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ENGLISH

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LIQUEFACTION OF COAL,
DP/POL/82/002
POLAND

Technical Report *

Mission 13 to 27 September 1985

Prepared for the Govenment of the Polish People's Republic
by the United Nations Industrial Development Organization,
acting as executing agency for United Nations Development Programme

Based on the work of James J. Lacey,
Process Development Unit (PDU) Construction Expert

United Nations Industrial Development Organization
Vienna

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October 7, 1985
English

ABSTRACT

Project DP/POL/82/002/B/01/37
September 13-27, 1985

This report covers a trip which included ten (10) days in the Katowice, Poland area for the purpose of assessing coal liquefaction process technology and process development unit construction progress. The purpose was to assist the government of Poland in its investigations of coal liquefaction aimed at augmenting their liquid fuel production capacity. The work was done for the Central Mining Institute and its subsidiary the Institute of Carbochemistry in Tychy-Wyry. Advice was rendered on basic technical problems of experimental units for direct coal hydrogenation. Construction progress was evaluated as regards coal grinding, slurry preparation, solids separation, and materials of construction. The report is prepared in daily journal form with an introduction, conclusions and recommendations regarding future work. Wide ranging discussions with many Polish workers are summarized with particular emphasis on their soon to be completed 80.0 kg/hr process development unit.

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October 7, 1985
English

SUMMARY

This trip covered the period of September 13-27, 1985 inclusive. After a side trip from Pittsburgh to Washington, D.C. (round trip) on September 13 to secure my visa to Poland, and an overnight flight to Warsaw, the period of September 15-25 was spent in the Katowice area at the Institute of Carbochemistry. On September 26 I flew to New York and planned to consult with the UNDP personnel and on September 27 return to Pittsburgh. A hurricane in the New York City area resulted in a change in plans. The discussions at the Institute of Carbochemistry dealt with the UNDP funded project entitled, "Liquefaction of Coal", DP/POL/82/002/B/01/37. My duties were covered by two job descriptions, viz., DP/POL/82/002/11-01/32.1c and DP/POL/82/002/11-02/32.1c and dealt with coal liquefaction technology and plant construction. The objective was to assist the Polish government in these areas whereby they may use their abundant coal reserves to increase their liquid fuel supplies. Discussions concerned the construction progress on the 80 kg/hr Process Development Unit (PDU) scheduled for operation in 1986. A review was also made of the 5.0 kg/hr unit being utilized to provide design data for the 80 kg/hr PDU. The PDU is essentially complete as regards equipment installation, with only the process piping to be installed. Certain sections are 95% complete while others (e.g., product distillation) are at 30%. Mechanical start-up is scheduled for March 1986, and technical start-up by June 1986. At present, these dates appear optimistic, but possible. The design of the 80 kg/hr PDU was based on the bench scale results from the 5.0 kg/hr. The Polish engineers have provided for recirculation of hot separator bottoms. This is a severe pumping service, but is required for their proposed non-catalytic operation in order to obtain adequate conversion. I recommended a 100% spare be provided, and it is being implemented.

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October 7, 1985
English

INTRODUCTION

The period covered in this report is September 13-27, 1985 inclusive. I made a round trip from Pittsburgh, Pa, to Washington, D.C. on September 13 to obtain my visa for Poland. Although the required material had been submitted to the Polish Embassy three (3) weeks before, the visa was not issued until the last day and necessitated my making a trip to Washington to pick up same. I left for Poland on September 14 and remained there until September 26, primarily in the Katowice area. During my stay in the Katowice area, I operated under two (2) job descriptions, viz., a) DP/POL/82/002/11-01/32.1.c (Process Development Unit (PDU) Construction Expert), and b) DP/POL/82/002/11-02/32.1.c (Coal Liquefaction Process Technology Expert). The overall purpose of both job descriptions is to assist the government of Poland in their investigations pertinent to direct coal liquefaction. This work is being conducted at the Central Mining Institute in Katowice and the Institute of Carbochemistry in Tychy-Wyry. The latter is a subdivision of the former. To minimize confusion in this report, the organization in Tychy-Wyry will be referred to as the "Institute" in this report.

The Polish government intends to utilize its ample coal resources to augment its liquid fuel supply, which is primarily imported. The present experimental plans call for the construction and operation of a 80 kg/hr (coal feed input) PDU to determine the optimum operating conditions for the liquefaction of several Polish coals. The program also includes the operation of a 5.0 kg/hr bench scale unit to provide back-up R&D for the PDU. In general, I advised on the technical problems associated with the construction of the PDU for direct coal liquefaction. I provided information on what was learned under various U.S. DOE funded programs such as SRC (Solvent Refined Coal), H-Coal, and EDS (Exxon Donor Solvent). The discussions centered on construction progress for the 80 kg/hr PDU as regards to coal grinding and drying, slurry preparation and preheating, hydrogenation, solids separation and final product distillation.

To simplify the organization of this report, it has been written in a daily journal format, starting with my trip to Washington, D.C. on September 13 and my return to Pittsburgh on September 27, 1985. This type of presentation lends itself to a convenient means to express conclusions and make recommendations. The whole period was spent at the Institute of Carbochemistry in Tychy-Wyry which is in the Katowice, Poland area. The Institute is composed of about 200 people and has six divisions, viz., a) Basic Technical Research (Mr. Rusin); b) Analytical Research (Ms. Ihnatowicz); c) Developmental Units (Mr. Swiadrwski); d) Process Engineering (Mr. Worsztynowicz); e) General Maintenance (Mr. Gabrys); and f) Management (Mr. Stawiany). Each division has about 30 people, except for Developmental Units which has approximately 50 people.

DISCUSSION

As indicated in the Introduction, this report is organized on a daily journal basis.

Day 1 - Friday, September 13, 1985

With the help of UNIDO in Vienna and UNDP in New York, a visa was obtained for my planned stay in Poland. Although all the necessary details were supplied three weeks before departure to the Polish Embassy in Washington, D.C., the visa was not obtained until the very last day. Accordingly it was necessary for me to travel from Pittsburgh to Washington on September 13, to pick up the passport and visa. Possibly in the future, the Polish Embassy in Washington could be respectfully requested to issue the visa at least a week before the scheduled departure date. Based on my experience with UNIDO in Vienna, a visa to Poland can be issued in approximately two (2) working days.

Day 2 - Saturday, September 14, 1985

On this date I left Pittsburgh on my flight to Warsaw with intermediate stops in New York and Frankfurt, Germany. Other than several aircraft delays due to mechanical difficulties, the flights were uneventful, except that Pan Am misplaced by luggage somewhere along the way. As a result I arrived in Warsaw, but my luggage did not. It finally did arrive about three (3) days later due to efforts of the Polish members of Institute of Carbochemistry, particularly Mr. Marian Krzyminski who rendered invaluable assistance in this matter.

Day 3 - Sunday, September 15, 1985

After an overnight flight, I was met at the Warsaw airport by a representative of the Institute of Carbochemistry, Mr. Eugene Jedrysik, and provided transportation to my hotel in Katowice. During the long drive from Warsaw to Katowice, we discussed the UNIDO coal liquefaction project and the various personnel assigned to the project. Mr. Jedrysik mentioned that the Institute of Carbochemistry at Tychy-Wyry had a new Director, Mr. Walter Matula, the former Deputy Director. Mr. J. Winnicki the previous Director is with the Central Mining Institute in Katowice on another project. We also discussed the schedule for my ten day stay in the Katowice area, which will conclude with a Tripartite Meeting in Katowice during the week of September 22, 1985.

Day 4 - Monday, September 16, 1985

This day was spent at the Institute of Carbochemistry at Tychy-Wyry; however, we paid a visit to Mr. Erast Konstantynowicz, Deputy Director of Central Mining Institute in Katowice. He is responsible for all the non-mining projects, which of course includes the coal liquefaction work. We talked in general about the 80 kg/hr PDU, and he

was interested in the apparent decreased emphasis that the U.S.A. is placing on coal liquefaction technology. I explained the DOE role as regards high risk, long range research and indicated no lack on emphasis, only a shift from large scale pilot plants to bench scale research.

We then traveled to the Institute of Carbochemistry at Tychy-Wyry. The main project at this institute is the 80 kg/hr (coal feed) unit presently in the construction phase with scheduled full-scale operation in 1986. This unit is a modification of their previous 50 kg/hr unit based on the Consol Synthetic Fuel (CSF) process. This modification will result in a SRC-II unit with some parts looking like H-Coal and EDS (Exxon Donor Solvent). They will use the "natural" catalysts in the coal due to the lack (and high cost) of Co and Mo in Poland. They have an extensive source of bituminous (Janina) coal with about 20% ash and 3% sulfur, which when cleaned yields an acceptable product containing about 8% ash and 1% sulfur. There is ample material available for a large scale coal liquefaction plant in the future.

I met with the following people:

- Mr. Walter Matula - Institute Director
- Mr. Emmanuel Rusin - Division Director
- Ms. Maria Ihnatowicz - Division Director and Institute Deputy Director
- Mr. Adam Worsztynowicz - Division Director

We reviewed the construction progress for the PDU:

a. All the basic equipment (pumps, vessels, heaters, etc.) has been procured and all pieces of process equipment have been permanently installed. Work is proceeding on the piping concentrating on connecting the individual pieces of equipment together and installing the required instrumentation and insulation.

b. The coal grinding, slurry preparation, hydrogen generation, and hydrogen compression (make-up and recycle) sections are 100% complete. This represents significant progress over the last ten (10) month period since my last visit.

c. The reaction section is about 95% complete and efforts are being concentrated on the product distillation section which is approximately 30% complete. Although this section is far from complete, the piping is relatively low pressure and can be installed rapidly. All electrical equipment should be installed by the end of this month.

d. Emphasis is being placed on the installation of the process control systems and delivery of certain items is being expedited. This work will continue over the next several

months. There is apparently a problem in receiving enough of the right kind of high pressure, high temperature let down and relief valves. These are generally expensive, long delivery items which, due to the erosive service, should be adequately spared throughout the plant. These items were discussed in more detail later in the week with Mr. Gabrys, Division Director for General Maintenance.

e. All construction is scheduled for completion by the end of the year. Allowing for a little slippage due to adverse weather and late deliveries, the PDU should be ready for mechanical start-up by March 1986.

f. Technical start-up is presently scheduled for June 1986 and appears to be realistic.

g. Although late delivery does not seem to be a problem, some valves designed and specified for operation at 450°C and 320 atmospheres, were delivered suitable for operation only at 230°C.

h. Experimental work is continuing on the 5.0 kg/hr bench scale unit to verify the operating conditions for the 80 kg/hr PDU. The 5.0 kg/hr unit developed the design for the larger 80 kg/hr PDU, and makes one run per week. At present, it uses no catalyst, and recirculates hot separator bottoms. The reactor has a 10 liter capacity with an I.D. of 80 mm and a length of 2.0 meters. Runs are being made at several space rates to investigate the variables of recycle gas composition and the suitability of several disposable catalysts. Work is also continuing on product upgrading and investigations are continuing into the possibility of using a mixture of crude oil and coal derived oil for preparing the slurry.

We spent the rest of the day discussing past DOE work for the H-Coal and EDS processes and the present effort at the Wilsonville plant on Two-Stage Liquefaction. I outlined the U.S. DOE past and present programs for coal liquefaction (pyrolysis, indirect and direct liquefaction). I concentrated on direct liquefaction, and how it related to the on-going Polish work being funded in part by UNDP. I briefly outlined the new work in two-stage liquefaction of coal. The Polish engineers have a real awareness of the problems inherent in this area of direct coal liquefaction.

Day 5 - Tuesday, September 17, 1985

The day was spent touring the 80 kg/hr PDU and inspecting construction progress. As indicated in our discussions on the previous day, completions ranged from 100% in the front end of the plant (slurry preparation and H_2 supply) to 30% at the back end (product distillation). Generally, the more difficult parts of the PDU are essen-

tially mechanically complete; however, installation of process instrumentation and vessel insulation has yet to be started. During the tour of the PDU we reviewed the design capacities of the various sections. In general, a conservative design basis was employed. There is more than adequate coal grinding, drying, and slurry preparation capacity available. Operations of these sections can be on basis of one shift per day to supply enough slurry feed for all three shifts of round-the-clock PDU operation.

I noted that the drying operation reduced the coal moisture content from 19% to 5%. This is adequate; however, 1% would have been better in order to reduce any possibility of foaming problems in the slurry preparation step. To get 1% moisture at this time would involve a major design change, and is not recommended. However, close attention to foaming possibilities in the production of slurry during PDU operations was advised.

We reviewed the design of the reactor feed heater. It is a convection heater processing all feed (coal, slurry oil, make-up hydrogen and recycle gas) to the reactor. It is a conventional, conservative design which has been proven in the early work in the German coal hydro plants as well as in a later plant built by the U.S.A. in Louisiana, Missouri in the 1950's. The more recent coal liquefaction plants in the U.S.A. used radiant heaters, which are prone to coking and require close operator attention. The convection style heater in the 80 kg/hr PDU should work with a minimum of problems.

We also reviewed the installation of the pump which will circulate the Hot Separator Bottoms back to the Reaction Section. As indicated in my previous report, this is rather severe pumping service, but can be made to work. The application is very similar to the H-Coal pump which is used to circulate reactor contents to maintain a liquid fluidized bed. I noted that this pump is being provided with a spare, which I recommended on my last trip to Poland. Although the spare has yet to be installed, the foundation for this pump had been completed.

We also discussed the design recycle gas composition which will vary between 70 and 80 vol.% H_2. This may be a little low. This results from the recycle gas scrubbing system which involves only an oil wash. No amine scrubbing is provided for H_2S removal. But the overall system should be adequate since the high purity make-up hydrogen (99.9 vol.%) will compensate. If not, total reactor pressure can be increased to insure an adequate H_2 partial pressure in the reactor.

Day 6 - Wednesday, September 18, 1985

Part of this day was spent at the Polish airline (LOT) office being reunited with my luggage which Pan Am had somehow misplaced between Pittsburgh and Warsaw. The rest of this day was spent working on this report and discussing the 5.0 kg/hr experimental unit. As

always, I was impressed on how well the Polish engineers and scientists work together and have integrated this project. I have previously indicated that 5.0 kg/hr unit was an excellent R&D tool which had been used to good advantage in the design of the 80 kg/hr unit. A good example was the discovery of the effect of circulating hot separator bottoms back to the inlet of the preheater.

On my last trip to Poland, we spent a lot of time discussing whether or not the 5.0 kg/hr unit should be converted to a totally integrated operation complete with distillation and pyrolysis capability. They were considering this modification, but I did not recommend that this be attempted. The 5.0 kg/hr unit was a very small unit to attempt such a modification, and would drain necessary resources away from the construction of the larger 80 kg/hr PDU. This recommendation has been accepted.

Day 7 - Thursday, September 19, 1985

Again, back to the Tychy-Wyry Institute where the discussions centered around the 80 kg/hr unit. I met with:

- Mr. Walter Matula - Institute Director
- Mr. Adam Worsztynowicz - Kinetics Expert
- Mr. Charles Gabrys - General Maintenance

They were interested in when I could return and whether we could decide on a convenient time for both sides. I would recommend a point after "technical start-up," which should be about this time next year. Then we will be able to identify any major problems at this point. A one week (5 working day) period was agreeable to both parties. I indicated that this agreement was subject to UNIDO approval.

We next discussed the mechanical aspects of the 80 kg/hr PDU with Mr. Gabrys and his people. The discussion centered around the let down valves. These were specified as control valves, Serck Glocon, Model 5061. Two (2) of these valves are required. They were specified and ordered correctly for 300 atmospheres and 450°C. The valves that were delivered were good only for about 200°C. These valves must be reordered and the correct valve supplied. Additionally the valve trim should be tungsten carbide. These are short delivery items (about 1 month) but relatively high cost (about $3,000 each). But the correct valves are required and must be purchased. It was recommended to keep the present low temperature valves and order high temperature bodies (finned) for them. Also two (2) new high temperature valves should be ordered as spares as well as extra trim sets (internals) for these critical valves.

Other type of valves that are a problem are the fifteen (15) angle valves and four (4) safety valves ordered in December 1984 and scheduled for delivery in January 1986. These deliveries should be expedited and the possibility of ordering more of these valves should

be considered, since adequate spares are required. These are relatively low cost (about $700 each), but long delivery time.

We discussed in great length a series of subjects such as:

a. Hydraulic Turbines - Required for a cost effective commercial plant, but not a PDU.

b. Acoustical Filters - Required to damp out flow fluctuation due to pumps and compressors. Flow measurement is difficult or impossible without these dampening devices. They should be installed in the PDU.

c. Data Acquisition - Generally installed in all PDU's and pilot plants in the U.S.A. Greatly improves data gathering accuracy and reliability. I would recommend such a system for the 80 kg/hr PDU, if UNIDO funds were made available. The systems are invaluable aids to scan, alarm, and compute during operation.

d. V/L Equilibrium Data - As this information is developed for coal liquids at PETC, I will send copies of pertinent reports to Poland.

e. Australian Coal Science Meeting - The Institute can not afford to send a representative to this meeting, but would like a copy of the proceedings. I will take care of this request.

Day 8 - Friday, September 20, 1985

At the Tychy-Wyry Institute, we concentrated our discussions on various aspects of start-up and operation of the 80 kg/hr PDU. We discussed coal grinding, drying, and transfer. The Institute members asked why nitrogen is not used as the inert transport gas instead of hot combustion gas. The latter is used, since it is available at no cost. Nitrogen can be used, but since the drying system requires a purge (for moisture control), there would be a continuous requirement for nitrogen make-up. I referred them to the material balances in the SYNTHOIL literature that I provided on my last trip to Poland.

We discussed slurry mixing and how it would be accomplished on a large scale commercial plant. The present batch system obviously would have to be improved, but until plants larger than 600 T/D are built and operated, this problem will not be addressed in detail. Proposed (but as yet untested) solutions involve "wet" grinding featuring pulverization of the coal in the slurry oil. The possibility of using on-line mixers is also being investigated.

The question of start-up was discussed and I recommended the use of a hydrogenated coal tar oil. The start-up of oil should have

similar properties to the proposed product oil. As regards solid separation, I indicated that the 250 T/D EDS plant successfully used vacuum distillation. Present DOE work is concentrating on solvent deashing, but this technique has not been proven to the extent that vacuum distillation has.

We discussed the use of centrifugal pumps versus positive displacement pumps. The former are used for high volume, low ΔP applications while the latter are utilized for low volume, high ΔP. As a result, slurry mixing and transfer generally use centrifugal pumps and reactor feed pumps utilize the positive displacement type. Both types of pumps are suitable for streams with high (up to 50%) solids content. Recent work in pump manufacture has indicated that some high volume, high ΔP applications (e.g., amine scrubbing systems) are suitable for centrifugal pumps. Future commercial plants can very well have centrifugal reactor feed pumps, but they have not yet been developed for application to the 80 kg/hr PDU.

Finally, I was asked to supply any information in the following areas:

a. H_2 and H_2S attack in SS 347 vessels clad with 2.5% Cr and 1% Mo. Evidently Westinghouse R&D has recently published articles in this field.

b. Sulfur and nitrogen analysis of the product oils in the range of 0.02 to 0.03 wt%.

If these material are available, I will send them directly to the Institute in Tychy-Wyry.

Day 9 - Saturday, September 21, 1985

No work at the Institute, but my hosts were kind enough to show me a little of the Polish countryside.

Day 10 - Sunday, September 22, 1985

Again no work at the Institute, therefore spent the day working on this report. However, did receive word that the Tripartite Review Meeting originally scheduled for Monday, September 23 has been postponed to Wednesday, September 25. Besides myself and the Institute members at Tychy-Wyry, representatives from Warsaw, UNIDO (Vienna) and UNDP (Geneva) will attend. Since I was not planning to leave Poland until Thursday September 26, no schedule change on my part was required.

Day 11 - Monday, September 23, 1985

As indicated this was the day originally scheduled for the Tripartite Meeting, but it was postponed until Wednesday, September 25.

Accordingly I spent the day at the Institute at Tychy-Wyry with various members of the Basic Technical Research Division and their Director Mr. Rusin. Our discussions centered on various methods of solids separation and carbonization. They intend to operate their 80 kg/hr PDU in two modes, viz.,

a. Fuels
b. Coke

In both modes, the Hot Separator Overhead is cooled, condensed and fractionated into light, middle, and heavy oil via atmospheric and vacuum distillation. In the "Fuels" mode, the net Hot Separator Bottoms are sent to vacuum distillation to produce the recycle oil and a residue. In the "Coke" mode, the net Hot Separator Bottoms are sent to a centrifuge to produce an underflow residue and an overflow oil which is fed to a vacuum distillation tower to produce recycle oil and a vacuum bottoms for carbonization. It is hoped that the latter product will be suitable for the manufacture of electrode coke, thereby obviating the necessity of importing petroleum "needle" coke into the country.

We discussed in detail the differences, if any, between the electrodes made from petroleum coke and that from coal. I will send them pertinent PETC publications in this area if they are still available.

We reviewed all the past Polish work on coal research which led to the design of the 80 kg/hr PDU. Much of the earlier work was based on the Consol Synthetic Fuels (CSF) process and the Polish results were very similar to that of DOE, i.e., the solids removal step never worked properly. Their experience with filters indicated poor mechanical reliability, and the use of centrifuges did not lower the ash content sufficiently to permit long term operation of the subsequent catalytic step. They evolved into their present process scheme by combining their successful unit operations for a complete process. As indicated earlier in this report, their process is a combination of the best aspects of SRC-II, EDS, and H-Coal.

We then engaged in a long discussion of the DOE work on two stage liquefaction. They would like to keep abreast of the developments in this area, and incorporate (if possible) any innovations that can be accomplished in an orderly manner. The discussions centered on solids removal via solvent deashing and supercritical extraction. I emphasized that these operations are still in the development stages, but appear very promising. I will keep them informed on the progress in this area.

Day 12, Tuesday, September 24, 1985

Again back at the Institute in Tychy-Wyry to discuss data logging and acquisition with:

- Mr. Eugene Jedrysik
- Mr. Adam Worsztynowicz

The latter has been recently promoted to Director of the Process Engineering Division, while Mr. Jedrysik is a member of this Division responsible for the work on the PCT properties of coal liquids. Additionally, Mr. Jedrysik is scheduled to come to the U.S.A. at UNIDO expense to work in his field at the University of Kentucky for six (6) months commencing in October 1985. At present he has no confirmation of when he will be in the U.S.A. and asked me to call the following person and verify his status:

Martin Frame
Duisberg Society
425 Park Avenue, New York 10022
Tel. (212) 751-5544

We then discussed at great detail the assumptions that must be made in scaling up the results from the 80 kg/hr PDU to a full-scale commercial plant. Generally the material balance can be set with some degree of accuracy; however, the degree of process and heat integration must be improved upon to obtain favorable economics. Finally the PDU is not suitable for obtaining accurate heat balance data due to its relatively small size and its inherent high ratio of surface to volume which tends to distort the calculation of heat loss.

Although the Polish workers have most of the current coal liquefaction literature, certain key publications are simply not available in Poland. I intend to send them the following reference material:

1. Frazier, G.C., Lin, K.H., and Edwards, R.E. "Evaluation and Analysis of Coke Formation and Deposition in Coal Liquefaction Process Equipment", Oak Ridge National Laboratory, Report TM-8057, July 1982.

2. Singh, C.D.P., Shah, Y.T., and Carr, N.L. "Effect of Mixing Energy on Hydrogen Reaction Rates in SRC-II Reactors", US DOE Report DE 1010450, January 1981.

3. Carr, N.L., King W.F., Jr., Anoon, W.G. "Prepilot SRC-II Development Project - Hydrogen Mass Transfer Study", US DOE Report DE 82010772, February 1982.

4. Rhodes, D.F., Miller, E.G. "Dissolver Mixing Tests at Fort Lewis SRC Plant", Analytical Technology Department, Gulf

Science and Technology Company, Pittsburgh, Pa, Report No. 532 RM 002 (1981).

5. Szaldow, A.J., Given, P. Ind. Eng. Chem. Proc. Des. Dev. 1981, 20, 27.

6. Supplementary Material from S.C. Hwang, C. Taonopoulos, I R. Cunningham, G.M. Wilson published with "Density, Viscosity and Surface Tension of Coal Liquids at High Temperatures and Pressures', Ind. Eng. Chem. Process Des. Dev. 1982, 21, 127-134. Can be acquired from:

Business Operations, Books and Journal Division,
American Chemical Society
1155 16th Street, N.W.
Washington, D.C. 20036

7. Chao, K.C. Purdue Univ., Lafayette, IN., "Phase Equilibrium in Coal Liquefaction Processes," Final Report EPRI-A-P-3450, August 1984.

8. "Phase Equilibrium Data for Coal Derived Liquids; Mixtures of Model Compounds", Final Report, International Coal Refining Co., Allentown, PA (Chromaspec Corp., Houston, TX/USA/DE - 8401712 DOE/OR/03054 - May 1984).

In general they are very interested in any recent published work on the vapor-liquid properties of coal liquids.

As a final request from the Director of the Institute at Tychy-Wyry he indicated that they have funding for this calendar year to send four (4) people to the U.S.A. It would be two teams of two people for two weeks each to survey the latest developments in direct coal liquefaction. They asked for advice on the arrangements and points of contact. I recommended that they write (through UNIDO) to the PETC Director outlining in detail:

1. Names and suggested dates
2. Background of visitors
3. Suggested itinerary (PETC, Wilsonville)
4. People at PETC they wish to consult (e.g., Thomas Torkos, John Ruether).

I indicated that their only contact should be with PETC, since any arrangements with Wilsonville will be handled by PETC. They indicated that a letter to the PETC Director would be forthcoming and asked that the request be expedited, when it arrives.

Day 13 - Wednesday, September 25, 1985

This was the day of the Tripartite Review Meeting at the Institute in Tychy-Wyry. It was attended by representatives from UNIDO (Vienna), UNDP (Geneva), DOE (Pittsburgh), Central Mining Institute (Warsaw and Katowice) as well as various members of the Institute for Carbochemistry at Tychy-Wyry. The agenda covered was as follows:

1. Introduction by the Chairman - Prof E. Konstantynowicz, Deputy Director of Central Mining Institute.

2. Report on Progress of Project Activities - Assoc. Prof. J. Kulczycka (Project Office).

3. Discussion on achievement of Project Objectives and Outputs - J. Kulczycka and J.J. Lacey.

4. Review of Project Budget - Mr. M. Maung - UNIDO.

5. Discussion on future Work Plan and delivery of Project Inputs - J.J. Lacey.

6. Inspection of the reconstructed PDU (80 kg/hr) - J.J. Lacey.

7. Conclusions and recommendations - Mr. J.J. Lacey and Mr. M. Maung both of UNIDO.

The proposed schedule was discussed and can be summarized as:

Section	Completion Date
Hydrogen Generation Compression and Recycle	February 1985
Coal Grinding and Slurry Preparation	November 1985
Preheat and Reactor Area	March 1986
Product Distillation	June 1986
PDU Integrated Operation	December 1986
Preliminary Report	March 1987
Final Report	March 1988

It was generally agreed that this was an attainable schedule, but rather optimistic at this point. It can be characterized as a "success

oriented" schedule. It should be reviewed in September 1986 at the next Tripartite Meeting and the progress measured.

The Polish engineers and scientists expressed gratitude for the financial and technical help supplied by UNDP and UNIDO. A project of this magnitude relies on active cooperation of all parties involved. A review of the recently completed work on the 5.0 kg/hr bench scale unit indicated that the design basis of the 80 kg/hr PDU was sound, and the success of the latter was primarily dependent on its timely mechanical completion and the results of its integrated operations. A review of the 80 kg/hr PDU operating parameters was made based on the results of the 5.0 kg/hr bench scale unit. The final report of the latter unit was issued in September 1985, but has not yet been received at PETC for review. It was adequately summarized at this meeting and indicated that critical areas such as circulation of hot separator bottoms, let down valve performance, solvent quality, and optimum recycle gas composition were adequately investigated and defined.

In reviewing the schedule, it was obvious that the Product Distillation Section at about 30% completion is a problem, unless adequate precautions are taken for the coming winter months. It was recommended that this area be "weather-proofed" so that construction work would continue unabated during the winter months. This is the only way to ensure mechanical start-up by March 1986 and subsequent technical start-up by July 1986. It was observed that based on the results of the technical start-up, significant renovations may be necessary in September 1986. This would be followed by full integrated operations in December 1986. Accordingly the first preliminary report could be expected (on schedule) in March 1987 and the first (final ?) technical report in March of 1988. It would appear that a one-year "no-cost" extension of this project would be in order.

We then entered into a detailed discussion of the UNDP budget for this project. The budget of $300K is approximately half spent with the remaining balance divided approximately among:

		$ K
1.	Fellowships...	50
2.	Experts...	70
3.	Equipment...	10
4.	Contingency...	15
	Total	145

The Polish indicated urgent needs for the following:

		$ K
1.	High temperature, high pressure valves...	13
2.	Twenty control valves...	15
3.	Pressure testing material...	3
4.	Portable flow meter...	4
5.	Micro-computer...	4
6.	Operating computer...	12
	Total	51

It was agreed to proceed with the Items #1, 2, and 3, and make a decision on Items #4, 5, and 6 in September 1986. A long discussion ensured as to how to finance Items #1, 2, and 3. It was agreed not to touch the remaining funds for Fellowships, but to add to the Equipment funds from that allocated to Contingency and Experts. I endorsed this plan of action, since it is the most logical expenditure of funds under the present conditions.

We next reviewed the UNDP Fellowship Program which should not be reduced or curtailed in any manner. There are six fellowships involved in this program, viz.,

1. 8 months IMMR (completed)
2. 6 months University of Del. (completed)
3. 6 months PETC (in progress)
4. 6 months University of Kentucky (planned)
5. 6 months Bottrop, FRG (planned)
6. 6 months (undefined)

As regards, Items #4, 5, and 6 it was recommended that these be spent at PETC to maximize input to this project. The Polish will consider this recommendation.

At the end of this rather long day we were driven back to Warsaw to the Hotel Forum. Due to a mix-up in our reservation we did not have a room at this hotel, but due to the gracious intervention of LOT, the Polish Airline, we finally secured a room for which we will be eternally grateful.

Day 14 - Thursday, September 26, 1985

Up at the crack of dawn to catch a Pan Am flight to New York via Frankfurt, Germany. Uneventful other than the reluctance of the average Warsaw taxi driver to accept payment in Polish zlotys. They all wanted payment in U.S. dollars which is against the law. However, after a sufficient wait, a driver was found who would accept payment in legal Polish zlotys. The day was spent in a rather long flight from Warsaw to New York via Frankfurt, West Germany. The time in transit was spent in completing and revising this report.

Day 15 - Friday, September 27, 1985

It was planned to spend the better part of the day at UN Headquarters in New York conferring with Mr. Chavez of UNDP. The plan was to cover the contents of this report and discuss the conclusions and recommendations. Due to adverse weather associated with Hurricane Gloria, US Air was cancelling my afternoon flight to Pittsburgh with only a promise of getting me out of New York on Sunday, September 29. Also as early as 5:30 a.m. various New York City (and New Jersey) offices including the UN were cancelling operations for the day. Accordingly I left New York early on Friday on the last flight to Pittsburgh. Upon arrival in Pittsburgh, I made arrangements to meet in New York at UN Headquarters on Thursday, October 3, 1985.

CONCLUSIONS

Considerable progress has been made in the construction of the 80 kg/hr PDU at the Institute of Carbochemistry at Tychy-Wyry, Poland. Several sections of the plant are complete while others are virtually complete lacking only the installation of the instrumentation and insulation. The Product Distillation Section needs a continuing effort with close attention paid to not losing any construction time during the coming winter months. As always with a project of this size and complexity, the last 5 to 10% of mechanical completion is the most difficult.

The present schedule is "success oriented" and rather optimistic; however, attainable if all goes well. It must be critically assessed at this time next year. The attainment of full integrated operations by December 1986 is dependent of successful mechanical start-up in March 1986 followed by technical start-up in July 1986. Even if these two "start-up" dates are met, a period of plant renovation will probably ensue, which may put the December 1986 date in doubt.

At present the budget does appear adequate for this project. It is recommended that expenditures be closely controlled; however, the purchase of spare parts is not to be ignored. The UNDP Fellowship program has greatly helped this project and should be continued. At present a Polish engineer, Mr. Marek S. Pawlowski, is at PETC on a six (6) month fellowship. This will help to improve their access to technical literature in the field of direct coal liquefaction. I will continue to send pertinent literature directly to the Institute in Tychy-Wyry.

I will also try to complete the arrangements for a 6 month fellowship for E. Jedrysik to study the current state of the art in physical properties of coal liquids. Another fellowship (possibly at PETC) should be arranged for yet another Polish chemical engineer to study the results from past US DOE programs such as H-Coal, EDS and SRC. This information is available at one place, the Pittsburgh Coal Technology Data Base at PETC. It has been organized for easy access and would be very valuable to the Polish coal liquefaction effort.

Certain critical sections of the 80 kg/hr PDU are essentially finished, e.g., coal grinding, slurry preparation, hydrogen production and compression. Work is still required on the preheater and reaction system, particularly the hot separator and the hot circulation pumps. The hydrogenation section is the most critical area of the PDU and its progress should be watched carefully. The completion of the electrical and instrumentation areas should be top priority. The section furthest from being complete is the product distillation area and progress should not be allowed to fall behind. Nevertheless, all projected completion dates appear attainable. I cautioned the Poles to be realistic in their scheduling particularly in the winter months. Also my experience has been that the completion of the last 5-10% of a construction project can consume an inordinately large amount of time and is the most frustrating portion of the construction effort.

Finally we concluded that my next trip should be in September 1986 and the visit should be arranged to include the yearly Tripartite Meeting. At this time a more accurate status of cost and schedule should be possible.

RECOMMENDATIONS

Based on my stay at the Tychy-Wyry Institute of Carbochemistry during the perioc of September 13-27, 1985, the following recommendations are pertinent relative to the Polish coal liquefaction effort (DP/POL/82/002/B101/37):

1. Although significant progress has been made in the construction of the 80 kg/hr PDU, concentrated efforts are still required to keep this project on schedule. The projected date for attaining full integrated operation (December 1986) is attainable, but optimistic. The Institute members should review the construction progress in detail on a monthly basis and advise UNIDO of any slippage during the coming winter months.

2. Implementation of the funding decisions made at the Tripartite Meeting (September 25, 1985) should begin immediately, particularly as regards the purchase of spare parts. Discussions on the possible purchase of a Data Acquisition System should be postponed until September 1986 when the status of the overall construction funding will be more clear.

3. There is a continual need to insure that the members of the Institute keep abreast of the latest developments in coal liquefaction. I will send the pertinent material when available. The UNDP Fellowship program has proven very valuable in this technology transfer effort and should be continued.

4. Work should continue on the 5.0 kg/hr unit and design improvements incorporated in the 80 kg/hr PDU. There is no need to integrate this unit to include distillation and pyrolysis. All efforts must be spent on completing the construction of the 80 kg/hr PDU.

5. Since the lack of physical property data has hampered the design of the 80 kg/hr PDU, I again recommend that E. Jedrysik spend 6 months in the USA on a UNIDO Fellowship and work in this area. Arrangements are underway for this and I will expedite it.

6. The use of a pump to recirculate a portion of the hot separator bottoms to the inlet of the preheater is critical to the operation of the 80 kg/hr PDU. This provides a means of obtaining sufficient coal conversion without costly catalysts. This pump and its 100% spare should be installed as soon as possible.

7. Another Polish fellowship should be established to send a qualified chemical engineer, engaged in the construction and operation of the 80 kg/hr PDU, to PETC in order to study the extensive Liquefaction Technology Data Base (LTDB) covering all past U.S. DOE efforts in this field. This LTDB has been organized for easy access to the key design and operating data for such processes as H-Coal, EDS and SRC.

8. A follow-up trip to Poland should be made in the September 1986 period to evaluate the construction progress on the 80 kg/hr PDU and review further developmental results of the 5.0 kg/hr bench scale unit. This period was acceptable to the Polish, UNIDO and UNDP people. Again I should spend a minimum of one week (5 working days) at the Institute in Tychy-Wyry.

9. Information exchange should be continued. I would recommend that Polish progress reports be sent to me when they are available. I will continue to periodically send pertinent coal liquefaction literature to them.

James J. Lacey

J.J. Lacey
October 7, 1985