



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



D04600

I D

Distr.
LIMITED

ED/MS.121/27
18 December 1972

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

**Expert Group Meeting on the Transfer of Know-How
in the Production and Use of Catalysts**

Bucharest, Romania, 26 - 30 June 1972

REPORT OF THE
EXPERT GROUP MEETING ON THE TRANSFER OF KNOW-HOW
IN THE PRODUCTION AND USE OF CATALYSTS

14.72-7377

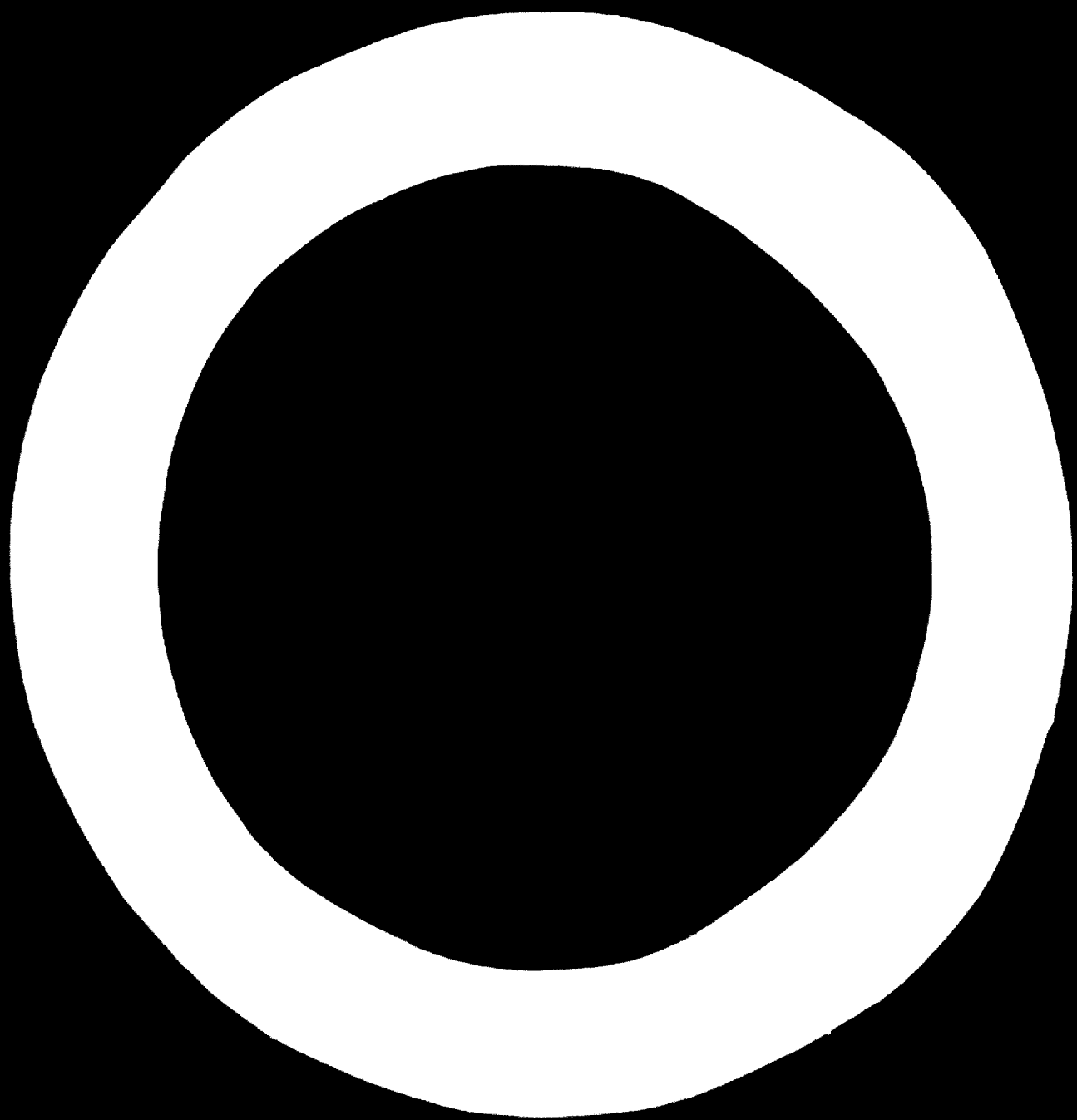


TABLE OF CONTENTS

		<u>Page</u>
Section I	Introduction	3
Section II	The development, production and use of catalysts in the developing countries	5
Section III	Test methods for catalysts and the evaluation of catalytic processes	8
Section IV	Plants and equipment for catalyst manufacture and catalytic processes	10
Section V	New trends in catalysis and in the use of catalysts	12
Section VI	The transfer of know-how in the production and use of catalysts	14
Section VII	Conclusions and Recommendations	18
Annex	Report of the visit to the Ploiesti Refinery and Petrochemical Complex and the Petrochim and I.C.P.T.P.T. Research Institutes	21

I INTRODUCTION

As part of the UNIDO programme of work for 1972, an expert group meeting on the "Transfer of know-how in the production and use of catalyete" was held at Bucharest, Romania from 26-30 June 1972, in co-operation with the Government of Romania. This international meeting constituted the first such activity of the recently established Joint UNIDO/Romania Centre for International Co-operation in the Field of Chemical and Petrochemical Industries for the Developing Countries.

The main objectives of the meeting were:

- (a) To identify problems related to the production and use of catalyete for the fertiliser and petrochemical industries in developing countries;
- (b) To provide guidelines for the future work programme of UNIDO in this field;

Additional objectives were:

- (c) To promote investment in production facilities in developing countries;
- (d) To consider ways and means of transferring catalyst technology to countries in which the chemical industry is sufficiently developed to justify domestic production;
- (e) To assist these developing countries in planning the future production of catalyete;
- (f) To identify future trends in the use of new types of catalyete for the fertiliser and petrochemical industries.

On behalf of UNIDO, Mr. M.C. Verghese acted as Director of the Meeting and Mr. A. Dumitrescu as Technical Secretary. On behalf of the Romanian component of the Joint Centre and the organising committee, Mr. A. Lungu served as Co-Director and Mr. V. Ionita was liaison officer. Mr. G. Saciu and Mr. I.V. Nicolescu of Romania were elected Chairman and Vice-Chairman respectively, and Mr. Fernando Colunga Diego, Rapporteur.

The meeting was attended by forty-seven persons from fifteen countries and one international organization: twenty experts from eleven countries (Bulgaria, the Federal Republic of Germany, India, Iran, Israel, Mexico, Romania, Turkey, the United Kingdom of Great Britain and Northern Ireland, the United States of America and Yugoslavia) and one international organization; one consultant from Romania appointed by UNIDO and twenty-six observers from eight countries (France, the Federal Republic of Germany, Iran, Italy, the Netherlands, Poland, Romania and the United States of America).

The inaugural address was made by the Minister of the Chemical Industry of Romania, Mr. M. Florescu. Mr. Verghese read a message from the Executive Director of UNIDO, Mr. I.H. Abdel-Rahman. Mr. A. Rotival, Resident Representative of the United Nations Development Programme reviewed the projects of Romania and Mr. Dumitrescu presented the over-all programme for the meeting.

Twenty-six technical and information papers were submitted for presentation and discussion at the meeting.

The participants visited the Ploiesti Refinery and Petrochemical Complex and the Petrochim and I.C.P.T.P.T. Research Institutes. A report of this visit is given in the annex.

In spite of the complexity of the problems and difficulties involved in the transfer of know-how and in the production and use of catalysts, the participants treated the subject objectively and arrived at conclusions and recommendations related to each of the original objectives. Of particular note are the recommendations which call for:

- (a) Unity of action between countries in the standardization of methods and techniques.
- (b) Mutual assistance in training.
- (c) Co-operative efforts in research and development.

(d) Specific, tentative offers of assistance from a participant from a developed country with respect to documentation facilities, services and catalyst know-how.

The meeting closed with messages of thanks and summaries by the Deputy Minister of the Chemical Industry of Romania, Mr. V. Belizna, Mr. Verghese and Mr. G. Suciu.

II THE DEVELOPMENT, PRODUCTION AND USE OF CATALYSTS IN THE DEVELOPING COUNTRIES

Papers on the development, production and use of a variety of catalysts were presented to the meeting. The subjects ranged from policy questions to research, from long-term experience in catalyst development and production and local problems relating to their use to novel reactions and technologies, such as the use of phosphoric acid as a catalytic medium for organic reactions. Some of the papers dealt with the specifics of catalyst preparation for the dehydrochlorination of ethylene dichloride, the hydrodesulphurization of fuel oil using a conventional catalyst, and the preparation of aromatics by catalytic reforming of petroleum fractions; other papers were concerned with problems of education and training.

Various papers called attention to the nature of the efforts made in some developing countries to promote know-how in view of the intricacies of industrial catalysts and catalytic processes. From reports presented and discussions which took place on this subject, it was evident that many of the developing countries were already actively involved, having developed facilities for physicochemical studies and pilot-scale evaluations of catalysts. These countries were determined to take steps which would qualify them to undertake catalyst assessment and also to produce the catalysts they needed for their industries. In fact, several of the papers concluded that in consideration of the domestic bulk consumption of catalysts, the country concerned should take such an active part in catalyst research and development that the country could eventually develop into a major catalyst manufacturer.

It was accepted as minimum requirement that users in developing countries should establish adequate facilities for catalyst assessment to allow for the examination of samples received from potential suppliers. Such facilities are needed not only because of commercial factors involved and geographical location, but also because of the unfortunate consequences that can result from total reliance on foreign catalyst manufacturers. In examples given by representatives of developing countries, some catalysts that were guaranteed for two years failed within six months, and the suppliers did not offer replacements. In spite of many obstacles to be overcome, the description of pilot units, the details given of testing procedures used and other revealing factors indicate that some developing countries were competent to proceed with the selection, development and manufacture of catalysts.

The depth of the experience achieved was clear from presentations describing reaction mechanisms, process thermodynamics, physicochemical characteristics of catalysts and the effect of operating variables on catalyst performance. Several participants however, expressed their concern at the expenditure involved and the time required for a developing country to establish such competence, and at the uncertainty of ever gaining this objective.

Not the least of the many difficulties to be encountered was the problem of financing catalyst projects in developing countries. Local problems involved in obtaining adequate finance from industrial units applying catalytic processes were presented by one of the participants.

Difficulties in recruiting staff adequately trained in this field were also discussed. Because there were so few good technologists, there was much competition for their services. Limitations in professional scope and prospects caused professionals to change position frequently which has acted as a deterrent in developing or building up expertise.

Representatives from developing countries in which catalyst manufacture had already been initiated offered suggestions from their own experience relating to the transfer of catalyst know-how to industry. The type of tests required and the equipment and techniques needed for quality control and evaluation of catalysts were discussed. It was agreed that development batches of catalysts were best prepared in equipment that was a prototype of a full-scale commercial

unit. This approach was considered essential for minimizing problems related to scale-up from the laboratory scale to operations in commercial units.

It was clear from papers presented that there was now a growing interest in the field of industrial catalysts both in universities and industrial laboratories of developing countries. However, the development of facilities for fundamental and applied research should be supplemented by courses in industrial catalysis at the university level.

Schemes for training scientists and engineers in operating catalytic units before undertaking assignments in research were considered by the participants as an important step in the generation of such expertise. One participant from a developing country believed that without such expertise the know-how of catalyst development and production alone was meaningless, because the consumer was not in a position to apply the catalysts that were manufactured. The expertise generated must include the commissioning steps in bringing a catalyst to life because without such competence even a proven catalyst may fail. The opinion was expressed that competence in catalyst technology cannot be considered established until the materials produced continue to function in commercial units for reasonable periods of time and under guarantees.

In exploring means to overcome the difficulties discussed, the Expert Group considered co-operative efforts and possible sources of assistance. It was felt necessary to examine the feasibility of establishing standards for catalyst selection. It was agreed by most of the participants that a documentation centre in catalysis would be of definite assistance. Statistics relating to the performance of catalysts supplied by different manufacturers in various units throughout the world, for example, could be of help to users in the selection of a supplier.

It was the general opinion that UNIDO could be of assistance in this regard both in supporting efforts to establish standards in catalyst characterisation and by establishing a catalyst documentation centre.

III TEST METHODS FOR CATALYSTS AND THE EVALUATION OF CATALYTIC PROCESSES

The problem of catalyst testing in developing countries was considered from two points of view: (a) the general problem of establishing criteria for catalyst purchasing and use, and (b) the exchange of experience and information on methods and techniques in catalyst testing.

Concerning the first aspect, representatives from developing countries stressed the importance of catalyst testing for their industries, suggesting means by which domestic competence might be realized. In order to establish a rational basis for comparison of catalysts offered by different producers, consideration should be given to: the selection of properties required to characterize each particular system; the establishment of correlations between process conditions and acceptable tolerances of critical properties of catalysts, and the definition of methods to be used in catalyst testing.

In regard to the standardization of methods for catalyst testing, the significance of some of the conventional criteria for the evaluation of catalysts was questioned. The basic criteria for evaluating and selecting catalysts were defined as the effectiveness of their activity and their selectivity and stability, that is their "life" under operating conditions in commercial plants. It was pointed out that the endeavours of the industry to develop reliable methods for investigating the dynamics of catalyst ageing in reactors were still active.

Representatives of several of the catalyst manufacturers expressed the opinion that catalyst users should not test catalysts themselves, but should leave testing to the catalysts suppliers. This approach, based on confidence in suppliers in lieu of effective local testing facilities, was discussed extensively and considered by most speakers as not entirely adequate. It was concluded that in spite of the numerous difficulties involved, a developing country should strive to establish competence in catalyst testing to ensure optimum performance in the operation of its chemical industry.

Consideration was given to methods applied in the investigation of the physicochemical properties of catalysts as well as their relationship to reactor characteristics. It was noted that in this area the exchange of experience between developing countries and co-operative programmes should be encouraged.

Instrumentation and the application of numerous methods were reviewed: adsorption measurements and BET techniques, pressure porosimetry, magnetic balance, X-ray, electrical conductivity and ESR, thermogravimetry, D.T.A., quartz microbalance, chromatography and activity tests. With regard to the activity tests, the determination of the activity of solid catalysts, account was taken of the physical phenomena associated with catalytic reactions, and the mechanical design and functional characteristics of various types of catalytic reactors. It was pointed out that the choice of a significant test reaction for a particular catalyst involved a critical decision.

Three levels of catalyst testing were defined: (a) simple comparative testing; (b) intensive catalyst evaluation, including simulated plant operation; and (c) fundamental examination to characterize in detail the catalyst and the reactions it catalyzes. The various techniques used at each level of catalyst testing were described and their usefulness to the catalyst researcher, catalyst manufacturer and catalyst user was assessed. The testing of the several types of catalysts used in ammonia manufacture was used as an illustration, considering both those testing methods which are common to all catalysts and those which are particular to individual catalysts. The measurement of a catalyst's activity, chemical constituents, and physical properties, such as surface area, pore structure, shape and strength was discussed.

As an important step in catalyst testing, the physical and mathematical modelling of heterogeneous processes was presented. This consisted of:

- Kinetic characterization of the catalyst.
- Thermodynamic characterization of the reaction.
- Scale-down of the commercial reactor.
- Formulation of the equation for heat and mass transfer.
- Subsequent adjustment of the kinetic data which characterizes the catalyst.

Highly instructive surveys of methods and procedures applied in manufacturing practice were presented by several catalyst manufacturers. These contributions conformed with the central theme of the meeting.

IV PLANTS AND EQUIPMENT FOR CATALYST MANUFACTURE AND CATALYTIC PROCESSES

The papers surveyed various aspects related to catalyst manufacture and their use in catalytic processes. The views of experts from large catalyst manufacturing companies in highly industrialized countries were confronted with the views, ideas and problems of experts from developing countries. The animated and interesting discussions of the papers presented served to underline the importance and need of examining thoroughly the various aspects of this particular field. However, time did not permit such an examination and the discussion therefore was somewhat limited.

There was a sharp divergence of ideas and opinions expressed by experts from the developing countries and experts representing large industrial catalyst manufacturers in developed countries. The latter were rather sceptical as to the possibility of manufacturing catalysts in developing countries and suggested that the production of catalysts should be limited to qualified companies in highly industrialized countries. Experts from developing countries emphasized the necessity of establishing catalyst manufacture in their countries, not only for economic reasons but also for political, social and techno-educational reasons. From the discussions, it appears that the manufacture of certain types of catalysts was possible with relatively simple production units. Such units could constitute a beginning of domestic manufacture of catalysts in developing countries. From this start manufacturing skills could be developed and experience gained in quality requirements and specifications.

The small-scale manufacture of a phthalic anhydride catalyst was presented as an example of this approach. The testing section of this kind of plant can be used for development and experimentation in this and related fields, as well as for the training of technical personnel. Several examples were given which demonstrated that the manufacture of certain types of catalysts in developing countries has been accomplished by mobilizing the intellectual potential of the country.

From the contents of the papers presented in this section and from the discussion which followed it appeared that the installation of carefully selected catalyst production units, initially limited to projects which can be realized with a relatively modest capital expenditure, was feasible in many developing countries. In certain instances these could perhaps be undertaken as joint

ventures with manufacturers established in the field; this would constitute a concrete expression of the transfer of know-how to developing countries.

It was suggested that UNIDO encourage and support intentions to install such catalyst manufacturing plants and their subsequent use for technological development in developing countries by the following means:

- (a) Procuring a technological small-scale model of a catalyst manufacturing plant combined with semi-technical scale demonstration units and pilot plants for the further development of catalytic processes;
- (b) Organizing an information service and technological documentation centre designed to provide developing countries with information on catalyst manufacturing processes and facilities as well as on catalytic processes; this centre should contain a patent documentation section. It was suggested that UNIDO co-ordinate its own activities in this particular field with those of the newly organized International Patent Documentation Centre in Vienna, Austria. UNIDO was offered the services of data processing facilities by a participant from one of the developed countries, it was hoped that other countries would follow this initiative;
- (c) Acquiring a mobile and easily transportable catalytic reaction demonstration unit which could be placed temporarily at the disposal of technical centres in different developing countries to promote development work in this field. This demonstration unit might be a corollary to the model catalyst manufacturing unit mentioned above;
- (d) Appointing experts to study the feasibility of catalyst manufacture and use in developing countries requesting such services;
- (e) Organising subsequent meetings on the subject of catalysis with more detailed agenda, narrowly defined topics, and possibly with an increased number of participants. Discussions could be combined with visits to catalyst manufacturing plants and to plants using catalytic processes. Emphasis at these meetings should be placed on catalysts which appeared to be of particular interest or importance to developing countries, and which could be manufactured feasibly in these countries. It was suggested that a group of papers could be presented briefly by a rapporteur at these meetings thus leaving more time for discussion and an opportunity to exchange opinions in informal gatherings.

V. NEW TRENDS IN CATALYSIS AND IN THE USE OF CATALYSTS

Both in papers and in discussions emphasis was placed on the increasing role of catalysis in meeting the rapidly expanding world-wide energy demand, and in providing feedstocks for an ever widening variety of products. Catalytic processes have become the most important tool in the majority of chemical conversions, irrespective of the size of the country or its economic scope. In spite of the fact that research efforts were not uniform throughout the world, and the most important achievements in catalysis were found in the developed countries, the developing countries were also becoming involved in catalytic research and development activities.

It was indicated that most of the over-all research at the present time was still devoted to heterogeneous catalysis, the development of improved catalysts, and more efficient processes. An increased interest was also being shown in homogeneous catalysis, in spite of earlier reservations in this field. Research achievements in heterogeneous catalysis relate particularly to improving the economics of prevalent transformations, decreasing reaction temperature and pressure, increasing catalyst life and yields, improving product quality and other such accomplishments. The improvement of catalysts and the development of new catalytic systems would be aided considerably by advances in methods for their synthesis and characterization. The extent to which developing countries could devote efforts to research in catalysis will be dictated by domestic conditions - techno-economic, social and political. The scale of operation will greatly influence the selection of routes which might be pursued in process development. Smaller units allow for greater flexibility in considering processes which give coupled products. These units may increase the scope of the industrial development.

Some opportunities of this kind were suggested in a paper on "New trends in catalysis". Other developments were described which promised significant commercial advantages. The impact of homogeneous catalysis was emphasized in this review of the more recent processes for the manufacture of acetic acid, ammonia and methanol, nylon intermediates in ethylene epoxidation, the oxo-synthesis, the ammoxidation of propylene for acrylonitrile production, hydrogenation processes, and others.

Regarding the oxo-technology, it was suggested that in the near future, rhodium catalysts will probably replace those containing cobalt. Catalysts based on rhodium also appeared to be more efficient for the synthesis of acetic acid, showing important economic advantages over the Wacker process.

In connexion with the manufacture of ammonia and methanol, recent technological changes allowed for considerable reductions in operating pressures. It was pointed out that interest in ammonia production generally precedes that of methanol in developing countries. Because of the similarities in these technologies, consideration should be given to the design of an initial ammonia plant which at a later stage could be converted into a methanol plant when ammonia capacity is to be extended. It seemed that in such cases it would not be advisable to use the low pressure methanol technology.

In the field of hydrogenation, new and interesting catalytic systems have been announced, several of which were expected to achieve commercial implementation in the near future. New catalytic systems which combine the advantages of homogeneous and heterogeneous catalysis were described. They were indicated as being highly selective, capable of functioning under mild conditions and easily removed from the reaction product by filtration.

In the manufacture of acrylonitrile by ammoxidation, important progress has been made in the development of improved catalysts, such as uranyl antimonate and tellurium molybdate, which decreased the formation of by-product acetonitrile.

The paper entitled "Activity and life of catalysts for the production of ammonia" stressed the importance of mutual understanding between the catalyst supplier and the customer. Because of the many factors involved, care must be taken in selecting the catalysts; quality and cost considerations must be carefully balanced, but it was indicated that even an extra cost incurred can be recovered rapidly by improved plant operation.

Trends for the improvement of contemporary catalytic processes in the oil processing industry were indicated. These processes include catalytic cracking, reforming, hydrocracking, hydrosulfurization and others.

The paper entitled "Improved economics in catalytic reforming" concerned the advantages gained by introducing bi- or poly-metallic catalysts instead of the conventional platinum catalysts for the production of aromatics and high-octane gasoline.

The increasing importance of hydrogenation processes, which essentially cover the entire range of petroleum products, was emphasized in the paper entitled "Trends in the development of catalytic petroleum refining processes." The development of new catalytic systems for reforming and cracking has improved over-all refining efficiency and product quality, and has led to a reduction in the heavy ends of the barrel.

VI THE TRANSFER OF KNOW-HOW IN THE PRODUCTION AND USE OF CATALYSTS

The world's major basic chemical technologies, such as those used in fertilizer manufacture, petroleum refining and petrochemicals, employ processes promoted by catalysts. Success in operating such industrial installations on a viable basis depends on the judicious selection of catalysts, their proper application and their uninterrupted availability.

Reliable catalyst manufacturers can provide know-how concerning the first two of these requisites, but the latter is subject to external and objective factors. Although capital costs for catalysts are high, the economic loss which may be suffered when a plant lies idle because of the lack of a catalyst may be much greater than the capital costs involved. Countries in which catalysts are not manufactured, developing countries in particular, may find themselves dependent upon manufacturers and thus in an insecure position concerning their most important chemical industries.

Relevant factors were examined to determine the extent to which pertinent know-how could be transferred to developing countries - which were particularly sensitive to the disruption of services - to guarantee continuity of supply of catalysts.

The catalysts considered were of several types classified as:

Conventional heterogeneous catalysts
Coated heterogeneous catalysts
Molecular sieves
Homogeneous catalysts
Single compound catalysts (unsupported Lewis acids,
organo-metallics, peroxides etc.)

The discussions were concerned primarily with the first type, whose materials also serve as the catalyst supports for the second type. These first two types of catalysts comprise the bulk of those vital to the basic chemical industries concerned and are at the focus of the central problem discussed.

The know-how pertinent to this subject was discussed with respect to such factors as:

- (a) Know-how in the selection of catalytic processes, catalysts and catalyst manufacturer.
- (b) Testing and characterization know-how.
- (c) Know-how in the use of catalysts.
- (d) Manufacturing know-how.
- (e) New processes for catalyst production.

A variety of types of materials exist even among the conventional heterogeneous catalysts, differing in complexity and volume of manufacture and uniqueness in application. Although the discussion was mostly general with respect to this point, each specific situation deserves to be studied on its own merits.

Know-how in the selection of catalytic processes, catalysts and catalyst manufacturer

Criteria for the selection of catalysts appropriate for the intended application are complex except when these are specified by the process to be applied. Reliance upon a supplier and his record of good service may be the determining factor in selection. More information with respect to both catalyst properties and manufacturers should be made available to developing countries to assist them in selection.

Testing and characterization know-how

The complex procedures used in the manufacture of catalysts are the propriety of relatively few producers. The nature of the materials concerned and the technologies of their manufacture has led to a situation wherein characterization and testing techniques are often empirical and vary from manufacturer to manufacturer. Catalyst performance is also often difficult to correlate with definitive material properties, which makes it difficult to specify simple evaluation procedures that would guarantee proper catalyst selection. Competent persons may also not be available in developing countries to carry out evaluation studies. Opinions expressed supported the contention that much could be done to render these techniques more uniform and to extend and intensify professional competence in developing countries. Furthermore, co-operation between research groups in developing countries could contribute to this end.

Know-how in the use of catalysts

Know-how in the use of catalysts is intimately related to the process concerned and may indeed be part of the proprietary technology transmitted to the user. Such information is usually not pertinent to other catalysts, even for the same process. Operational parameters may be optimized in application, but the primary information, including training of personnel, is optimally provided by the catalyst supplier. As there is a constant danger that some trainees may not continue to work in their trained capacity, replacements should be available to meet such challenges.

Manufacturing know-how

The transfer of manufacturing know-how constitutes a very sensitive and complex problem. Improvements in manufacturing have led to a situation in which smaller volumes of individual catalysts are being manufactured and an over-capacity in manufacturing facilities has developed. Manufacturers are reluctant to encourage competitors to enter this field. Members of the Expert Group appreciated the difficulties of this problem. It was agreed that there should be compensation for any such transfer of know-how. Users might expect to benefit from improvements developed by their suppliers and licensors in the field of the subject license, without additional, burdensome royalty expenses. Such conditions should be considered for negotiation in the basic contractual agreement. In some cases, know-how could be transmitted by establishing joint companies which would employ the proprietary technology in the developing country. Means should be found for transferring the know-how in catalyst manufacture that is evolved in some developing countries and which may best benefit to other countries because of their similarity of need, economic structure, and the like.

In spite of the vital need of the basic chemical industries of many developing countries, the local domestic manufacture of catalysts in these countries may not always be desirable or even possible. Many factors must be weighed in analysing needs and the potential viability of such an industry. Many aspects of the situation including economic, technical and cultural factors such as current catalyst requirements, industrial development plans, over-all industrial structure, available markets, patent protection for processes involved, level of risks which could be supported, level of technical competence of labour force and the availability of supporting services must all be taken into consideration.

New processes for catalyst production

Co-operative efforts between developing countries and manufacturers of catalysts in developed countries can be perceived in the area of joint research in new catalytic materials; these would relate to new processes for existing products or new products entirely. This effort would be

mutually beneficial for the manufacturer as it would: introduce new concepts to his research and development programme, lower his research costs and make new markets available. The developing country would benefit from having access to evaluation techniques and applications techniques, and from the financial aid received for research.

VII. CONCLUSIONS AND RECOMMENDATIONS

The documents prepared for the Expert Group Meeting form valuable reference material for developing countries in the field of catalyst production and use. The report and papers presented should therefore be edited and published with minimum delay and distributed. The meeting noted with satisfaction that the Joint UNIDO/Romania Centre offered to print the report and papers.

The contacts and discussions during the meeting proved to be very useful for experts from developed and developing countries, it was recommended therefore that similar meetings be organised or sponsored by UNIDO in the future. The possibility of large catalyst-producing companies or countries hosting such future meetings, and UNIDO making it possible for experts from developing countries to participate should be explored.

The test methods and procedures for analysis and use of catalysts now in use by producers, users and researchers differ considerably. Because of this a common basis for comparing physical and chemical characteristics, and tests on the efficiency and life of catalysts do not exist. The following participants were therefore invited to constitute a committee to study (by correspondence) the feasibility of setting up uniform test procedures for catalysts:

W. Bedford	(United Kingdom of Great Britain and Northern Ireland)
O.F. Joklik	(Federal Republic of Germany)
E.I. Korohak	(United States of America)
H.J. Lovink	(The Netherlands)
I.V. Nicolescu	(Romania)
Paula Putanov	(Yugoslavia)
S.R. Sen	(India)
S.W. Weller	(United States of America)

The committee is requested to report its conclusions within six months to UNIDO. If the standardization of methods is feasible, the committee should initiate action to draw up such test procedures for the catalysts used in sulphuric and nitric acids and fertilizer production, the petroleum refining industry and the petrochemical industry, starting with one sector. Mr. Weller was requested to be the convenor of this committee.

Information such as the names and addresses of catalyst manufacturers throughout the world, the types of catalysts they produce, the specifications recommended, the services they are prepared to render, test methods and precautions to be taken, is not available to many users in developing countries. UNIDO therefore should collect such information and make it available to all interested catalyst users in developing countries. Such data should be up-dated when new information becomes available. The participant from the Federal Republic of Germany tentatively offered facilities and his services in setting up a catalyst documentation centre.

It is necessary to avoid duplication of effort which might be undertaken in the field of catalysts. UNIDO therefore should establish contacts with the International Congress on Catalysis, with the relevant professional societies and with major institutes of catalyst research to minimize duplication of effort.

Some developing countries which have already built fertilizer and petrochemical industries have felt the need of training technical personnel in this field. It was recommended therefore that UNIDO should explore the possibility of establishing such training in the catalyst development centre of the Fertiliser Corporation of India, in the Joint UNIDO/Romania Centre and in other developing countries for groups of five to ten scientists, engineers or chemists, for periods of three to six months. (A request was made to the expert from India to inform UNIDO in due course about such a possibility. Other countries were also invited to offer such training facilities.)

Because difficulties exist for catalyst users in developing countries in testing the claims of various catalyst manufacturers, it is recommended that physical and chemical tests for catalyst characteristics be set up by

catalyst users in developing countries. Pilot testing of catalysts in units simulating plant conditions may give adequate evaluation. UNIDO however, should consider rendering assistance in establishing such testing facilities if a country specifically makes such a request. A tentative proposal for the transfer of know-how on this subject was offered by the participant from the Federal Republic of Germany.

Difficulties are often encountered at various centres in testing catalysts using the same procedure and test methods and in interpreting the results. The Joint UNIDO/Romania Centre is therefore requested to investigate setting up such a facility to which developing countries could refer cases for testing and advice.

Visiting and studying the facilities of catalyst manufacturers in developed countries to learn testing procedures and the like presents difficulties for some people in developing countries and UNIDO is therefore requested to provide fellowships to countries which may make official requests for such training.

Some developing countries expressed the desire to go into catalyst manufacture. UNIDO therefore should assist countries which request help in performing feasibility studies for catalyst production. The participant from the Federal Republic of Germany expressed his intention to offer free assistance in this regard.

Because difficulties are encountered in the standardization of methods for catalyst testing and because it is desirable to co-ordinate the efforts made in developing countries in this direction, it is recommended that UNIDO support the realization of co-operative programmes proposed by developing countries concerning the elaboration of methods for catalyst testing.

ANNEX

Report of the visit to the Ploiesti Refinery and Petrochemical Complex and the Petrochim and I.C.P.T.P.T. Research Institutes (25 June 1972)

Mr. V. Ionita, Production Manager of the Petrochemical Group Ploiesti, greeted the members of the Expert Group and gave an over-all presentation of the enterprises. A film was presented on the development of this installation, followed by discussions with the participants.

The visit to the refinery included: (a) The catalytic cracking unit whose throughput is one million tons per year, producing C₃ and C₄ fractions for further petrochemical processing and gasoline, and (b) the catalytic reforming unit whose throughput is one million tons of gasoline per year, producing high octane gasoline, benzene, toluene and isomeric xylenes.

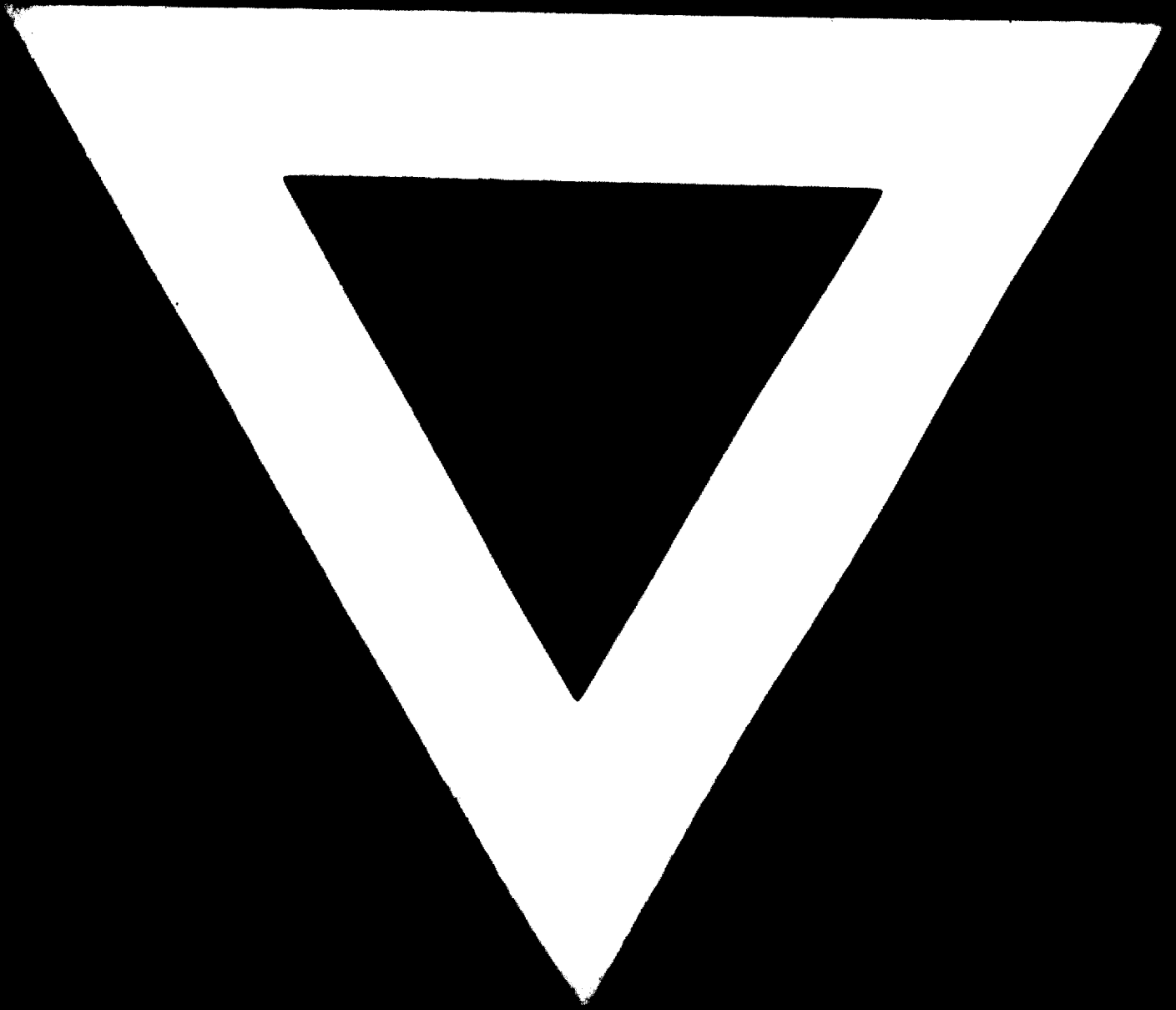
The olefins plant of the Petrochemical Complex was then visited. Ethane and propane raw materials are processed to produce 35,000 tons per year of ethylene and 20,000 tons per year of propylene.

The activities of the Petrochim Research Institute were presented by Mr. G. Musca, its Director. Mr. I. Ghejan, Scientific Director of I.C.P.T.P.T., described the work and structure of this institute. Following a period of questions and answers, the laboratories were visited.

The participants particularly enjoyed the opportunity for discussion with the personnel of the plants and laboratories.



We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.



74.09.11