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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Services for Alumina Industry

DP/IRA/84/002

Terminal Report

Prepared by the secretariat of UNIDO

Vienna, September 1988

Introduction

Aluminium is primarily needed for consumption in Iran by industries such as construction, electrical appliances and household goods, transportation equipment, machinery and fabricated metal products.

In 1978 the consumption of aluminium in Iran was about 75,000 tons whereas it figured at around 120,000 tons per year when this project was launched. However, the capacity of Iran's only aluminium producing plant (IRALCO) as well as its actual production requires alumina raw material of about 90,000 tons per annum, all of which imported. Also, a significant increase in aluminium production capacity is planned and it is estimated that Iran's alumina requirements would reach some 600,000 to 800,000 tons per year in the 1990ies.

Consequently the Iranian Government is eager to exploit its own resources for producing alumina from domestic ore reserves available in the form of alunite and bauxite. Alunite ore is a complex of sulphates and silicates of aluminium, iron, potassium and sodium. Vast reserves exist in the north-western region of Iran. Bauxite deposits of the Alburz Mountains constitute the second potential local raw material for the production of alumina. Reserves have been estimated at some 54 million tons.

In anticipation of the requirements for undertaking prospection and exploration of ore reserves, and feasibility studies for alumina production based on alunite and bauxite ores the Aluminium Raw Materials Programme (ARMP) was set up in 1981 by the Ministry of Mines and Metals, with the following mandate:

- i. continuation of necessary geological and mining work for producing the necessary samples of aluminiferous ores
- ii. establishment of a testing laboratory capable of undertaking the technological tests on the various ore samples made available through (i) above
- iii. contracting a feasibility study for the production of alumina from alunite to outside sources that have developed a commercial scale technology for this purpose.

The ARMP has organized test work with ore samples abroad. The geological and laboratory tests carried out indicated that alunite ore bodies are suitable for immediate exploitation and would be able to meet part of the alumina requirements of the country towards the end of the decade. Subsequently, the bauxite reserves would have to be exploited to meet the remaining requirements. The absence of the relevant specialized laboratory facilities, equipment and expertise in Iran has resulted in a continuing drain on foreign exchange resources and delays in test work. The Government therefore decided to invest in a laboratory capable of undertaking the necessary test work. As a first step in the implementation of such technical co-operation, the ARMP has requested a small scale project to:

- (a) investigate the necessary conditions for the successful implementation of the alunite feasibility study and assist in the first stage of negotiations with potential suppliers of technology
- (b) Assist in the design of the testing laboratory, including the identification of the necessary detailed requirements
- (c) Identify the needs for further technical co-operation that may be required through UNDP.

1. Objectives of the project:

With its long-term objective the project was to lay the grounds for developing the production of alumina from indigenous aluminiferous ores, including alunite and bauxite.

The immediate objectives of the project were

- 1.1 the identification of the best sources and means for carrying out a techno-economic feasibility study for the production of alumina from alunite ores of Iran;
- 1.2 detailed design and identification of requirements for a technological testing laboratory for the Aluminium Raw Materials Programme (ARMP);
- 1.3 preliminary testing of aluminiferous ore samples within the country;
- 1.4 establishing the framework of further technical co-operation to be provided to the ARMP.

2. Activities carried out and outputs produced

The description of the activities and outputs as outlined in the project document relate to:

- 2.1 Ascertaining conditions for preparation of detailed feasibility report on processing alunite to alumina, including
 - (a) Evaluation of the available data on aluminiferous ore deposits
 - (b) Detailed examination of the requirements of the feasibility study report to be prepared by foreign sub-contractors
- 2.2 Designing the technological laboratory
 - (a) Design work by local sub-contractor
 - (b) Technical consultancy by UN consultants for the design work
- 2.3 Identification of areas of future UNDP technical co-operation with the ARMP

Based on the above activities the following outputs were expected to be reached:

Ad 2.1

- Iranian geological consultants report including data on the composition of ore samples, and selection of representative samples to be used for the feasibility study.
- Report on the results of contract negotiations with the eventual sub-contractors including detailed terms of reference for the feasibility study

Ad. 2.2.

- Laboratory design
- Laboratory consultants report, inclusion of conclusions and recommendations in the laboratory design

Ad. 2.3

Areas of co-operation identified

The project produced the following actual outputs:

Ad. 2.1

Technical report: Bauxite and alunite mineral commodity, based on the work of Dr. Erwin Mack, expert in mineral resources evaluation and mine development (DP/IRA/84/002/11-03) and Dr. Istvan Vörös, expert in bauxite industrial geology (aluminiferous ores - Post 11-04), prepared in September 1984

The report provides information on bauxite and alunite resources and recommendations for survey and exploration of the deposits. Local recommendations for bauxites from the Jajarm area, the Siah Rudbar and Shirin Abad area, and the the Ganu area are given. As regards alunites the consultants suggested to select the Taykand deposit for further consideration.

Technical report: Exploration of bauxite and alunite - ARMP, by Dr. Erwin Mack, Post 11-05, November 1985

The report supplements the previous one and provides detailed recommendations for finalizing the drilling programmes under way in the various bauxite areas. It was found that sample preparation was a bottle-neck in the progress of work. The report also suggested fact-finding on the Zagros - Kordestan and Yazd bauxitiferous ares. As regards alunites, due to previous preparatory work, it was suggested that the team of VAMI, Leningrade (under UNIDO sub-contract) could immediately commence further investigations on the Syrdan - Hassanabad alunite deposits, as well as on Zajkan - Zajkandy and Tajkand - Haftsandough alunite areas.

Ad. 2.1 and 2.2.

- Technical report: Application of industrial scale technology for processing aluminiferous ores - Establishment of the alumina raw materials testing laboratory, prepared by Dr. K. Solymer (Hungary), consultant in processing of aluminiferous ores, in October 1984 - Post DP/IRA/84/002/11-01

Essentially, the report contains the following summarized recommendations:

- to elaborate a feasibility study for processing bauxite parallelly with the feasibility study relating to the alunite processing, in order to decide the priority of setting up an industrial scale alumina plant.
- the modified Bayer-process is recommended for processing diasporic-chamositic Iranian bauxites, characterized by the use of special catalytic additive, 2-stage digestion (simultaneous processing of diasporic and boehmitic or gibbsitic ores), intensive caustic soda regeneration.

- The establishment of the Aluminium Raw Materials Testing Laboratory is fully justified. UNIDO's assistance in the procurement and purchase of instruments and equipment which require hard currency is highly recommended.

- For the main partner institutions VAMI (alunite processing), the Jamaican Bauxite Institute (laboratory and pilot plant) and ALUTERV-FKI (bauxite processing and transfer of technology for laboratory investigations) are recommended.

Ad. 2.2.

- Technical report: Establishment of an Aluminium Raw Materials Testing Laboratory - by Dr. Conrad Douglas (Jamaica), Consultant on materials testing, - Post DP/IRA/84/002/11-02, December 1984

The report recommends:

- It is critically important to pursue a feasibility study on the use of bauxite for alumina production

- It is recommended that a critical approach be taken in the selection and procurement of equipment against the objectives of the raw materials laboratory and in the context of available maintenance services

- In the selection of equipment it should be made conditional where possible that suppliers crews conduct on-the-spot training programmes on the use of equipment.

- The procurement and delivery of equipment must be done on a timely and carefully scheduled basis to minimize storage time, scheduling visits of installation team, etc.

- Warranties and guarantees must be carefully examined

- On the placement of firm orders a detailed delivery schedule should be developed to be followed by monitoring of delivery status

- The sample preparation area of the laboratory is particularly critical because of the hardness of the bauxites and special grinding equipment should be selected

- The ongoing recruitment programme of staff should be continued on accelerated basis

- A detailed training programme involving in-house and local training, study tours and fellowships and on-the-spot training by visiting consultants and equipment supplier representatives

- A detailed mechanical, electrical, electronic preventive maintenance programme must be developed for all equipment

- In house maintenance services should also be developed

- An inventory of all spares must be established including stock and re-order levels

- In addition to the spares normally delivered, the project management should determine the possibility of establishing a system of receiving spares on consignment from equipment suppliers and make arrangements to pay for them only when they have been put in use.

The activities were supplemented by visits of the National project Director (Mr. M. Shariari) to hold negotiations with various know-how suppliers in Europe to enable the preparation of terms of reference for feasibility study with laboratory testing of bauxite for alumina production in Iran.

Procurement of equipment:

ALUTERV-FKI delivered an industrial rapid analyser by neutron activation for investigations of aluminiferous ores. The equipment was installed in May 1985. For installation and training a Sub-contract with ALUTERV-FKI was concluded to provide 3 weeks training by 2 Hungarian experts on the use of the equipment in Iran. Due to the political situation the training had once to be interrupted/shortened. Training was continued by 2 Hungarian experts in Iran in June 1986. A problem was faced in provision of adequate counterpart for training, i.e. the electronic expert was not available.

Project implementation was also somewhat hampered by the change in management of the ARMP - Mr. Shariari left and was replaced by Mr. Hassanzadeh and, subsequently, by Mr. M. Nadali.

Study tours and training:

Study tours were undertaken, e.g. by a group of five Iranian specialists to Turkey and Yugoslavia in April 1985 and a group of four specialists to Hungary on the use of equipment.

3. Achievement of immediate objectives

The immediate objectives as outlined in the Project Document and described under 1. (page 2) of this report have been achieved to a great extent.

The following details may be provided

Objective 1.1 "the identification of the best sources and means for carrying out a techno-economic feasibility study for the production of alumina from alunite ores of Iran;"

This objective has fully been met by the activities and advice provided by all experts serving the project, as well as through the study tours by the National Project Director. In addition, a visit by a UNIDO staff member was undertaken to the USSR to discuss conditions of know-how fee terms. A final review of the scope of the project and technicalities of the alunite feasibility study in a Government/UNDP/UNIDO meeting in Vienna took place in November 1984, in which the advice of an independent consultant was also sought (Mr. F. Allen, UNDP consultant).

Objective 1.2 "detailed design and identification of requirements for a technological testing laboratory for the Aluminium Raw Materials Programme (ARMP);"

The identification of requirements are fully reflected in the expert reports. Design and application of industrial scale technology for processing aluminiferous ores is covered by the report of Dr. Solymer (post

DP/IRA/84/002/11-01. The report by Dr. Douglas contains requirements and the selection of necessary equipment for the ARMP, with operations and requirements therefor. Design activities were undertaken by local experts, taking into account the advice/recommendations by the foreign experts provided under the project.

Objective 1.3 "preliminary testing of aluminiferous ore samples within the country;"

Sufficient information on how to organize bauxite and alunite exploration, including sample testing is provided in the report by Messrs. Mack and Vörös. Actual testing of samples was undertaken under the follow-up project DP/IRA/85/003 Development of an alumina industry.

Objective 1.4 "establishing the framework of further technical co-operation to be provided to the ARMP."

This objective has fully been met through discussions by the UNIDO experts with the ARMP personnel in the field, through UNIDO staff member missions in the field and at UNIDO HQ, through visits of the National Project Director to equipment suppliers abroad. The terms of reference for the follow-up project were elaborated, incorporating pilot scale testing programmes.

4. Utilization of project results

The project may be regarded preparatory assistance to obtain first-hand information and to pave the way for further preparation towards investment decision on bauxites and alunites as source of future production of alumina in Iran. Based on the experts' recommendations, particularly outlined in the reports by Messrs. Mack and Vörös, - see page 3, the geological exploration of deposits is progressing and there is no doubt on quantitative availability of ore. However, it was realized that significant testing input was required to conduct the first techno-economic studies to enable starting the comparative assessment work between bauxites and alunites for serving the future alumina production, as possible alternative or parallel sources of raw materials.

Based on the results of the project, a project document for a large scale \$ 3 million project (DP/IRA//85/003) was elaborated for Development of the Alumina Industry in Iran, with the immediate objective to

(a) develop a techno-economic data based for an investment decision on the development of an alumina industry based on the indigenous aluminiferous ores through

- (i) technological pilot tests of alunite ore samples and a comprehensive techno-economic feasibility study on the processing of alunite into alumina, sulphuric acid and potassium sulphate, including a feasibility study on the marketability of the by-products of this process.
- (ii) laboratory tests of bauxite ore samples and a feasibility study on the processing of bauxite into alumina
- (iii) a subsequent comparative study of the techno-economic viability of industrial scale production of alumina using alunite or bauxite ores

(b) Establish a technological/metallurgical testing and research laboratory.

(e) Conclusions and recommendations

The UNDP/UNIDO consultants who visited Iran in 1984 confirmed that the low-grade local bauxite ore is suitable for the production of alumina by the modified Bayer process. However, they concluded that the final decision for the development of alumite and/or bauxite-based alumina industry could be reached only after the finalisation of the feasibility studies for both raw materials. Thus, the implementation of these studies, with the assistance from UNDP/UNIDO was strongly recommended by all parties concerned, as was the setting up of an aluminium raw materials testing laboratory. The recommendations resulting from project DP/IRA/84/002 (implemented with a UNDP input of \$ 163,554) have actually been taken up for implementation by the Iranian Government with further assistance through the UNDP financed and UNIDO executed project DP/IRA/85/003.