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05059



Distr.
LIMITED

ID/WG.158/19
9 August 1973

ORIGINAL; ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on the Development
of the Synthetic Rubber Industry

Snagov, Romania, 25-29 June 1973

FINAL REPORT^{1/}

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EXPLANATORY NOTES

Joint UNIDO/Romania Centre

The full title is "Joint UNIDO/Romania Centre for the Development of Petrochemical and Chemical Industries for the Benefit of Developing Countries".

Emulsion technology

The manufacturing method in which the monomers (butadiene and styrene in the case of SBR) are emulsified in water with the aid of materials such as soap; reaction between them is initiated by the addition of catalysts and stopped at the required stage. The unreacted monomers and water are removed to produce the solid rubber. Nitrile and polychloroprene rubbers as well as SBR are made in this way.

Solution technology

The manufacturing method in which the monomers are dissolved in a suitable solvent (which varies according to the type of rubber being made); reaction between them is initiated by the addition of catalysts and stopped at the required stage. Unreacted monomers and solvent are removed by distillation leaving the solid rubber. Polybutadiene, butyl and ethylene/propylene as well as (more recently) styrene/butadiene rubbers are made in this way.

The following abbreviations are used in this report:

SBR

Styrene Butadiene Rubber

t.p.a.

tonnes per annum

INTRODUCTION.

As part of the UNIDO and the Joint UNIDO Romania Centre work programme for 1973 an expert group meeting, having as its title "The Development of the Synthetic Rubber Industry", was convened at Snagov, Romania, from 25 to 29 June 1973.

The main purpose of the meeting was to enable developing countries to reach their own conclusions, based on objective technical and economic information, regarding the desirability or otherwise of establishing a synthetic rubber plant and, if desirable, what type of plant producing what types of rubber. The meeting also aimed to provide guidelines for the future work programme of UNIDO in the field of synthetic rubber manufacture. Other aims were the promotion of new investments and the transfer of know-how.

CONCLUSIONS AND RECOMMENDATIONS

1. Accurate market surveys are essential before any manufacturing of synthetic rubber is considered and it is recommended that UNIDO should offer help, on request, in producing such surveys.
2. If a survey of a particular developing country indicates an insufficient market in the coming years to establish a plant, the matter should not be allowed to drop. On the contrary, with UNIDO's help, similar surveys should be done in suitable neighbouring countries to see if it might be possible to establish a plant supplying several countries in the area. This could for example apply to groups of Arab countries. (A general request was made to UNIDO to help find out more about a co-operative synthetic rubber venture that is under progress between several South American developing countries).
3. Having established the presence of a suitably sized market, it is essential that detailed feasibility studies should be made and that these should include reference to types of plants considered most suitable for the circumstances prevailing in the developing country. (The delegates from Egypt and Yugoslavia sought UNIDO aid in helping them to arrive at the correct decisions about their proposed plants.)
4. The meeting considered that, initially at any rate, SBR is the most suitable rubber for a developing country and it is recommended that at the start, developing countries should confine their investigations to this type only.
5. It is unlikely that, using the emulsion type of process to manufacture SBR, a plant of less than about 30,000 tonnes per annum capacity would be a viable venture. However, the meeting agreed that there could well be circumstances in a developing country or a region which could make it possible for a smaller plant to be an attractive

proposition. This could well be the case if solution-type technology were used for manufacture. It is, therefore, recommended that feasibility studies should include considerations of alternative methods of manufacture of SBR. (The representative from Yugoslavia requested assistance to help making a decision on the type of process to be used in that country's proposed plant.)

6. Several developing countries are interested in investigating the manufacture of poly-isoprene. It is even more necessary to have accurate market and feedstock surveys and studies of types of processes available for this type of rubber and it is recommended that such countries should proceed very cautiously. (The representative from Egypt stated that in due course assistance would be needed to help his country to make a decision regarding isoprene and it is recommended that UNIDO provide assistance.)

7. The developing countries are very eager to see a considerable increase in the transfer of technology at the rubber-use level and it is recommended that UNIDO should help by organizing a seminar for rubber processors. This could perhaps be combined with an investment promotion meeting to which representatives from developed countries could be invited. (As an immediate step, UNIDO should give wide circulation to the papers presented by J.M. de Oliveira Ramos and Doverstrand Ltd.)

8. The feedstock situation both within the country concerned and in the remainder of the world is a vital factor in any feasibility studies, and it is recommended that thorough surveys be done on likely world-wide availabilities and prices of these materials in the coming years before a decision is reached to establish a plant.

9. The experts emphasized the need for continued training for personnel and the meeting concluded that every means should be sought to fill this need. It is recommended that a handbook listing institutes etc., offering courses in various aspects in rubber technology, together with brief details of the syllabi, be prepared by UNIDO. (The representatives from Yugoslavia and Egypt stated that they wish to progress through UNIDO the offer made by the Joint UNIDO/Romania Centre.)

10. Developing countries have a great interest in being kept up to date on developments, both technical and statistical, in the manufacture and utilization of synthetic rubber. This need was felt as well by the developed countries anxious to keep abreast of events in the developing world. It is, therefore, recommended that UNIDO act as a clearing house for the collection and dissemination of information of this sort.

11. Many of the developing countries have problems in formulating Invitations to Tender for equipment and, at a later stage, in deciding which Tenders to accept. It is recommended that UNIDO offer assistance in this direction. (The representative from India made a specific request for such assistance in connexion with a synthetic rubber project.)

12. Joint ventures are probably the quickest and best way to set up a synthetic rubber industry. There is thus a distinct need for an investment promotion meeting very soon to help developing countries to further the establishment of synthetic rubber and end-product plants and it is recommended that UNIDO should include the subject of synthetic rubber at the next such meeting.

1 ORGANIZATION OF THE MEETING

Apart from the welcoming and closing speeches and the election of officers, the agenda of the meeting was divided into three sections as follows, and all papers presented were considered in one of these sections:

- (i) Present status and future trends in the world and in developing countries;
- (ii) Technologies for the manufacture and use of raw materials and synthetic rubber;
- (iii) Technical and economic criteria for developing small synthetic rubber plants.

The meeting was attended by 12 experts from Brazil, Canada, Egypt, the Federal Republic of Germany, India, Romania, the United Kingdom of Great Britain and Northern Ireland, the United States of America and Yugoslavia, representatives of the Industrial Development Centre for Arab States and the International Institute of Rubber Producers and 10 observers from the Federal Republic of Germany, the German Democratic Republic, Iran, Italy, Romania and the United Kingdom of Great Britain and Northern Ireland.

A. Dumitrescu (UNIDO) was Officer-in-Charge of the Meeting. T. Volintiru (Romania) was elected Chairman of the Meeting, M. H. El Hafnaw (Egypt) Vice-Chairman, and R. Paget (United Kingdom of Great Britain and Northern Ireland) Rapporteur.

Fifteen technical papers were presented and discussed at the Meeting (see annex). The participants visited a tyre plant in Bucharest.

Although there was considerable divergence of opinion on some of the matters discussed at the meeting, it was considered by all present to have been a success and of benefit both to representatives from developed and from developing countries. One subject which kept emerging during discussions because, no doubt, it was clearly on everyone's mind, was the current and likely future problem of the shortage and hence high prices of feedstock for synthetic rubber manufacture namely butadiene and styrene. Since the cost of these basic raw materials forms a very high proportion of the cost of the rubber produced from them this is clearly a matter of importance to the SBR industry.

The meeting also agreed that it is unlikely that the production of rubber from any synthetic elastomer plants which may be erected in future in developing countries will affect the overall production and use of the natural product.

II. PRESENT STATUS AND FUTURE TRENDS IN THE WORLD AND IN DEVELOPING COUNTRIES

The first paper presented in this section gives estimates of likely rubber (and plastic) consumption for various end-uses in Egypt in the coming years and concludes that, on volume grounds alone (approximately 20,000 t.p.a. of all grades by 1980) there is a case for establishing a synthetic rubber plant as an extension to an already planned naphtha cracker. A number of other reasons such as shortage of hard currency and variations in price of natural rubber are also given in support of this. Summaries of investment costs in Alexandria for an 80,000 t.p.a. naphtha cracker as well as those for a number of associated plants are given, and detailed costings are presented for a 20,000 t.p.a. stereo-specific polymerization plant and for a 35,000 t.p.a. SBR unit. The paper presents a case for choosing poly-isoprene rather than SBR but concludes that the final decision is not an obvious one but will depend on many factors under consideration at the moment.

The analysis set down in the paper illustrated the technical and financial considerations in a developing country on the point of making a decision whether or not to invest in a synthetic rubber plant and was much discussed. There was considerable debate on whether the proposed plant was likely to be economically viable but the expert from the country concerned pointed out that there were factors which can make a plant an attractive proposition to a developing country when a similar plant would be completely out of the question in another environment. Much depended on what is meant by "economically viable" and what factors were taken into account.

A further paper summarized the current situation in Brazil. This illustrated the situation in a country producing both natural and synthetic rubbers. It was noted that the production of poly-isoprene is also being considered.

A paper presented by a Yugoslav expert reviews in detail the past, current and expected future rubber consumption patterns in this country. In 1975 and 1985 elastomer consumptions are estimated to be 90,000 and 130,000 tonnes respectively. Information is given on how these amounts are spread through the processing industries. It is expected that the rubber will be used mainly in vehicle tyres. The export/import situation is reviewed, the paper pointing out that currently exports (of products) are valued at 17% of imports (of raw rubber and rubber products). The paper goes on to show that with the establishment of the Pandevo naphtha cracker there is a sound case for establishing a SBR plant and some financial figures are presented. These indicate that at the selling prices required to produce a satisfactory return to the plant, it will need tariff and perhaps other protection. There is some discussion on the type of process (emulsion or solution) to be used. No decision has yet been reached on this matter, however.

The discussion on this paper showed that the expert was concerned that the correct choice of polymerization process (solution or emulsion) should be chosen for the venture, which was for a 40,000 t.p.a. SBR plant. It was generally agreed that this capacity plant would be viable and it was suggested that UNIDO might be able to help in providing a consultant to recommend which type of polymerization process should be used - at least in the initial stage - in the plant, bearing in mind local conditions and patterns of rubber consumption. The expert felt that development into isoprene rubber in her country would be hindered by the lack of availability of sufficient feedstock isoprene.

In a short discussion it was clear that problems with isoprene availability would be likely to hinder everywhere the development of poly-isoprene production for some time to come.

The paper presented by an expert from India (which produces both natural and synthetic rubber) gave detailed statistics of rubber production and consumption, showing that over 133,000 tonnes (over 70% natural) were used in 1971-72. India has an SBR plant based on feedstocks produced from alcohol from molasses but newer and projected plants derive and will derive their raw materials from petrochemical units. The production of natural rubber is also increasing. The situation regarding synthetic rubbers other than SBR is presented: a 20,000 t.p.a. poly-butadiene plant is to be erected in Baroda using feedstock from a naphtha cracker; a butyl rubber plant using feedstock from oil refineries and a naphtha cracker is being considered; and a nitrile rubber plant based on indigenous raw materials and local know-how is expected to come on-stream in 1975. The paper also gives details of the research and development facilities available in private concerns as well as in government institutes.

This paper summarized the situation in a developing country which was not only expanding its synthetic rubber production but was also extending its rubber tree plantations. One participant pointed out that a problem could arise in the coming years, since, from the figures presented, an over-production situation could develop. The expert presenting the paper agreed that this could happen but stated that if overall demand did not reach anticipated levels active steps would be taken to plan natural rubber exports to a limited extent. The observer took the opportunity of drawing the meeting's attention to a potentially dangerous situation for all producers of isoprenic rubbers, both natural and synthetic, namely that there could well be world over-production of such types of rubber by 1980 and that the erection of further poly-isoprene plants could only make the situation worse. If isoprenic rubber prices fell this would almost certainly affect SBR and other synthetic rubber prices. The situation could well be made worse by the improvements in the latex yield of rubber trees

by various methods which would almost certainly take place in the coming years. Delegates agreed that there is considerable scope for such improved natural rubber production and noted carefully the observers' opinion on the future isoprenic rubber situation.

A short presentation on the status of the synthetic rubber industry in the Arab countries showed that as yet no individual country in this group can justify a plant in the foreseeable future. However, the paper also gave a description of attempts being made to study possible co-operative action by groups of these developing countries and the delegates considered that there could well be opportunities elsewhere in the developing world for such co-operation. A company observer stated that a practical example is a group of developing South American countries who are co-operating in the establishment of a joint synthetic rubber plant.

A Romanian paper gave details of how the synthetic rubber industry in that country had developed from its beginnings in 1963. The technical characteristics of the currently produced grades of SBR are quoted and details are given of more recently developed products such as butadiene-acrylonitrile rubber and a resin. The properties of these latter products are compared to well-known grades from elsewhere. Considerable work is being done on the production of lattices for various end-uses. There was considerable discussion, particularly between the Romanian experts and delegates from other developing countries since this paper illustrated the progress that one of their number had made in the manufacture of synthetic rubber over the past few years. During the discussions it was stated that considerable quantities of imported natural rubber are still being used in Romania but that there are plans to reduce this by producing poly-isoprene.

The first section concluded with a paper presented by a Romanian group of authors giving statistics of synthetic rubber production and consumption in many countries of the world and indicating likely future trends. It was shown that although the consumption of SBR will continue to increase this will form a decreasing percentage of the total. The balance will comprise increasing proportions of poly-isoprene and poly-butadiene. This situation is likely to apply to both developed and developing countries. The share taken by ethylene-propylene rubber, although small, is likely to increase markedly. A considerable part of the paper is devoted to a non-technical analysis of the development of the synthetic elastomer industry in Romania and mention is made of likely future developments into types of rubber other than SBR (butyl, nitrile, etc.) and there is a section on current fields of research. The paper called forth some questions from experts from developing countries, indicating their interest in learning about the progress in rubber production and consumption in the developing world.

III. TECHNOLOGIES FOR THE MANUFACTURE AND USE OF RAW MATERIALS AND SYNTHETIC RUBBER

This section opened with a technical paper which in addition to giving a historical review of the discovery and production of butadiene as a chemical, presented an up-to-date summary of the current sources of butadiene, the impurities occurring with it and methods for their removal. The paper includes many tables and diagrams and twenty-four cross references are given. It will form a useful guide for those countries (particularly those with naphtha crackers) which are contemplating the erection of a synthetic rubber plant and which will, almost certainly, need a butadiene extraction unit. One delegate thought that developing countries which have or plan to have a naphtha cracker but not a synthetic rubber plant (yet) might investigate the extraction of butadiene from the C₄ stream since its export could provide a useful source of foreign exchange.

The next paper reviewed the progress of attempts leading up to the production today of satisfactory polymers by solution as opposed to emulsion technology. Details are given of one of the processes, showing its versatility and a list is given of types of rubber which can be produced. Investment and operating costs for a 25,000 t.p.a. plant are presented and a list of plants using this solution-type process and their locations is added. They range in size from 18,000 to 55,000 t.p.a.

The discussions which took place indicated that delegates from developing countries were interested in the solution method of producing polymer and after discussion recommended that any such country contemplating a move into synthetic rubber production should study the processes using solution technology very thoroughly in view of their versatility and of the fact that a number of small sized plants appeared to be operating satisfactorily, one of them in a developing country (not present at the meeting).

one expert, however, cautioned that this type of rubber had not yet found a general acceptance for use in vehicle tyres. Nevertheless, the meeting felt that at any moment now there could be a break-through into acceptance for tyre-use for rubber made from one or more of the solution-type (high-vinyl and/or low-vinyl) processes and that this development, when it came, could be of significance to all developing countries considering building a rubber plant.

A Brazilian contribution gave a practical example of the replacement of natural by synthetic rubber from a medium-sized users experience. This illustrated that by persevering it was possible not only to replace the one rubber by the other but also use other local materials and thus produce a fully-satisfactory end-product at lower cost. All the developing countries present expressed the view that the type of information presented in this paper was of great value to their countries, particularly to the very many small and medium sized rubber-user plants already working and being established. There was a feeling that more should be done to facilitate the exchange of such type of information perhaps by arranging meetings. Such meetings could cover a wide range of rubber processing industries such as hose, V-belt, shoe and other of mechanical goods manufacturers. It was pointed out that in most cases there was unlikely to be a problem of providing information to a possible competitor particularly when the countries concerned were separated geographically or for other reasons. The dissemination of such information could serve to stimulate the use of rubber in developing countries and would help to implement one of the recommendations of the Vienna meeting of March 1972, viz. "to support actively the setting up of rubber product manufacturing industries in developing countries". Increased use of rubber in a country could in appropriate circumstances lead logically to the manufacture of the synthetic raw material.

After a brief review of the current situation regarding the use of SBR as a replacement for natural rubber for use in tyres in Romania, most of the next paper discusses the work that is being done in that country to see to what extent natural rubber can be further replaced by poly-isoprene, in view of the decision to proceed with the erection of a plant to produce this type of elastomer. Various types of tyres (including radial) are considered as well as the individual parts of each type of tyre. Properties of poly-isoprene and its blends with natural and SBR rubber are discussed and special chemical improvers are mentioned. The overall conclusion is reached that although there are a number of problems associated with the use of poly-isoprene, these can be overcome in most, but not yet all, cases. There are 11 tables and diagrams incorporated into the report.

The meeting noted with interest the progress that has been made in the use of synthetic rubber for tyres in Romania and particularly the partial replacement of the natural product, and that further replacement will take place when poly-isoprene is made. All experts, however, agreed that the use of natural rubber will continue, for the foreseeable future, to take a very important part in the rubber industry.

IV. TECHNICAL AND ECONOMIC CRITERIA FOR DEVELOPING SMALL SYNTHETIC RUBBER PLANTS

The final section of the meeting opened with a paper which discussed the market for and manufacture of speciality lattices - in particular the carboxylated butadiene co-polymer type. This is used for carpet backing, paper coating, fabric backing and other purposes. Since over 90% of the solids in the latex consist of styrene and butadiene i.e. the raw materials for SBR manufacture, developing countries already manufacturing or about to make SBR, particularly those with textile and/or paper industries, could well consider extending their activities to include this type of latex. Details are given of raw materials required, plant capital and running costs and sample profit statements. During the discussion which followed this paper the authors stated that they are willing to transfer the technology involved and also to assist developing countries who wish to enter the appropriate end-use fields.

The next paper questioned the need for developing countries to enter the field of rubber manufacture, pointing out that small plants are relatively very expensive and the feedstock over the coming years is likely to be very short. The author felt that the foreign and local currency required to establish a plant could be better spent on agricultural projects although he recognized that a petrochemical complex may be a matter of national pride.

Whilst the meeting recognized the need for a very thorough examination of all factors, including alternative uses for investment capital, most developing country delegates and experts were of the opinion that with the continuous drain on foreign exchange reserves that imports of rubber involve, it is vital for those of them who have petrochemical plants already operating or under consideration to investigate the extension of these to include synthetic rubber. It was agreed, however, that except in special circumstances it would be difficult to justify a synthetic rubber plant based on the importation of all raw materials.

All developing countries, however, recognized that a rubber plant uses little man-power and requires much capital for its establishment (a high proportion in "hard" currency).

The succeeding paper discussed the basic considerations involved when a developing country decided to investigate the establishment of a synthetic rubber industry. The various types of the synthetic product are reviewed and the conclusion reached that SBR (and perhaps BR) are the grades most likely to be of interest - at least initially. The importance of accurate preliminary studies is stressed and the feedstock situation in the years to come is considered in detail. The paper emphasizes the necessity when calculating manufacturing costs of putting the correct value on these materials when they come from a local plant - particularly in years to come when they could perhaps be exported as such at high returns to the base plant. Mention is made of the problems of imposing protective duties on imports. Having made a decision to have a plant, the paper points out how necessary it is to have properly trained personnel.

The meeting felt that this was a useful basic paper for developing countries to study before committing themselves to erecting a plant. The necessity for an adequate supply of trained personnel throughout the entire industry was noted and one delegate from a developed country offered facilities for discussion seminars particularly for synthetic rubber end-use applications. An expert from a developing country confirmed the need for continuous training and suggested that UNIDO could help in arranging this. Representatives of the Joint UNIDO/Romania Centre offered facilities to developing countries for in-plant training in certain fields of the synthesis and processing of synthetic rubber. One participant from a developed country pointed out that there were several institutions in the United Kingdom of Great Britain and Northern Ireland and elsewhere which could offer basic training in rubber technology.

A spokesman for an international organization representing several developing countries said that he thought that all such countries interested in petrochemicals generally should study carefully the section on feedstocks, particularly the remarks relating to aromatics.

There was agreement on the necessity for accurate and thorough market surveys as a start to any plant feasibility study.

After a general introduction on the emulsion-type process indicating that this is the most widely used today, the next paper went on to give a very detailed study of the economics of a typical SBR plant based on emulsion technology. This included sections on the sensitivity to changes in Assumptions and the Effect of plant capacity on the Economics. This latter included consideration of a 20,000 t.p.a. plant indicating that the costs per ton of installed capacity would be about 40% higher than those of a 35,000 t.p.a. plant. The product cost would be about 20% higher. Thirteen tables were given as appendices to the report.

The meeting was unanimous in agreeing that this paper will form an excellent guide to the economics of the emulsion-type process for developing countries with sufficient potential synthetic rubber consumption and who are considering establishing a plant, particularly since although the main calculations are based upon a 35,000 t.p.a. plant there is, as mentioned above, a section considering the effect of reducing the size to 20,000 t.p.a.

Annex

LIST OF PAPERS AND ASSOCIATED DOCUMENTS
PRESENTED TO THE MEETING

- ID/WG.158/1 Provisional Agenda
- ID/WG.158/2 List of Participants
- ID/WG.158/3 List of Documents
- ID/WG.158/4 Small polymerization units for the
manufacture of synthetic rubbers in
the developing countries
R. Lamberson, United States of America
- ID/WG.158/5 A synthetic rubber plant? Or not?
R. Paget, United Kingdom of Great
Britain and Northern Ireland
- ID/WG.158/6 Economic criteria for the establishment
of a styrene-butadiene synthetic rubber
facility
G. W. House, Canada
- ID/WG.158/7 The construction programme for a
synthetic rubber plant in Yugoslavia
B. Janković, Yugoslavia
- ID/WG.158/8 Manufacturing of synthetic rubber in
Alexandria Petrochemical Complex
M. H. El Hifnawi
- ID/WG.158/9 New and old processes to produce pure
butadiene
H. Klein, Federal Republic of Germany
- ID/WG.158/10 General purpose rubbers by solution
polymerization with anionic catalysts
W. W. Crouch and R. S. Harmer,
United States of America



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