management and water pollution control, and to increase the number of institutions providing such training.

These grant programs develop new technical information and broaden the base of scientific participation in water research. This broad participation provides practical training for professional personnel in specialized fields of natural resources. The Department's training grant and research fellowship programs award direct support to institutions and individuals for specialized training in water pollution control.

ENERGY

GASIFICATION AND LIQUEFACTION OF COAL

The Department of the Interior's program in this area consists of in-house scientific and engineering development work by the Bureau of Mines and research contracted for by the Office of Coal Research. The objective of both agencies is the production of petroleum-type fuels and natural gas substitutes from coal by processes that are economically competitive with the natural products. At the same time, however, the total program is carefully coordinated to avoid any duplication of effort.

Conversion of coal to liquid and gaseous fuels is being investigated in the development stage by five routes, namely, carbonization, solvation, hydrogenation, gasification, and catalytic synthesis. The processes thus far evolved employ two or more of these five methods. Gasification is required to produce the hydrogen for hydrogenation, as well as the synthesis gas for catalytic synthesis. Carbonization yields a liquid product suitable for hydrogenation into a petroleum-type liquid. Solvation provides a means of separating the hydrogen-rich fractions of the coal from its recalcitrant high-carbon content and the mineral matter. In this way a product suitable for hydrogenation into a liquid petroleum-type oil is obtained.

Four projects aimed at production of liquid fuels from coal are being conducted under contract to the Office of Coal Research. They are: (1) Solvation followed by hydrogenation, (2) Fluidized carbonization followed by hydrogenation, (3) Hydrogenation of the whole coal and (4) Carbonization of coal as slurry in petroleum-type residues. The in-house projects being performed by the Bureau of Mines are: (1) Novel methods for hydrogenation of coal and tars, (2) Entrained flash carbonization and vapor phase hydrogenation, and (3) Catalytic synthesis of gasoline.

Work directed toward production of gaseous fuels from coal involves a number of projects designed to eliminate or reduce the oxygen requirement for production of hydrogen and synthesis gas. Contract projects under the Office of Coal Research are: (1) Superpressure gasification, (2) Use of molten salts, and (3) Dolomite, to furnish the required reaction heat. In-house projects of the Bureau of Mines are concerned with: (1) Fluidized gasification of caking coals, (2) Two-zone gasification with air to produce synthesis gas or a rich producer gas, and (3) Fixed bed gasification of caking coals to produce an industrial gas.

Two processes are also under development—one by contract, the other in-house—for the hydrogenation of coal at high temperature into a natural gas substitute. One process would convert pretreated coal to gas suitable for upgrading by catalytic synthesis and would generate a portion of the hydrogen required in the hydrogasifier by the injection of steam which would serve also to control the temperature. The other process would use a raw bituminous coal to produce a high-Btu gas directly and would produce the hydrogen needed externally or by reaction internally of steam with iron. Catalytic synthesis of high-Btu gas is also being investigated.

Bureau of Mines programs in basic research are directed toward study of corona and high-frequency electrical discharges and laser beams in reactions with coal. These are supplemented by studies directed toward determining acid catalysis mechanisms, production of hydrogen catalytically from coal and to the electrochemical hydrogenation of coal; the latter two, at low temperatures and atmospheric pressure. Projects under contract involve processes that react coal at extreme temperatures in electrically generated plasmas.