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November 1985

RESTRICTED ENGLISH

LIQUEFACTION OF COAL

DP/POL/82/002

POLAND

Technical Report *

Mission 17 to 31 October 1985

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

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Vienna

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ABSTRACT

LIQUEFACTION OF COAL
DP/POL/82/002/11-04/32.1.1
POLAND

This report describes my visit, as an Instrumentation expert, to the Central Mining Institute, Katowice and to the Institute for Carbochemistry, Tychy - Wyry, Poland in support of this project.

The visit covered a period from the 17th-31st October 1985 and the objective was to advise the team there on methods of measuring and controlling the basic parameters on the 80 kg/hr P.D.U. plant, the 5 kg/hr bench scale unit and on instrumentation matters generally.

The main conclusions are that in principle, the instrumentation and control equipment to be incorporated in the 80 kg/hr plant is adequate for operating the plant, but as it is an experimental plant, the instrumentation necessary for data collection and analysis could be improved.

If the recommendations made are put into practice it should result in improved operational and experimental performances.

The main recommendations made cover, experimental facilities for testing alternative valves and let-down systems, an alternative approach to the lead bath preheater, facilities for testing high pressure instrumentation, a test proceedure for the gas detection systems, data logging facilities, increased staffing in the Instrument Department and technical education and training.

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INTRODUCTION

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POLAND

The purpose of this project is to assist the Polish Government in their investigations of coal liquefaction processes with a view to utilizing their coal resources in order to meet the liquid fuel requirements of the country.

The immediate objectives are:-
To prepare for the start of a programme to test, at P.D.U. scale (80 kg/hr) the process parameters for the effective liquefaction of selected coals.

To carry out a programme of liquefaction R & D in a 5 kg/hr bench scale unit to define appropriate process operating parameters.

This report describes my visit, as an Instrumentation Expert, to the Central Mining Institute C.M.I. at Katowice, Poland and to the Institute for Carbochemistry at Tychy-Wyry, Poland, in support of this project. The visit covered a period from 17th-31st October 1985 and the objective was to advise the team at the Institute on methods for measuring and controlling the basic parameters in the P.D.U. and on instrumentation matters generally

The discussions with the staff on the Institute covered a much wider range of topics than had been specified in the original job description remit, but I think that this was beneficial to all.

The major part of the mission consisted of daily discussion sessions with the Chemical, Mechanical, Design and Instrumentation staff associated with the project.

Many of the topics raised were returned to time and time again as earlier discussions were thought out further, raising other considerations.

Because of this the report has not been compiled as a daily chronicle of matters discussed, but on a subject basis, where discussions over a period of days have been collected together and are combined, together with the conclusions and recommendations, under the subject heading. This report has been compiled from rough notes that were made during the discussion periods and which were written up each evening.

I would like to record my thanks and appreciation to Dr Kidybinski and his staff at the central Mining Institute and to Dr Matula and his staff at the Institute for Carbochemistry, for their kindness, consideration and cooperation during my visit. I would like to record my special thanks to Prof. Kulozycko for looking after me so well and to Eng. Marian Krzyminski who acted as interpreter for me.

RECOMMENDATIONS

1. I recommend that consideration should be given to provide piping and isolation facilities round the let-down valve so as to allow for the experimental testing of alternative valves and let down systems.

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2. An alternative type of preheater to the lead bath type should be considered. A fluidised sand bath type of approach is suggested.

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3. Workshop facilities for the high pressure testing of high pressure differential pressure cells and pressure transducers should be provided.

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4. A standard test proceedure should be adopted to monitor the service -ability of the gas detection sensors.

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5. The provision of a simple data logging facility should be considered.

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6. I recommend that consideration should be given to increasing the staff level in the Instrumentation Department.

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7. I recommend that consideration be given to allow members of the Instrument Department to attend technical education and training courses in Great Britain.

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1. INTRODUCTORY MEETINGS & VISITS

A. Visit to the Central Mining Institute (C.M.I.)

The first visit and meeting of the mission was to the C.M.I. where discussions were held with the Deputy Director, Prof. Kidybinski who outlined the activities of the Polish Mining Industry and in particular the role of the C.M.I. within it. He highlighted the various activities within the C.M.I. and where coal conversion technology fitted into it. Coal conversion technology research is undertaken by the Institute of Carbochemistry at Tychy-Wyry. The Institute forms part of the Central Mining Institute.

A visit round the C.M.I. was particuarly useful in showing me the level of instrumentation and control equipment being used in the Industry.

B. Introductory meeting at the Institute for Carbochemistry.

At my first visit to the Institute, Prof. Kulozycka introduced me to the Director, Dr Matula and to the Deputy Director Prof. Ihantowicz. We then had a discussion, where the Director outlined the activities on the 5kg/hr and the 80kg/hr liquefaction plants and the Institute.

The Director then acted as chairman at a formal meeting where I was introduced to senior members of staff at the Institute (see appendix) who introduced themselves and then described their functions and responsibilities at the Institute. I concluded the introduction by outlining my technical background and experience in the instrumentation and control aspects of coal conversion technology.

The discussions that followed ranged over a very wide field and the major part of the questions put to me concerned the activities in coal conversion technology in the Western World. In particular I was asked to express my personal views on the future of coal conversion technology. I hastened to point out that the views I expressed were my own and not necessarily the views of the British Government or the National Coal Board.

In my opinion there is little doubt that the conversion of coal into petro-chemical type of products will have a major part to play in the energy supply situation of the future.

The big question marks rest with the time scale of arriving at the position of having full scale production plants available for use, and when they will be required.

In Great Britain an abundance of oil and gas from the North Sea fields will ensure that we are independant of foreign supplies for well into the twenty first century. In the light of this, in my opinion, there does not seem to be a great urgency in furthering the research and development and the building of demonstration type plants that is necessary to establish this technology. In consequence of this the capital investment in this field is not as high as it might be. A further point in curbing the enthusiasm in coal conversion technology is the economics of conversion, where current oil prices will have to rise considerably, which they will do as supplies become less plentiful, before fuel from coal will be viable.

I think that the great danger with this unenthusiastic approach is that when the time comes to use this technology to replace dwindling oil supplies, the technology may not have been developed sufficiently to replace it. If this happened we may have to buy the technology from abroad and modify it to suit our home produced coal.

In the case of the Polish Nation, which has no home supply of oil, but large reserves of cheap coal, the urgency and incentive for developing coal conversion technology should be much greater, although the problem of high capital investment is recognised.

To put the relative activities in Great Britain and Poland in perspective, it is public knowledge that the design of a demonstration plant with a throughput of approximately 40kg/hr has been completed in Great Britain and the construction of the plant is hoped to begin shortly. In Poland a 80kg/hr plant is in the course of erection here at Tychy-Wyry.

I was questioned in detail on the coal conversion technology activities at the Coal Research Establishment of the N.C.B. where I had been employed for many years, but for obvious reasons I had to reply in general terms only.

I was particularly asked to comment on problems that had been experienced in the instrumentation and control aspects of the development work. I explained that most of the problems could be attributed to the very adverse environmental conditions under which the equipment had to operate, and the characteristics of the materials being handled. These conditions included, high pressure and temperature, hydrogen migration, the errosion properties of the material and the small size of the plants.

The activities at the Institute were further discussed and in particular the 5kg/hr liquefaction bench scale unit and the 80kg/hr P.D.U. scale plant. The 5kg/hr unit is operational but was between runs and therefore unable to be seen operating. The 80kg/hr plant is being errected and is expected to be completed in the spring of 1986. This time scale is very much in line with the bar chart.

A visit to the plants was planned for later in the visit when I would be able to judge the situation first hand.

2. INSTRUMENTATION AND CONTROL DISCUSSIONS

A. Introduction

In the following daily sessions, discussions took place with the scientific and engineering staff and site visits were made to the plants and workshop facilities, in support of these discussions. The topics discussed were returned to time and time again during the sessions, as earlier discussions were thought out further. In the light of this, the reporting of these sessions have not been compiled as a daily chronicle of points discussed, but on a subject basis, where the discussions over a period of several days have been collected together and are presented under each subject heading.

B. Visit to the 5kg/hr and 80kg/hr Plants.

I was shown around the 5kg/hr plant which was not operating. I noted that British Glocon valves and bonnets were being used, one in the let down system.

I was then shown around the 80kg/hr P.D.U. which is under construction. Most of the mechanical hardware appears to be in position. Instrumentation, pipe work, trace heating, heating and lagging, electrical installation and instrumentation piping and wiring has not yet started. Installation of instrumentation and control cubicles and panels in the control room has yet to begin.

All work is being undertaken by a company called Separator of Katowice, a major design, procurement and installation company in Poland. It already undertakes major contracts for the Polish Mining Industry. A major in-put to their design work comes from the project team at the carbochemistry Institute.

C. Visit to Instrumentation Workshops

I was taken to the Instrumentation and Control Department, where I was shown the facilities for repairing the electronic and pneumatic instruments and control valves.

I inspected one of the typical six point recorders that will be fitted in 80kg/hr control room panel. It had a chart width of 10cms. (4inchs) with ink pen and electrical chart drive. There will be in the region of twenty of these units in the control room. The need to ensure that analysis of events on each chart during a run could be matched, was emphasised and agreed.

I was also shown repair work being undertaken on the e.m.f./ i. convertors, used for interfacing thermocouples with temperature controllers. This appears to be a requirement for all thermocouples, the convertor giving an output signal of 0-20m.a. (In the West this facility is usually incorporated in the temperature controller)

The workshop facilities are, in my opinion, sufficient for supporting the 80kg/hr in instrumentation and control maintenance, with the exception of lack of facilities for the high pressure testing of pressure transducers and high pressure differential cells.

Deatils of high pressure test equipment are to be forwarded to the Institute.

D. Safety.

In discussions on safety aspects of the plant I outlined major safety philosophies influencing the design of plant.

1. High Integrity Engineering.

I outlined this concept which consists of ensuring that such a high standard of engineering is maintained, in all its aspects, that an event of plant failure is unlikely to occur. This means that highly skilled and experienced engineering staff, inspection, checking and supervisory facilities have to be provided and is an expensive concept to introduce. It has the financial advantage of only needing good quality flame proof type equipment to support this concept. I pointed out that I knew of one major petroleum company in the U.K. that used this concept in its research facilities. It is also used on plants at the Coal Research Establishment of the N.C.B.

2. Intrinsic Safety.

This basic concept, which is highly detailed in British Standards, relies on the fact that measures are taken to ensure that should a fault occur in the instrumentation and control equipment it will be impossible for the equipment to feed sufficient energy along the cables to the plant to generate a spark and so ignite any gas that may have collected. The main tool in applying this concept is the use of Barriers between the equipment and the plant items.

An engineering leaflet detailing this concept was tabled at the meeting and handed over to the Institute staff.

3. Blast Cells.

This concept is self explanatory in that a cell is designed to withstand any explosion in the plant contained within it.

On the 80kg/hr plant the safety design concept appears to be sound. In areas where high power electrical heating is used, such as on the reactor, where the level is too high to incorporate barrier systems, the blast cell principle is used. In other areas of the plant pneumatic instrumentation is used except for thermocouples which are fed to controllers and recorders via convertors.

E. Gas Detection System

As a further measure in ensuring the safety of the plant and the personnel, two multi-channel gas detection systems are being incorporated in the plant, with the instrumentation being displayed in the control room. The equipment is being supplied by Sieger Ltd, a British company. I commented that I was familiar with this type of equipment and had been responsible for the purchase, installation and maintenance of several of them.

As part of the contract with Sieger two of the instrumentation personnel are to be given a familiarisation course by Sieger. I was asked to comment on wether I considered two to be sufficient. I considered that it was on the basis that the two trained personnel could impart their knowledge to the untrained members of the Department.

We discussed one of the basic considerations of these gas detection systems, where the sensors are sited in the plant area and may only be subjected to gas leaks at very infrequent intervals. It is imperative that, regardless of how infrequently they may be required to operate, one can quarantee that they will do so. I explained that on plants where I had this equipment I had introduced a testing proceedure which consisted of an engineer testing each sensor every three to four weeks. using a test gas.

By noting the sensitivity of the sensor, by means of the common meter display on the control room instrument, over a period of time any lowering of sensitivity due to ageing or contamination of the sensor could be seen and remeadial steps could be carried out.

I recommended that this proceedure should be discussed with Seiger during the familiarisation course. I agreed to forward to the institute information on test gases and the testing technique.

F. Control Valves.

The problem of control valve wear, particularly on the seats and trim, was discussed in detail. I explained some of the experience that I had in using ball valves in some of these high pressure high temperature applications. These valves due to their type of action, fully open or fully closed, were less suseptable to wear than the standard control valve.

The question of using these type of valves in automaticaly controlled and remotely controlled systems was raised.

I pointed out that the ball valves could be remotely controlled using actuators, electrical or pneumatic. This was apparently unknown to the team.

My experience had been limited to plants much smaller than 80kg/hr plant, but on these smaller plants ball valves were being succesfully used in automatic control systems covering the filling and emptying of storage vessels both at high temperature / high pressure applications.

The main problem area with the ball valves was in the sealing of the valve stem. Most manufactures fit P.T.F.E. seals, which are unsuitable for high temperature operations, but valves using graphite seals and suitable for high temperature operation are available.

The valves and problems associated with the pressure let down system were then discussed.

In the 5kg/hr plant this is achieved in one operation by a Glocon control valve. In the 80kg/hr plant it is proposed to have a two stage system, the system pressure being reduced to half pressure in the first stage and then from half pressure to approximatly atmospheric pressure in the second stage.

I outlined the pressure let down system that I was familiar with in which two valves are connected in series, with a small storage capacity between them (This could be the length of the pipework). The valves are opened and closed alternately, the length of time for which this takes place being dependent on the ammount of material required to be removed from, for example the reactor. One of the advantages of this type of system is that the disturbances in the vessel are reduced, in the event of a valve failure complete decompression of the vessel is less likely to occur and if the number of open and shut operations are monitored and integrated against time, a measure of flow from the reactor can be achieved.

After further discussion I recommended that bye-pass pipework, that could be isolated, should be fitted round the existing let down valve system so that testing of alternative valve arrangements such as the series system using high pressure, high temperature remotely operated ball valves could be undertaken without great disruption to the plant.

Manufacturers data on high pressure / high temperature ball valves and actuators is to be forwarded to the Institute.

G. Flow Measurement.

On the 80kg/hr plant the two main areas requiring flow measurments are the flow of hydrogen and the flow of slurry type material.

In the case of hydrogen flow this offers no great problem using for example orifice plates and differential pressure measurment provided precautions are taken to take account of the migratory property of the hydrogen. To reduce this effect the diaphragms in the differential pressure cell should be gold plated.

In the case of slurry flow measurement, due to the very adverse nature of the material and the wear it produced, it was agreed that the orifice plate and differential pressure measurement technique was not suitable for applications where continuous operation of plant was planned.

An orifice plate life of approximately one week had been experienced on plant at the Institute. I agreed that this was in line with my experience.

I then described indirect methods for establishing flow that I had experience with, such as measuring the level of material in a vessel and integrating the change of level with repect to time to establish flow. A method that had been used quite successfully on a slurry feed tank output flow was to incorporate two metering vessels, of known capacity, in parallel with each other and to automatically control the filling and empty--ing of the two vessels alternately.

Counting the number of operations against time establishes the flow rate. The size of the metering vessels has to be considered in relation to the flow value, the practical number of operations of the control ball valves and the accuracy of measurement required.

The more elaborate types of flow measurements were then discussed. These included ultrasonic, crosscorrelation techniques and heat loss sensers. I outlined my experience with these techniques and expressed the view, in the light of this experience, that these techniques had not been proven in the harsh environment of this type of plant. I also commented on the high relative cost of these techniques.

H. Level Measurement

This was discussed in detail and the team described the methods used at the institute and the problems that they encountered. Differential pressure measurements are used for vessel level measurements. In the low pressure areas of the plant nitrogen purged pressure measurements are taken near the base of he vessel and at the top. In the high pressure areas of the plant the same system is used, without purging. They experienced problems with blockages.

I described a level measurement technique very similar to the one used at the institute which had been quite succesful. The main difference was that the process feed pipe to the vessel was continued into the vessel to near the base of the vessel (as a dip tube). The pressure difference measurement was then taken at a position on the process pipe just before it entered the vessel and the inside of the top of the vessel.

This approach reduced the problem of blockages, particularly in the measurement at the bottom of the vessel. I repeated the point of using differential pressure cells incorporating gold plated diaphragms. The question of establishing the level of material in a vessel in which the stirrer operated at high speed causing a vortex was raised. I suggested that a calibration may initially be required feeding known quanties of material into the vessel.

I was then questioned into the use of nucleonic equipment for level measurement. I explained that I had experience with the use of this type of equipment for vessel level measurement and that it was very succesful.

One of the attractions of this equipment was that it could be fitted to vessels without the need for vessel wall modification or process downtime.

The cost of this equipment was then discussed and I gave them the figure that I had been given from a manufacturor before I left England.

The cost of a continous level system depended upon the size of the vessel but a figure of between £7,000 to £10,000 Stirling could be expected.

I explained that if any of this equipment was to be purchased, it was most important that the conditions under which it was expected to operate, such as vessel dimensions, wall thickness and material charecteristics were supplied to the equipment manufacturers so as to ensure that the source and containment vessel were suitable for the application.

I tabled and left at the Institute manufacturers leaflets for a continous Level Measurement System, a Level/Interface Measurement System and a Density Measurement System all using nucleonic principles.

J. Blockages.

This problem was discussed and it was generally agreed that the problem of blockages was a major one with no general cure. As a means of reducing the problem in the instrumentation and control field it was agreed that where pipe stubs had to be used they should be kept to an absolute minimum length and that trace heating should always be incorporated and taken right up to the instrument or transducer fitted.

It was also considered desirable that where pipe stubs had to be used facilities to allow rodding out to be undertaken, should be incorporated wherever possible.

Diaphragm capsules were also recommended so as to isolate the instrument from the process medium.

K. Preheater Instrumentation and Control.

The two types of Preheaters incorporated in the plants were discussed.

In the first type two process pipe lines are fed through the preheater bath. One of these lines contains a solids/oil solution, while the second line contains hydrogen. The objective is for the solution to leave the preheater at a temperature of approximately 400^{0}c. The preheater vessel is filled with lead which is heated by means of electrical heating elements positioned on the outside of the vessel. The heating elements are controlled in an ON/OFF mode from a temperature measurement.

Problems have been experciencеd in two main areas, firstly the poor control of the temperature of the lead bath allows the solution temperature to rise to such a value that coking of the solution occurs blocking the pipe.

In the second case, reduction of the solution pumping rate or complete failure of pumping, allows the residence time of the solution in the section of pipe in the lead bath to increase. This raises the temperature of the solution to a level where again coking occurs.

To avoid the first problem it is essential that a more responsive and accurate method of temperature control is required for the bath,

To avoid the second problem, it would appear that should the pumping rate slow down or stop, a means of quickly reducing the bath temperature to a level at which coking could not occur is necessary.

In my opinion the lead bath preheater approach is satisfactory for preheating materials that do not suffer from changes in state should the temperature rise too high. In this applicator, where avoidence of overheating is critical, I do not think that it is possible for this type of preheater to satisfy the requirements outlined, due to the "heat sink" effect of the mass of lead in the vessel and also due to the poor control response.

I recommend that consideration should be given to an alternative method of preheating and suggested that a fluidised sand bath type of approach might be considered. It would consist essentially of a bed of sand contained in the preheater vessel and fluidised. It could be heated by electrical elements which could be postioned inside the bed, while some heating could still be provided from the outside of the vessel. The fluidising medium could be air, or hot gas if available.

The process pipes containing the solution and the hydrogen would be coiled and positioned in such a way that they were submerged in the sand bath when fluidising occured.

In this concept better temperature control of the bed would be achieved due to the good heat transfer coefficient of the fluidised sand bath and the reduction of the control lag due to the position of the heating elements. In the event of failure of pumping, the fluidised bed could be slumped and clear the process pipes allowing the temperature to fall quickly. A further refinement could be the use of secondary air, fed in above the bed, as a further aid to cooling.

Discussion then turned to the main 80kg/hr Preheater and the drawings were tabled and explained to me. This unit is an air preheater where hot air is circulated through the unit by means of an air blower. The air path is via a hot gas chamber being heated by 2 gas burners running on commercial gas. The gas burner units are commercial packages which include sensers for measuring the temperature of the heating chamber, the surface temperature of the process pipew ck and the outlet temperature of the process materiel. Cut - Outs are provided to prevent the temperature of the heating chamber rising above a critical value.

A manually set valve controls the ammount of hot air allowed to leave the circulating system, via the stack, and trims the circulating air temperature.

It was established in discussions that as long as the temperature did not rise to a value at which coking could occur, the accuracy of the temperature control was not critical.

After further discussions and considerations I considered that the instrumentation and control aspects of the equipment supplied was adequate.

The question was raised of establishing a means of identifying whether or not pumping had stopped so as to avoid the problem of coking. I pointed out that pressure measurements were already incorporated in the process pipework at the inlet and outlet from the Preheater and that a differential pressure measurment could be made which could establish whether or not flow was taking place. The loss of pressure difference, in the event of stopped flow, could be used to alarm or to switch off the burners.

An alternative to this could be to measure the inlet and outlet pump pressures.

L. Data Logging.

I had a discussion session with Mr. Eugeniusz Jedrysik who is responsible for data processing activities at the Institute. He expressed an interest in the possibility of applying data acquisition techniques on the 5kg/hr and 80kg/hr plants. Their experience to date in this field is with a Hewlett Packard small computer system that they have at the Institute. This is used for the reduction of data from the rigs and laboratories, design calculations etc. They were wondering whether by increasing the storage capacity of the equipment it could be used more fully.

I outlined the experience that I had in this particular field. The desirability of designing and incorporating the plant signal transducers and transmission aspects while the plant being designed was highlighted.

Common problems to be guarded against such as plant signal reactions with the data acquisition system were discussed.

In general terms, where signals are required for data purposes an independant signal should be provided at the plant, for example, duplex thermocouples should be used where temperature measurements are being fed to the data system. In case of other measurements either a seperate transducer or a signal isolating convertor should be incorporated,

It was suggested that approximately 64 signals would be required for logging from the 80kg/hr plant and that in the region of 50 % of these signals would be temperature measurements.

I outlined one of the systems that I had been responsible for several years ago (1980) so as to give some guidance on what could be done and at what cost. This system was responsible for logging data from 3 plants. It had a capacity of 120 inputs, a main memory of 28k bytes which could be expanded and a backing store by a duel floppy disc unit giving a data capacity of 0.5m bytes. The peripherals consisted of a printer graph plotter and visual display unit.

The cost of the equipment was in the order of £30,000 Stirling (1980 prices), which did not include the plant transducers. As a simple guide this could be in the order of £100-£200 Stirling per channel.

I recommended that as this was their first step in this type of activity, they should consider a much simpler system than the one that I had outlined. I suggested that with a simple system, the signals from the plant could be data logged and by having a tape punch included in the logger, data tape could be produced and subsequently fed into the excisting Hewlett Packard system, via a suitable interface, for data reduction and analysis.

I agreed to forward to the Institute manufacturers information on simple data logging systems.

M. Documentation.

The instrumentation and control docmmentation provided for the 80kg/hr plant was discussed. I expressed an opinion that this was a most important aspect in ensuring that sufficient information was available to support the maintenance of the plant and the spares holding and ordering.

The P and I (Process and Instrumentation) diagram was studied. Further documentation was tabled and studied, this consisted of hook-up diagrams and specification sheets for the instrumentation and control equipment.

The documentation had been produced by the company SEPERATOR and in my opinion was good.

N. Staffing Level in Instrument Department.

I was asked for my opinion on the adequacy of the instrumentation support available at the Institute. The staff at the Instrument Department consists of an engineer and 4 technicians.

I expressed the opinion that this level of staffing was not sufficient to support the continous operation of the 80kg/hr plant let alone support any other activities on the site that might be going on at the same time.

I recommended that consideration should be given to employment of extra technicians. I was asked what level of staffing I considered necessary. I recommended that during the continuous operation of the 80kg/hr plant, the minimum requirement was 2 technicians per shift. This means a compliment of 8 technicians on the basis of 3 shifts per 24 hrs and a 5 day week. I also recommended that this support should be backed up by at least one extra technician working days in the workshop.

P. Education and Training.

I was questioned on the availability of suitable instrument training courses in Great Britain and if courses were available, whether or not I considered it desirable for some of their instrumentation staff to be sent on them.

I explained that there were several companies in Great Britain that provided this type of service and that I had sent several of my technicians on these courses. This was not a reflection on their technical competence but an updating to keep pace with advancing technology. The scope of the courses varied from basic to advanced.

In the case of the technicians at the Institute, I considered that it would be highly desirable to arrange for some of them to attend these courses, so as to broaden their knowledge. It would also give a good insight on how instrumentation and control equipment and techniques were progressing in Great Britain and the Western World.

At the request of the Institute mangement I agreed to forward course prospects and syllabus from companies in Great Britain who held courses.

I had also taken with me to Poland a draft copy of a Britsh Standard "Industrial Instrumentation Installation", which was refered to on several occasions during our technical discussions. I was questioned about the availability of this document and I agreed to find out if it had yet been published as a British Standard so that the Institute could buy one.

R. Instrumentation and Control - General.

During my final session at the Institute I was asked by the Director to comment on the Instrumentation and Control to be incorperated in the 80kg/hr plant.

In my opinion the instrument and control equipment is adequate for operating the plant. In the light of my visit minor changes may be considered. My only area of doubt is if detailed experimental work, such as operating under various conditions and analysis of results, is required. This could be very time consuming due to the lack of automatic data handling facilities in the Instrumentation provided. I considered that the analysis of plant data after runs was also going to be very manpower intensive. This could be particularly important if delays in the running of the plant were experienced due to delays in analysing data from the previous run.

I explained that a common method of establishing the adequacy or not of the instrumentation and control content of a plant was to relate the capital cost of the instrumentation and control content of the plant to the total capital cost of the plant. On standard production plant the instrumentation and control content could be in the order of 5% - 10% of the total plant content. In the case of the experimental plants, I have experience of plants with an instrumentation and control content of up to 25% of the total cost of the plant.

A further request was if I could provide any information on spares for two types of differential pressure cells being used at the Institute. These two cells are from British manufacturers, one by Kent Ltd and the other by Foxboro Ltd. I was able to provide the name and address of the Foxboro agent in Poland, but I was not able to provide any information on the Kent Ltd equipment. I agreed to follow this up on my return to England.

I was also asked if I could discuss with Serck Glocon, a British company, an order that they have placed with them.

As a final request I was asked if I would send them manufacturers literature on equipment suitable for the technology that they were working on.

APPENDIX

Senior Members of staff met on visit

CENTRAL MINING INSTITUTE

Prof. A. KIDYBINSKI	DEPUTY DIRECTOR

INSTITUTE FOR CARBOCHEMISTRY

DR. W MATULA	DIRECTOR
PROF. M IHNATOWICZ	DEPUTY DIRECTOR
PROF. Y KULCZYCKO	DIRECTOR OF UNIDO ACTIVITIES
PROF. S HULISZ	COORDINATOR OF COAL LIQUEFACTION GOV.PROG.NO.1
PROF. F RUSIN	HEAD OF DEPARTMENT
ING. J SWIADROWSKI	HEAD OF P.D.U. DEPARTMENT
ENG. A WORSZTYNOWICZ	HEAD OF PROC. ENG. DEPT.
ING. T GABRYS	HEAD OF MECH. ING. DEPT.
ING. W STAWIANY	HEAD OF ADMINISTRATION
ENG. M KRZYMINSKI	HEAD OF RAW MATERIALS PREP. LAB.
ENG. B KIECKA	HEAD OF DESIGN DEPT.
ENG. S BOROWKA	RESEARCH WORKER P.D.U. DEPT.
MR. W SZCZEPANCZYK	HEAD OF CONTROL MEASURMENT DEPT.
MR. E JEDRYSIK	DATA HANDLING RESPONSABILITIES.