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PROGRESS IN ELECTRIC PIG IRON SMELTING[1/]

by

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SUMMARY

Introduction

The past five years have been a period with ample available world plant capacity for pig iron production and depressed prices on the export markets. This situation has created a very hard climate for small producers of ordinary and special grade pig iron. In Europe furnaces in Italy, Portugal and Sweden have been shut down. In Japan, the import duty on imported pig iron was cancelled, and many of the relatively small electric furnaces for smelting beach sand concentrates have been stopped or been rebuilt to ferro-alloy production.

In some countries where special conditions with regard to supply of raw materials or electric power favour electric smelting, electric furnaces have been built during the last five years. New and large furnaces for conventional cold charge smelting have been added to existing pig iron plants in countries like

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Canada and Norway. Of particular interest are the new ELKEM electric pig iron plants being started up now in Yugoslavia and South Africa. In total nine furnace units are connected to rotary kilns for thermal pretreatment of the charge with transfer of hot charge to the electric pig iron furnaces.

Preheating in rotary kilns has also made inroads in the ferro-alloy industry in recent years. A substantial number of ELKEM furnace units are now in operation in ferro-nickel production in New Caledonia, Japan and Brazil. One ferro-manganese plant in Japan is using kiln-prereduced charge, while a Finnish plant for ferro-chrome using a similar process will be put in operation in the summer of 1968. A smelting plant has also been erected in Egypt for the production of ferro-manganese and pig iron utilizing the rotary kiln pretreatment process.

Conventional electric smelting

The electric pig iron industry has expanded in areas where cheap hydro-electric power is available such as Western Canada and the north of Norway. In British Columbia (Canada) The Consolidated Mining and Smelting Company of Canada Ltd. has started operation of ELKEM furnace No.2 of 33,000 kVA for production of foundry grade pig iron from pyrite ash. At A/S Norsk Jernverk, Mo i Rana (Norway), ELKEM furnaces Nos. 5 and 6 of 60,000 kVA are operated on sintered and pelletized iron ore concentrates.

Typical production figures from these furnaces are as follows:

Production tons per week	Load MW	Power consumption kWh	On load time %
5,000 - 6,000	30-36	2000 - 2050	96 - 99

This Norwegian pig iron plant is supplied with iron ore concentrates mainly from the nearby Rana mine and with coke breeze from the coke oven plant for carbonization of the Spitsbergen coal. In the carbonization plant part of the coal gas is used for ammonia production. These Norwegian plants are well situated for utilization of local resources of hydro-electric power, iron ore and carbon with short transport lines for ore and coke. However, the major part of the pig iron and steel products have to be exported to England or transported to southern Norway. Accordingly, the plant has to carry rather high costs of transportation for the finished products.

Electric smelting with kiln-pretreated charge

Calcination, preheating and prereduction of the pig iron charge followed by electric reduction and smelting is not a new concept. As early as in 1953 Elektrokemisk built a pilot plant comprising a rotary kiln connected to an electric furnace with direct, continuous transfer of the hot charge. The early results from these pilot plant tests indicated substantial savings in the kWh consumption and correspondingly increased pig iron production in the electric furnace. Later the ELKEM scoop-feeder system for feeding raw coal sidewise through openings in the kiln lining was developed. The use of raw coal or a mixture of coke and coal as reducing agent has been quite thoroughly tested in pilot plant operations in Norway, in South Africa and in Japan. The results from these comprehensive tests show the following advantages in the use of raw coal rather than coke in the "kiln/electric pig" iron process:

The volatiles in the coal are liberated in the kiln and are burned by controlled supply of secondary air. This supplies heat to the kiln and helps to establish a favourable temperature profile in the charge throughout the length of the kiln.

The coal carbonized in the kiln is transformed to highly reactive coke or char.

Further advantages are:

Coal is cheap in some areas.

Expensive installation of separate carbonization plant is avoided.

Results from pilot plant tests carried out in the ELKEM plant in Norway now cover a wide range of different types of iron ores and sources of carbon. Particularly interesting are the excellent results obtained with titaniferous iron ores from Japan and South Africa. The Norwegian tests were repeated on much larger pilot plant scale in Toyama in Japan with pelletized and sintered TiO_2 - containing sand concentrates. The power consumption was drastically reduced:

	Cold charge	Kiln-treated charge
Norwegian tests		835-1015 kWh
Japanese "	2508 kWh	989-1132 kWh

In South Africa large-scale pilot plants have been operated by Anglo American Corporation under the inspiring direction of Mr. Ian Cairns. The very successful tests have been followed by the foundation of the Highveld Steel and Vanadium Corporation Ltd. and erection of a large iron and steel plant for utilization of titaniferous iron ore and local coal. The plant consists of four rotary kilns and four ELKEM electric pig iron furnaces each rated 30,000 kVA. The kilns will be operated according to the special process developed by Anglo American, and the hot prereduced charge transferred to the electric furnaces.

At Skopje in Yugoslavia, Rudnici i Zelezara Skopje have erected an integrated iron and steel plant with kilns and 3-34,500 kVA and 2-45,000 kVA ELKEM electric furnaces. The iron ores are low grade silicious chamosite lump ore and limonite ore which are preheated in the kilns. The first three furnace units of this plant are now in operation. The furnaces have so far been operated with hot charge on reduced load due to restrictions both in the power supply and use of liquid pig iron in the steel plant.

Ferro-nickel - smelting

The combination kiln-electric furnace is used successfully in the extraction of a Ni-containing pig iron or ferro-nickel, from Ni-containing magnesiumsilicate ores (garnerites).

The nickel- and iron-containing raw, sandy ore is mixed with approx. 4% coke and calcined and preheated in rotary kilns to 700-900°C. The charge is transferred hot to ELKEM furnaces. The power consumption is in the order of 550-600 kWh per metric ton of dry ore.

The following ELKEM ferro-nickel furnaces are installed or under erection:

New Caledonia	7 units
Japan	3 "
Brazil	2 "

The transformer ratings of the ferro-nickel furnaces are from 4,600 to 15,000 kVA.

Outlook for the future

Electric pig iron smelting is an alternative to blast furnace smelting of iron ores. The process was first adopted in the Scandinavian countries, Italy and Japan, later in Yugoslavia and South America, then Canada and now in South Africa. The electric furnace is used for special types of raw materials. With the introduction of kiln preheating and prereduction new technology is being explored and developed. This new technology has now passed through many years of pilot plant operaions and two quite large industrial "kiln/electric" plants have been erected. According to the pilot plant test results available, drastic reduction in power consumption has been achieved, which will have its impact on the productivity and economy of the process.

Transfer of technology from pilot plant scale to large industrial scale always generates problems which have to be solved. Valuable experience is already available from industrial scale ferro-nickel smelting, using the same combination of kiln and electric smelting. In this industry many of the operational problems have been solved.

The combined "kiln/electric" process opens up interesting possibilities for utilization of off-grade iron ores and non-coking coals for pig iron production in the developing countries.

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