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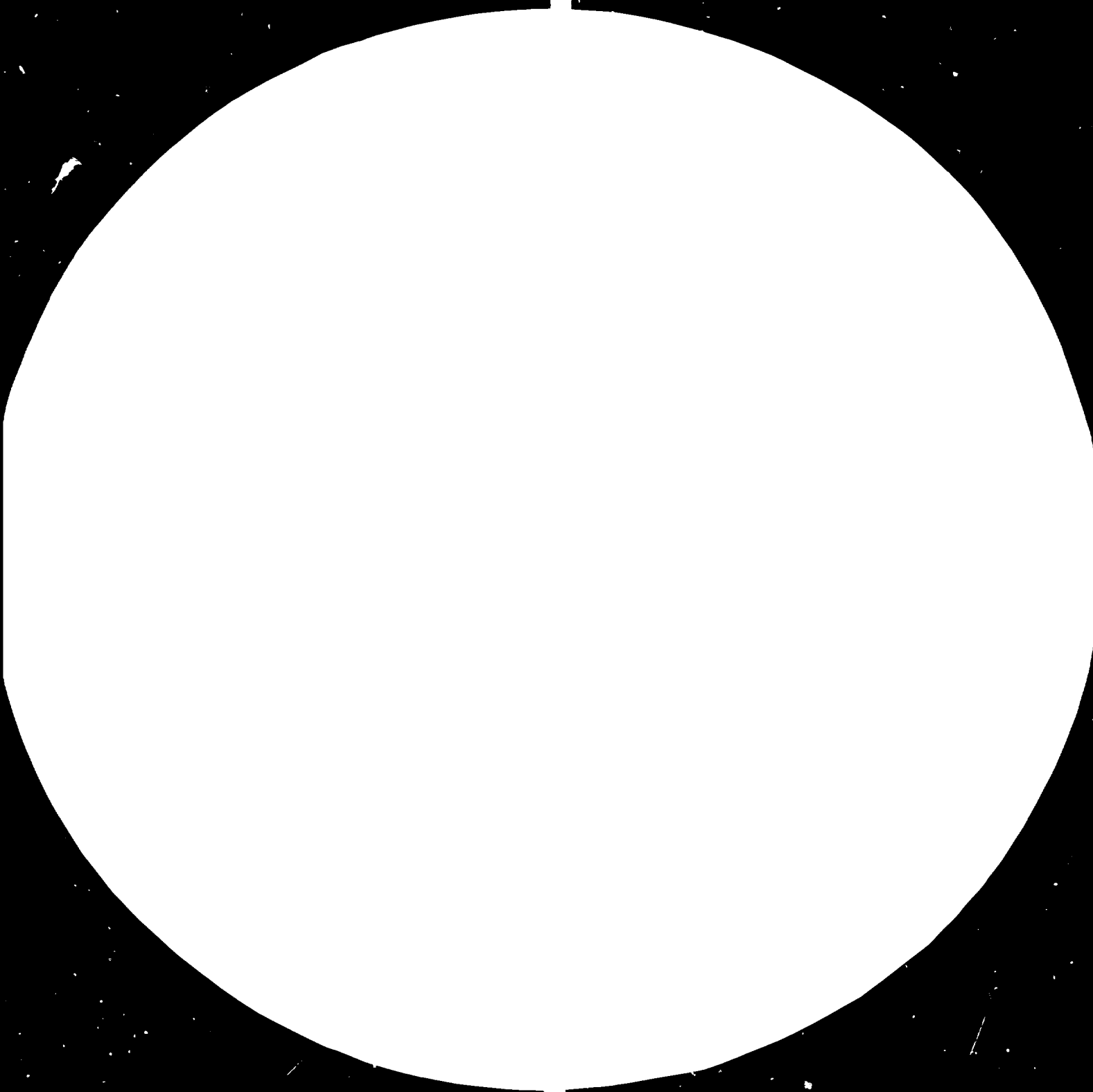
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Resolution test targets are used to measure the resolution of a system. The resolution is the ability of a system to distinguish between two points that are close together. The resolution is measured in cycles per inch (CPI). The resolution of a system is the number of cycles per inch that the system can resolve. The resolution of a system is the number of cycles per inch that the system can resolve. The resolution of a system is the number of cycles per inch that the system can resolve.

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30 May 1983

INTEGRATED COAL CONVERSION

DP/POL/77/102

POLAND

Technical Report*

Prepared for the Government of Poland
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of R.J. Pugmire
Expert on NMR Spectroscopy

United Nations Industrial Development Organization
Vienna

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SUMMARY OF VISIT

On October 17, 1982, I arrived in Vienna, Austria and on Monday, October 18th I began my orientation period at UNIDO in preparation for the visit to the Institute for Carbo Chemistry at Tychy-Wyry in Poland. An entrance visa to Poland was obtained on the afternoon of October 20, 1982 and on Thursday morning, October 21, I flew from Vienna to Katowice where I was met at the airport by Mr. L. Wojceich Dyczewski, Department for Cooperation with Foreign Countries at the Central Mining Institute in Katowice. Mr. Dyczewski took me to the Silesia Hotel and informed me that the following morning I would be picked up by Miss Barbara Robak and taken to the Institute to begin my activities. On Friday morning, October 22, a car, a driver, and Miss Robak met me at the hotel and transported me to the Institute of Carbo Chemistry at Tychy-Wyry. There I was welcomed by Mr. Walter Matula, Deputy Director of the Institute and the following individuals: Dr. Jerzy Winnicki, Director; Mr. Walter Matula, Deputy Director; Dr. Stanislaw Hulisz, Coordinator of Research Programme; Dr. Emanuel Rusin, Chief of Division of Basic Technological Researches on Coal Liquefaction Processes; Dr. Maria Ihnatowicz, Chief of Structural Analyses Laboratory; Dr. Aleksandra Rusin, Structural Analyses Laboratory; Miss Barbara Robak, Structural Analyses Laboratory; Mr. Jerzy Swiadrowski, Chief of Investigation Plants; and Mr. Adam Worsztynowicz, Group for Eng. Calculation. Miss Robak served

as interpreter during the initial welcome in order to assure that no language barriers were present that would obstruct our free and open communication. The day was spent visiting with individual members of the Institute regarding problems of interest to them in their coal liquefaction program. Mr. Swiadrowski and Mr. Worsztynowicz gave me an extensive tour of the process development unit and the bench scale liquefaction unit that is located at the Institute. The process development unit is now undergoing major engineering redesign and reconstruction in order to convert the PDU from a two stage to a single stage liquefaction process. Institute personnel indicated that it would be at least a year before this work is completed and the PDU can be placed back in operation. In the meantime the bench scale reactor is being employed to explore engineering parameters associated with the move to a single stage liquefaction process. A great deal of effort is being placed on the redesign and reconstruction of this PDU as the liquefaction program is now lagging behind due to technical problems associated with the originally conceived two stage liquefaction process. This process has now been abandoned and as stated previously the hardware is being redesigned and reconstructed in hopes that the single stage process will be much more successful.

During the weekend, the Central Mining Institute in Katowice provided a car and a driver and Miss Robak served as hostess for some visits to the Mining Museum at Sabzre and for visits to local cultural

interest in Krakow. On Monday, October 25th, I met with Dr. Jerry Winnicki, Director of the Institute for Carbo Chemistry at Tychy-Wyry. He had been away from the Institute on my arrival on Friday and we had a most pleasant visit about the goals of the Institute and the people who were working within the Institute. On October 25th and 26th, I spent the time discussing details of liquefaction problems, chemical reaction mechanisms associated with liquefaction processes, and coal derived liquid characterization problems. I consulted extensively with Dr. Aleksandra Rusin and Miss Barbara Robak regarding the use of their newly acquired NMR equipment for the characterization and analysis of coal derived liquids.

UNIDO has purchased two major pieces of equipment for the Institute. An electron microscope and an NMR spectrometer were purchased approximately one year ago from JEOL Incorporated (a Japanese instrumentation firm). Following installation of the equipment a year ago, it was found that the line voltage at the Institute was not sufficiently stable to enable the NMR spectrometer to operate. In addition, there were deficiencies in the operating characteristics of the electron microscope. While the microscope has taken data periodically during the past year, it still does not meet all specifications of the manufacturer and has yet to be placed in proper operating condition. The NMR spectrometer was only placed in operation shortly before my arrival at the Institute. This was made

possible by Mrs. Rusin's ability to borrow a 5 KVA 3-phase voltage stabilizer that is used to supply sufficient line voltage stabilization to allow the proper operation of the magnet power supply. However, another 3 KVA 1-phase voltage regulator is needed to permit line stability for the operation of the power supply to the computer system. Without this second voltage regulator it is not possible to operate the spectrometer for long periods of time, i.e., overnight, since line voltage fluctuations will trip the protective circuitry in the computer system and shut the spectrometer down. Hence, up until the time of my arrival only three proton NMR spectra had been obtained. I encouraged Mrs. Rusin and Miss Robak to obtain a carbon-13 NMR spectra on the same samples for which they had obtained proton spectra. While I was there, one spectra was obtained and in analyzing the data I suggested the modification of instrumental parameters in order to extract additional information from the coal derived liquid sample that was of interest to them at that time. These experiments were begun during my visit and were not completely finished prior to my departure. It appeared that the experiments were providing the information that I had predicted would be found and which would be of use to individuals within the Institute.

The equipment that has been purchased represents a major investment on the part of UNIDO and is sorely needed by the Institute. However, circumstances do not yet prevail that will allow for the efficient use of the equipment to solve the Institute's problems. In-house maintenance capability does not exist for the NMR spectrometer

and it is not clear to me that a sufficiently high level of maintenance capabilities exist at the present time for operation of the electron microscope. These problems must be solved in the near term in order to maximize the investment made in equipment. In particular, the problem of maintenance on the NMR equipment must be solved rather quickly since the first major maintenance problem that occurs will render the spectrometer totally inoperable and it probably will not be operable until a maintenance engineer can come to the Institute from one of the western nations. I was told that it takes as long as three months for a maintenance engineer to obtain a visa in order to enter Poland. If conditions continue which require such delays, maintenance will become an intolerable problem and the efficiency of the use of the equipment will become very low. This efficiency problem will greatly increase the costs of acquiring the data that the Institute so badly needs in the characterization of the coal and coal products as it works to complete development of the liquefaction program.

The costs of operation under these conditions can perhaps be illustrated by means of a simple calculation. I do not know the cost of the spectrometer which was purchased but an estimate of the cost can be used to illustrate the point to be made. Let us assume that the spectrometer was purchased at a total cost of \$125,000. It is a normal practice for instruments of this type to consider the useful lifetime to be approximately five years and, hence, to amortize the cost of the investment over a five year period. Hence, the cost of

having the instrument just sitting in the laboratory is \$25,000 per year. Secondly, one has to consider the amount of time that the instrument can actually be used. There are a total of 8,760 hours in a year. In major NMR research facilities, the equipment is used 24 hours a day, seven days a week. However, due to normal instrument maintenance and periodic major maintenance problems, the average efficiency of use of the equipment is usually in the range of 60-70 percent. Hence, under the most optimum conditions wherein a strong in-house maintenance capability exists which requires only occasional input from outside maintenance engineers, total operating time of 5,500 to 6,000 hours per year can be achieved. In the present case at the Institute of Carbo Chemistry, it is not possible to operate the equipment during the night or during weekends or holidays because the equipment cannot be left unattended due to the major line voltage fluctuation which automatically shuts down the instrument. Hence, the equipment can only be used during the normal working hours, which would amount to approximately 2,000 hours per year. If one assumes a 60-70% efficiency factor as used in the example given above, one could only expect total operational time during the course of a year of between 1200-1400 hours. It is easily seen that if instrument amortization costs amount to \$25,000 per year, the cost of amortization of the equipment per hour of anticipated use would be \$17.86 as the minimum compared to \$5.00 per hour in the example cited above. Neither of these calculations involve the costs of the operators who

who must operate the equipment, the maintenance costs and routine operational costs and supervisory costs which are associated with the operation of any instrumentation. I have no way of estimating what these would be in Poland but from experience in the United States I find that such costs are at least as high as the amortization costs. Thus, one can see that the costs of operating the equipment is not a trivial matter. If one compares the costs on the basis of just amortization between the two operational scenarios, it is quite clear that under the present conditions within the Institute, the operating cost is at least three times as much as it would be if some of the problems within the Institute relating to instrument operation and maintenance could be solved. One must realize that these costs go on irrespective of whether data is acquired. Hence, during the first year that the NMR instrument was installed in the laboratory, Institute personnel were only able to obtain three spectra. On the basis of instrument amortization costs alone, the cost of each spectra was at least \$8,000. I point this out just to illustrate the magnitude of the problem which must be dealt with in order to allow the Polish scientists to pursue their activities in an efficient and cost effective manner. Similar arguments could be made for the electron microscope but the present case illustrates the point adequately.

On Wednesday, October 27th, I gave three lectures at the Institute for Carbo Chemistry on coal structure, coal maceral structure, and coal liquefaction problems. On Thursday, October 28th, I spent the

day at the Central Mining Institute conferring with Dr. Kułczycka and other Institute members regarding the physical and petrographic properties of the coals presently being mined in upper and lower Silesia. I requested reports which would allow me to examine the physical, chemical, and petrographic properties of the various coals and the Institute personnel gladly obliged. I requested this information in order to select a suite of coals which might be of interest to personnel at Penn State University and the University of Utah for further detailed study of the type not presently going on in Poland. Institute personnel were very helpful in providing the information to me and a suite of 33 coals was selected. It was agreed that, if possible, kilogram quantities of these coals would be sent to me as soon as they could be assembled and appropriately packaged. During the day I gave two lectures at the Institute on coal structure and liquefaction processes. Members of the Institute of Carbo Chemistry at Tychy-Wyry, the Central Mining Institute at Katowice, and other institutes involved with coal related problems in the region were invited and were present. I had the opportunity of spending approximately 1 1/2 hours conversing with Dr. Anna Marzec regarding the work that she is doing on proton relaxation phenomena in coals. I find that this work is of very high scientific quality and is noteworthy. We discussed many common interests and the possibility of future contacts and/or collaboration.

On Friday, October 29th, Mr. Dyczewski met me with a car and driver and picked up Mr. Frank Scargill and transported us to the airport at Katowice for our departure from Poland.

RECOMMENDATIONS

The following recommendations are felt to be absolutely necessary to assure that the integrated coal conversion project can make reasonable progress:

1. A high level of competence and ability resides with the people that I visited. They are motivated to succeed in the project that they are working on and are willing to sacrifice in order to achieve the goals of the Institute. However, present circumstances in Poland now make it difficult for these individuals to be able to achieve their goals in a timely fashion. Current difficulties in communication with the west and researchers in the coal liquefaction area will exacerbate the present delays in the project. It is absolutely critical that close ties and communication be maintained with other laboratories that are working on similar problems in order to take advantage of developments that are made outside Poland.
2. There is a critical shortage of technical information available to the scientists at the Institute. Books and journals are difficult to obtain. Efforts should be made by UNIDO to provide funds to purchase the latest books in the fields of research of the Institute. While I visited the Library, I found that many journals were just not available that are absolutely essential to providing the data base and

awareness of research in other parts of the world which are essential to the success of personnel at the Institute. For instance, personnel asked me about papers that are readily available outside of Poland but which cannot be obtained inside the country. UNIDO can make a significant contribution by assuring that appropriate funds are provided to purchase journals and books as requested by Polish scientists and engineers

3. Equipment maintenance is a major problem which must be dealt with quickly or the equipment that has been purchased to date by UNIDO will have almost no value to the Institute. An in-house maintenance capability must be developed within the Institute to take care of the routine maintenance and operational problems. Furthermore, mechanisms must be secured which would permit maintenance engineers to respond on call to supply spare parts and on-site engineering support to solve maintenance problems. At the present time intolerable delays are required before such outside maintenance support can be secured. Unless these two problems are dealt with it is only a matter of a very short time before the equipment will be inoperable because of maintenance requirements. Personnel within the Institute have the inherent capabilities of being able to address the problems of routine maintenance but they must have proper training and be supplied with spare parts in order to be able to do just the routine things that are required on a day-to-day basis to insure efficient equipment operation.

4. If a second phase for the current project is initiated, it is absolutely essential that project personnel be given the opportunity to travel to western countries as in phase one in order to obtain first hand knowledge of recent developments so that these developments can be incorporated into operational procedures. Furthermore, selected individuals in highly technical areas should be given the opportunity to obtain additional training by way of advanced degrees and/or post doctoral training in the west in order to increase breadth of their background in problems associated with coal conversion technology and the upgrading of coal derived liquids. UNIDO should provide financial support for a limited number of fellowships that would allow such training to occur. In addition, specialists from the west should make periodic visits to Polish laboratories.
5. UNIDO should consider changing its equipment procurement policy in order to more closely coordinate bidding procedures and final selection processes with the host institutions. No equipment should be purchased without the full knowledge and concurrence of the using organization and the individuals who will be using the equipment. The problems associated with the electron microscope and NMR spectrometer in Tychy-Wyry would in large part have been eliminated if payment for the equipment had been withheld until proper installation had occurred and all performance parameters had been adequately met. At the present time the Polish institutes have no

recourse to the instrument manufacturers because of the manufacturers poor performance since payment has already been made. The procedure at our laboratory at the University of Utah is to withhold payment until all operational requirements have been met for a particular piece of equipment. In some cases this has taken as long as six months to a year but it has always been successful since full payment of the equipment has been withheld until satisfaction was received. Such conditions can only be obtained if there is a closer working relationship established between the procurement procedure of UNIDO and the using organizations within the host country.

6. It is absolutely essential that funds be provided to purchase two voltage stabilizers for use in the Carbochemistry Institute in Tychy-Wyry. At the present time a borrowed unit is in use as a stabilizer for the magnet power supply. This unit is to be surrendered at the end of the calendar year. This stabilizer has to be replaced and, in addition, a second stabilizer, as described previously in the report, must be purchased before the equipment can operate properly.

