

ABSTRACT

This final technical report covers progress achieved and work performed during the period of July 1, 1976 through November 30, 1978 on Chem Systems' Liquid Phase Methanation Process - Installation and Operation of the LPM Pilot Plant.

The LPM Pilot Plant construction was completed in Texas City, Texas and the unit was prepared for shipment to the Institute of Gas Technology HYGAS Pilot Plant in Chicago, Illinois.

After delivery to the HYGAS site, the unit was reassembled and installed. Check-out included pressure testing with nitrogen, cold oil circulation tests and, finally, several round-the-clock runs with process oil and nitrogen at conditions up to 550^oF and 600 psig. Additional steam tracing and insulation were added to the plant to insure continuity of operation even in severe weather conditions.

Operations at IGT included seven runs totaling 2,347 hours of on-stream time with 122 hours of methanation of HYGAS synthesis gas and 193 hours of steam-methane reformer gas. Feed gases were used with hydrogen/carbon monoxide molar ratios ranging from 2.2 to 9.5 and flow rates up to 1.3 million SCFD. Reactor conditions have ranged up to 750 psig and 675^oF with a variety of circulating oil flow rates. Conversion of CO as high as 100 percent have been observed.

The basic operability of the process was demonstrated in a 50-fold scale-up from a smaller process development unit. Catalyst rate constants were determined and the LPM kinetic model was checked over a wide range of process conditions for three different catalysts. Information accumulated also includes extent of the shift reaction, by-product selectivities, catalyst bed fluidization and circulating oil stability.

Laboratory support work at Chem Systems Research Center included testing at least nine different catalyst formulations in the bench scale unit and the Process Development Unit. In addition, laboratory support studies included simulation of IGT's steam-methane reformer synthesis gas, testing a new process liquid with a low pour point, developing catalyst reduction and process start-up procedures for the pilot plant, and providing back-up testing of all pilot plant catalyst batches.

An experimental program studying the rates of carbon formation in vapor-phase methanators was conducted at the Chem Systems Research Center. Three catalyst formulations were tested with a Lurgi-type feed gas both with and without steam injection at several temperatures and pressures. A total of 33 runs were completed with methanation times ranging up to 1,200 hours where the average run was 470 hours in duration. Results indicate that the intrinsic physical and chemical properties of the catalyst play a much more important role in the rate of carbon formation than do the theoretical thermodynamic equilibrium boundaries for a particular synthesis gas.