SECTION 17

PROJECTED PLANT PERFORMANCE

17.1 GENERAL

The conceptual Oil/Gas process plant described here has been designed to be capable of processing the design feed at the design rate and to produce products of design quality and quantity. Where uncertainty in basic process design information existed, the equipment was specified to cover this uncertainty.

Successful industrial experience is behind the design of major parts of the complex; this includes the coal mining, coal preparation, acid gas removal, sulfur recovery, fractionation, and cryogenic separation process, among others. There is also process development unit (PDU) and some pilot plant experience/data as background for the key hydroliquefaction step. The design is considered to be workable with the understanding that the estimated cost has the probability of being greater than if additional information were available; this is often the case for first-generation plants.

A number of specific process steps/equipment items that are important to the plant's performance are discussed in the following paragraphs.

17.2 SLURRY RECYCLE

The use of slurry recycle to improve the product gas/oil ratio is considered practical as an extension of results obtained in both bench scale and pilot plant work as reported by Pittsburg and Midway Coal Co., in August 1975. The reported results of runs SR-3, -4, and -5 from the Tacoma pilot plant were utilized as input to averaging calculations that are believed to be a realistic basis for the design; this was discussed in detail in Section 15 of this report.

17.3 PROCESS GASIFICATION

The design of the process gasifier is an extension of work reported by BCR and is related to the Bi-Gas pilot plant program now in its early stages at Homer City, Pennsylvania. The material and energy balances were checked using the computer program called Gasify, which was generated by BCR under contract to OCR. The results of Parsons calculations and the computer-assisted calculations provided the basis for a prediction that the gasifier will produce the desired products at the specified rates.

17.4 HIGH-PRESSURE SYNGAS HEAT RECOVERY

Synthesis gas, containing approximately 20 wt % entrained char, flows from the top of the high-pressure process gasifier at 1,700°F and 1,000 psig through lined ducts, and then through the tubeside of three critical service heat exchangers, in series. The first is a steam superheater, 20-1301 (one shell), with Incoloy 800 Grade 2 tubes. The second, a gas/oxygen exchanger, 20-1302 (one shell), has an inlet gas temperature of 1,500°F and 321 stainless steel tubes. The third, a steam boiler, 20-1601 (two shells), also with 321 stainless steel tubes, operates with an inlet gas temperature of 1,470°F.

These three heat exchangers are vertical, shell-and-tube single-pass units. Gas with entrained char flow is from top to bottom of each exchanger. To minimize tube abrasion, the tube inlets are fitted with abrasion-resistant ceramic ferrules to protect the turbulent entry area. The tube materials of construction are selected on the basis of proven suitability at the specific set of operating conditions.

These syngas coolers are patterned after units in petroleum fluid cracker regenerator gas outlet coolers and fluid catalyst line exchangers. These exchangers are also similar to the high-pressure tubular boilers cooling ash-laden syngas under similar conditions in a coal-based ammonia plant.

17.5 FUEL GAS GASIFIER

The design of the fuel-gas gasifier is a combination of entrained two-stage technology with normal blast furnace practice. The use of a bustle pipe for air supply and the slag tapping and plugging techniques, as well as the specified refractories, are widely practiced and proven in the blast furnace field. It is considered therefore, that this design is a practical combination of extrapolation of gasifier technique with proven appurtenances from metallurgical practice that is not expected to generate insolvable operating problems.

17.6 FUEL GAS HEAT RECOVERY

The low Btu gas flows from the top of the fuel gas gasifier through the char cyclone at a temperature of approximately 1,800°F. The air/fuel gas exchangers No. 1, 24-1302 (3 shells), and No. 2, 24-1304 (2 shells), receive the fuel gas at 1,800°F and 780°F, respectively, serving to preheat the combustion air to the fuel gasifier to above 1,200°F. The 1,200-psi steam generator, 24-1303 (2 shells), receives the hot fuel gas discharging from No. 1 air/fuel gas exchanger at 1,400°F. These heat exchangers are designed for critical service as is the proven practice in the petroleum industry.

The air/fuel gas exchangers are of the special fixed-tubesheet type similar to those used for high temperature gas services in steam methane and naphtha reforming plants. The process gases are in countercurrent flow with a single-pass tubeside configuration. The inlet channel and tubesheet is lined with a low-iron/low-silica insulating castable designed to maintain

the metal temperatures within the allowable stress limits. A shellside expansion joint is provided to allow for the thermal differential expansion between the tubes and the shell.

The 1,200-psi high-pressure steam generator, 24-1303, is of the fixed-tubesheet, modified fired-tube, natural thermosyphon design. The process gas flows through the tubeside, which is of single-pass configuration. The conical inlet and outlet gas channels, together with the one-pass tube layout, provide a geometry that minimizes impact erosion and gas pressure energy loss. The shellside (water side) of the generators are serviced by strategically placed downcomers and risers arranged to provide a well distributed flow of steam and water throughout the bundle. The downcomers and risers are served by an external steam drum that is placed at sufficient elevation to provide a minimum of 15:1 water-to-steam ratio in the risers. The external steam drum will serve one or more boilers and is complete with the necessary internals required to provide the specified steam purity.

The fuel gas/150-psi steam generators, 24-1305 (2 shells), are of the same general design as the high-pressure units, except that economics of either an external or integral steam drum will be considered in the final design of these units.

Dependable performance is considered assured from these fuel gas cooling and heat recovery units.

17.7 GASIFIER FEEDERS

The dry feeding of coal to the high-pressure process gasifier is postulated as a screw feeder. This design is based on the preliminary results of the ERDA-sponsored development programs pursued by Ingersoll-Rand, Westinghouse, Foster Miller, and others. This work was extrapolated to the size and pressure requirement of the present design. It is recognized that development work is required to arrive at continuously operable units meeting the very severe conditions. However, it is felt that such devices can be available in time to meet the construction schedule provided that in-progress development work will continue and will be successful under the various ERDA programs.

17.8 FILTRATION

The design used vacuum filtration. Leaf-type vacuum filters are routinely used in laboratory work without serious problems, and rotary filters of this type should perform satisfactorily. Furthermore, the liquids in the present design are lower viscosity than those for which pressure filters have been used in the pilot plants. Vacuum filters have been used in large numbers and for many decades; this background of successful operation influenced the selection of this type of equipment with confidence that it can perform reliably.

Redesign of standard vacuum filters to accommodate the high temperature (500°F) operation is considered to be achievable. The filtration rates used in this design are based on basic laws of filter design conservatively interpreted.

17.9 SOLVENT RECOVERY

Filter cake solvent recovery using drying kilns is expected to perform satisfactorily using the design variation introduced here. The admixture of hot char with the filter cake is expected to eliminate coking and caking, which has occurred in pilot plant kilns that have been used to dry the filter cake/wash oil mixture produced in the filters.

17.10 SLURRY FEED PUMPS

Considerable effort was expended to determine that centrifugal pumps are a practical means of dissolver slurry feed. Pump manufacturers were contacted, and it was concluded that the pumps specified here are a reasonable extrapolation/refinement of existing pumps in successful commercial slurry service.

Centrifugal pumps have been used in H-Oil plants transporting abrasive catalyst suspended in oil for over five years without major maintenance problems. A similar pump was inspected after two years in oil sands slurry service and showed no appreciable wear. It is concluded that these pumps will provide reliable service.