seemed especially impressed by the absence of good models for what goes on in synthetic fuels plants, fluidized-bed combustion chambers, or magnetohydrodynamic systems, where the operating conditions are severe. The temperature and pressure are very high (2000 K and several hundred atmospheres), and there are corrosive chemicals and streams of finely divided (40-micrometer-diameter) particulate matter flying about at high speeds. Moreover, instrumentation capable of monitoring what is happening under such adverse conditions is also lacking. The idea is to make process development more scientific and less empirical or experience-based. Thus, improved instrumentation, including the use of laser and acoustic techniques, would allow acquisition of the type of data needed to construct models and verify them. It would also tie in to the development of process control techniques. In addition to instrumentation, dedicated test facilities would be needed that could duplicate the conditions of an operating synfuels or other plant.

To coordinate the proposed program, the study panel recommended that "overall responsibility . . . be assigned to an appropriate group." What kind of group was left unspecified, but apparently the possibilities range from setting up a new division in one of the Department of Energy's national laboratories to an all-new organization similar to the Solar Energy Research Institute. One observer suggested that this recommendation carried an implied criticism of DOE, which some think does not have a clear idea of what should come next in advanced coal and synfuels. Cooper did not go that far but did tell *Science* that the hoped-for response from DOE, which sponsored the study, is the establishment of an ad hoc committee to decide the best approach in the next few months.

The largest part of the report is addressed primarily to physicists and seeks to acquaint them with coal, coal technology, and research problems in these two areas. The panel was roughly divided into two groups, those ignorant of coal but expert in various areas of physics and those practiced in the art and science of coal, including some engineers. This heterogeneous bunch did not attempt to review every aspect of coal but instead identified seven general topics within which there clearly were opportunities for physicists and their research techniques to contribute. These topics were pore structure of coal, analytical techniques, instrumentation and control techniques, modeling and flow theory, materials, size-dependent phenomena, and catalysis.

Catalysis was a rather obvious topic to investigate, as physicists have been actively pursuing research in surface science for many years. Size-dependent phenomena, which mainly refers to what happens when coal is ground up into small particles, is considerably less intuitive. On the face of it, nothing seems remoter from the elegant world of physics than grinding up lumps of coal. Yet existing processes are wasteful of both energy and material. In one of its recommendations, the report suggested an investigation in coal particles of various sizes of the mechanisms by which the cracks that lead to fracture are initiated and subsequently propagate. Claimed the panel, "One immediate and very far reaching implication of the better understanding of the fracture physics of coal would be the design of energy efficient mills."

Development of an advanced coal and synfuels industry will require decades and hundreds of billions of dollars. With this kind of investment, said one study panel member, it is important "to get it right the first time." The American Physical Society's coal report is telling the community it can help to get it right, but will physicists heed the call?

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*"Report to the American Physical Society by the Study Group on Research Planning for Coal Utilization and Synthetic Fuel Production," *Rev. Mod. Phys.* **53** (4, part 2) (October 1981).

0036-8075/81/0925-1484$01.00/0