THE PRODUCTION OF ALUMINA (ALUMINUM OXIDE)

WITH THE AID OF NATURAL STEAM

(A condensation of the original report written in Icelandic)

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SUMMARY:

The natural steam in Iceland is a valuable basis for the production of alumina from bauxite. The steam gives Iceland an advantage over most European countries in this respect. The alumina could be sold to other European countries where the production of alumina is less economical. Eventually it might also be used in Iceland for aluminum metal production, since the country has potentially great hydroelectric power. Suitable bauxite has not been found in Iceland, however, and would, therefore, have to be imported.

For some time it has been recognized that if geothermal activity in Iceland were utilized directly as heat energy, it could become one of Iceland's most important natural resources. The State Electricity Authority has been studying this possibility for some time along with the technical aspects of drilling for steam and hot water. The production of alumina is one of the possibilities which has been suggested for the utilization of natural steam.

Production of alumina (aluminum oxide)

Industrially, alumina is most important as an intermediate product in the production of metallic aluminum from bauxite. Even so, the production of alumina is not generally considered to be a part of the aluminum production proper, since the production of alumina and the electrolytic production of aluminum usually are not carried on at the same location.

Alumina is also used to some extent as a refractory and absorbent material as well as for several other uses, most of which require specific grades or physical properties of alumina.

Alumina is almost exclusively produced from bauxite. Few bauxite deposits exist in the more northerly countries. Because of its geological formation it is mostly limited to hot and moist climates. It is found as a residual deposit on or near the surface. The element aluminum is, however, very extensive in the crust of

the earth, but most chemical combinations other than bauxite have defied commercial utilization for alumina production.

Bauxite is a colloidal mixture of hydrolyzed oxides of aluminum and iron. In addition, it contains some titanium oxide and other minor impurities.

Bauxite is usually not worked to a great extent at themine as most plants for alumina are in the more northerly countries where inexpensive heat energy is available. Roughly speaking, 2 tons of alumina are obtained from 4 tons of bauxite, which in turn yields 1 ton of aluminum metal.

The most common method for production of alumina out of bauxite is the Bayers method. By this method, the ground bauxite is leached in caustic to dissolve the aluminum oxide, iron oxide, and titanium oxide remaining undissolved. These undissolved substances are separated from the solution and the aluminum oxide is precipitated in crystalline form.

Besides the bauxite, some caustic soda or soda ash and limestone are necessary. These materials are used interchangeably according to their availability.

Bauxite for the Bayers method is valued according to alumina and silica content. High silica content is undesireable because it makes some of the alumina in the bauxite unavailable and spends the alkali. There is a considerable difference between the price of alumina in America and in Europe. It is likely that this difference is caused, to a great extent, by the fact that America has natural gas which is greatly used for this purpose, whereas in Europe coal is chiefly used for alumina production. It is interesting to note that Norway which has no coal in the country itself imports almost all her alumina.

The transport of the bauxite is another factor that greatly influences the location of alumina plants. Canada imports all her bauxite, mostly from South America, but also some from West Africa. The United States also imports the majority of her bauxite requirements, mostly from South America and Jamaica. Europe has access to bauxite in the Mediterranean countries and West Africa. Since the production of alumina is almost entirely limited to the more northerly

countries, the transport of bauxite is an important factor.

To produce 1000 kg. of alumina, approximately 2000 kg. of high grade bauxite are requred, plus 61 kg. of caustic soda, (76% Na_2O), 11.5 tons of steam, 100 kg. of fuel oil, 315 KWH of electricity, 40m^3 of water, and 6.4 man-hours.

Economic considerations

Even though the greatest part of alumina is used for aluminum reduction, these two operations may or may not take place at the same location. Both operations require great amounts of energy, but of different kinds. The energy considerations are of great importance in the location of the plants, since alumina requires cheap heat energy, while aluminum reduction requires cheap electrical energy.

Because of the great steam requirements, the alumina production is conveniently located where natural gas oil or cheap coal is available. It may be said that where good conditions are present for processing the bauxite in the country which has the end use, it is usually imported crude. This transportation is mostly by sea, on special barges, and is, therefore, inexpensive. Transport by land is, however, always expensive, especially over long distances.

The capital cost of an alumina plant using the Bayers method is in the neighborhood of $100 per 1000 kg. of annual capacity. The price of alumina varies considerably according to end use, however, and is generally higher for purposes other than aluminum. The price of alumina for aluminum production in Canada and the U.S. appears to be $45-50, whereas European prices are $60-75 per metric ton.

By the Bayers method, steam requirements for the production are approximately 11.5 metric tons for each 1000 kg. of alumina. This is equivalent to 1.3-1.5 tons of coal.

By assuming that natural gas be used for the production in the U.S. and that natural steam be used in Iceland, but that the initial capital investment be slightly higher in Iceland because of freight charges on machinery, etc., a comparison on the various items of production cost show that the total cost of production is

similar in Iceland and the U.S. but that this production cost is much lower than the cost of alumina in Europe. It is interesting to note that the cost of production in Iceland would be 40-50% higher if there were not an abundance of natural steam. This fact explains readily why countries like Norway which do not have cheap heat energy do not produce much alumina.

Conditions for alumina production in Iceland

The economic considerations in general indicate that the natural steam is a basis for alumina production, since it is obtainable at 1-2% of the price of coal, in terms of heat energy. There are two steam fields in Iceland that have good possibilities in this respect because of their closeness to harbors. Krysuvik field is located some 25 Km from Hafnarfjörður, which has a harbor, and the Hengill field is some 18 Km from Thorlakshofn, where a harbor is being constructed. Both these fields are located in the southwestern part of Iceland near Reykjavik.

The steam is obtained by drilling wells which are cased to withstand the pressure of the steam. In both these areas, some drilling has been successfully performed already, but the steam these wells yeald is not enough for the above mentioned purposes at present. Theoretical considerations indicate however, that vaste amounts of natural steam may be obtained through deep wells similar to those in Italy.

Since the natural steam really is the basis for its economic suitability, it is only fair to mention that this geothermal activity is going to last for thousands or millions of years, and is therefore more lasting than gas from oil fields and most other cheap sources of heat energy.

As a matter of fact Iceland would seem to be the natural supplier of alumina for the other European countries, such as Norway, which imports great quantities of this material both from America and from other European countries. Her imports amount to some 80,000 metric tons yearly at present, but are expected to be as high as 160,000 tons by 1956.

Iceland has potentially great amounts of unharnessed water power which in the future might be of importance as an end use of alumina within the country itself.

Bauxite has to be imported, however, but the energy considerations are far more important in this connection.