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ESTABLISHMENT OF IRON AND STEEL INDUSTRIES IN THE ARAB COUNTRIES TO SUIT LOCAL CONDITIONS[1/]

by

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Summary

The Arab Countries are short in coking coals but rich in other energy resources as petroleum, natural gas, low-grade solid carbonaceous materials and timber. Accordingly, they are trying to find out the most suitable technology for establishing their iron and steel industry according to their local conditions. Sudan, which is rich in timber, could use the low-shaft charcoal blast furnace while Syria, producing 300,000 t/year petroleum coke, could use it (after being desulphurised) for the reduction of their iron ores in electric smelting furnaces.

The majority of Arab Countries are rich in natural gas. Accordingly, and as a result of an intensive research program, a gaseous reduction process was proved on the pilot scale. Their iron ores are poor and difficult to concentrate to suit the sponge iron-steel making route. Therefore,

efforts are being made to combine gaseous reduction and smelting in the same process.

The Industrial Development Center of the League of Arab States (IDCAS), and many Arab Countries, each on its own, are in different stagés of adopting the gaseous reduction route as a basis of their iron and steel industry.

The Arab Countries, while covering quite a good area in Africa and Asia, are short in coking coals. However, they are rich in other energy resources and reducing agents as petroleum, natural gas, low-grade solid carbonaceous materials, and timber.

Accordingly, although some of them started their iron and steel industry by following the classical blast furnace-oxygen steel making route, they are all convinced that it is essential to found this basic and strategic industry in their lands on local natural resources. Those following the classical route are spending about thirty million U.S. dollars hard currency per million tons of steel production a year, for importing coke or coking coal.

Each Arab country is trying to find out the most suitable technology to follow, according to its local conditions. For example, a study was performed to use the low-shaft charcoal blast furnace for iron production in Sudan.(1)

The study was based on the fact that the [illegible] is rich in forests. The proved reserves of a high-grade iron-ore body in Abou-Toulo mountains, south of [illegible] Province, is 35 million tons, averaging about [illegible] % Fe ([illegible] % Fe_2O_3 , 7.0 % SiO_2 , 1.7 % Al_2O_3 , 1.0 % CaO + MgO , [illegible] % S , 0.1 % Mn). The ore can be easily extracted due to its presence on the surface. 250 kilometers to the south there are rich sub-tropical forests, the wood of which can be transported to Abou-Toulo area. The main railway to Rebeck (a city on the white Nile) and to Port-Sudan on the Red Sea is only 30 kilometers from the ore area.

It has been estimated that the annual consumption of R.C. bars in Sudan for the coming few years will be about 50,000 tons.[2] Accordingly the plant was designed for this capacity, which would be doubled in the future. A 200 t/day low-shaft blast furnace, a mixer, two small steel converters, and a mini-rolling mill will furnish the main parts of the plant. Two extra sections, namely timber preparation and wood carbonization, provide the charcoal requirements of the plant (the carbonization oven gas will be used as a fuel in the plant). One ton iron needs about 0.7 ton charcoal which could be produced from about 2.2

tons timber. Accordingly, the forest area required to provide this plant with charcoal was found to be of 50 kilo-meter diameter, working on a one hundred year cycle to produce 500 tons of timber daily. Investment cost was estimated at about 20 million U.S. dollars while the production cost was calculated at about 110 dollars/t R.C. bars.

An alternative to build the plant at Abou-Toulo is to transport the ore to the Kebek Region where water is abundant all over the year, forestry areas are more near, lime stone and dolomite are available, and cheap electric power generated from the Rosaires Dam can be used.

A second example of how the Arab Countries are trying to establish their iron and steel industry according to their local conditions is that of Syria. In this case a preliminary appraisal of the probable production costs showed that they are a bit higher than normal prices. However, the viability of a project of this nature in a developing country cannot be judged solely from a comparison of the cost of local production with the delivered cost of imported products, since the saving of foreign

employment of native labourers, the gained skill
ience, etc. must all be taken into account.

main iron-ore occurrences in Syria are situated
ward of Aleppo in Northern Syria. The ore bodies
ed at Radjou, Alamdar, Kerry, and Wadi-Nashab and
estimated reserves amount to 65 million tons.
ore-forming iron minerals are hematite, hydrated
, and ferruginous alumino-silicates. The iron con-
es between 30 % and 40 %, and about its fourth is
h the alumino-silicates. Other constituents of
re SiO_2 10-18 %, Al_2O_3 8-12%, CaO + MgO 8-10 %,
%, P 1-3 %, and S 0.2 - 0.8 %. All concentration
s were tried on this ore and only with a complex
, including magnetic roasting and concentration,
ncentrate assaying about 55 % Fe at 75 % recovery
.

e alternatives were suggested to the Syrian
t for the production of iron from these ores; the
eduction route, the Krupp-Renn process, and elect-
ing. The first alternative was excluded on the
t this route requires high-grade ores or concentr-

ates, while the Syrian ores or even the concentrates are too low in their iron content to be suitable for it. Also, natural gas in Syria is not that abundant, the proved reserves are of the smallest in the Arab Countries and amount to 21 billions cu.m. only. The second alternative, the Krupp-Renn process, was also excluded on the basis of not being efficient in treating the ferruginous aluminosilicates, beside the other snags which led to its stoppage in many parts of the world.

The reduction of iron in ferruginous aluminosilicates in electric smelting furnaces requires an intimate contact between these minerals, the reducing agent, and the fluxing material. Since the ores should be concentrated, and for this purpose they are ground very fine to affect efficient liberation, it has been suggested to agglomerate the fine concentrates into iron-carbon pellets containing a certain percentage of CaO, which increases the pellets strength and accelerates reduction.(3)

Petroleum coke is produced in Syria at an annual production rate of 300,000 tons. However, this coke is very high in sulphur, 7-10 %. Many desulphurization techniques were tried on this ore [illegible] high-temperature [illegible], which could eliminate [illegible] 90 % of the sulphur, together with increasing [illegible] activity.(4, [illegible]) This [illegible] one with respect to the Syrian project. Petroleum coke is a main constituent of the electrode paste used in electric smelting furnaces, and it can be used as the carbonaceous material in forming the iron-carbon pellets.(6) Preheating and partial reduction of the pellets, before being charged into the smelting furnaces could be achieved in any of the recent mechanisms used for this purpose.(7)

It has been recommended that a plant would be erected adjacent to the already existing 120,000 tons R.C. bars/year rolling mill at Hamah. The productive capacity will be 300,000 t/year steel products in the first stage, then doubled to 600,000 t/year. The chosen site has the advantages of being near El-Assy river, the railway connecting the ore area to Tartous harbour on the Mediterranean, the Tartous refinery, and a big electric power station.

Electric smelting requires huge amounts of electric power and this will be available from Euphrates Dam hydroelectric power station and could be generated at quite a low price from natural gas. The estimated price from both sources is about [illegible].5 cent/kWh.

It has been announced recently that a new iron ore body of a slightly better quality than those described above was discovered at El-Zabadany area near Damascus. Work is being carried out to investigate it.

Apart from these two local resources of carbonaceous materials that can be used in our iron and steel industries, there are some other potentialities but none can be a basis for following the classical route. The high-sulphur bituminous coal of Algeria (32 million tons proved reserves), the sub-bituminous coal of Egypt (30 million tons), the anthracite of Morocco (28 million tons), the Lignite of Tunisia (20 million tons), and the unestimated high-ash coal reserves in Northern Yemen are all not suitable for the blast furnace and can only be used in its alternatives as the low-shaft blast furnace, the electric smelting furnace, or direct reduction processes using solid reductants.

Natural gas and petroleum as the main future basis of iron and steel industry in the Arab Countries

The majority of Arab Countries are rich in natural gas and petroleum, beside being rich in iron ores. Realising this fact, and the fact that all Arab Countries have no proper coking coals, there started in 1950 an intensive program of research work aiming at finding out a process for iron production that uses these natural hydrocarbons instead of coke. The research program was finalized by proving, on the pilot scale, a multi-compartment fluo-solid reactor that could reduce the ore to 95 % reduction.[8]

There are now many gaseous reduction processes which have been proved on the industrial or semi-industrial scale. The product of these processes, sponge iron, whether lumpy or pulverized, can be charged to the steel making furnaces as scrap substitute, if of a certain high purity and high extent of metallization, or otherwise, to iron-making furnaces.

It was not possible until now to concentrate any of the iron ores in the Arab Countries to the degree of producing sponge iron suitable for direct steel making. It is also claimed that no more than 25 % of the known iron ores in the world could be used, as-mined or after being concentrated, for the production of sponge iron suitable for direct steel making. To pre-reduce the ores for the object of charging them in smelting furnaces, though this pre-reduction cuts down of energy and reductant consumption and increases the productivity of smelting units, this mechanism means the addition of an extra stage to the processes of steel production from iron ores. Accordingly, it was thought that a gaseous reduction process combining smelting with reduction would be in a better position in comparison with the classic route then those achieving reduction only as a pre-treatment.

On these lines the local efforts are conducted now. The distribution of the different elements between metal and slag when smelting under a hydrogen atmosphere, and the extent of hydrogen solubility in the molten iron under different conditions, were determined.[9, 10] A smelting hearth has been designed to be fixed at the bottom of the fluo-solid reactor mentioned earlier. Arrangements were done at the reactor base, and proved, to effect the smooth flow down of the reduced material into the smelting hearth and the streaming up of the reducing gases, formed in the hearth, through the reactor. Natural gas or vaporized naphtha will be blown in the hearth over the surface of the melt together with preheated oxygen and pulverized calcium oxide. The flow rates of reducing agents, oxygen, and lime were calculated per ton iron produced per hour according to different assumptions for the extent of metallisation and gangue content and composition, of the sponge falling into the hearth. In each case the composition of the gaseous mixture, resulting from the partial combustion of the fuel, and streaming up the reduction reactor, should be such that to affect the reduction of the ore to the required extent. In the mean time, the heat developed due to this partial combustion should suffice all the heat requirements of the process. Practical experimentation on a pilot-plant scale will check up and re-evaluate all the calculated figures.

Being of the developing countries, it is difficult to develop, on our own, such processes to the industrial scale and it is more advisable to co-operate with some other parties for this purpose. To the belief of the author, such a programme would be of great value to all countries deficient in coking coals and high-grade ores.

Future of Iron and Steel Making in the Arab Countries

Although many Arab Countries are thinking, each on her own, of manufacturing sponge iron for steel production, and many techno-economic studies were done for this purpose, the Industrial Development Center of the League of Arab States (IDCAS) is conducting a feasibility study for establishing iron and steel works in different parts of the Arab World, on co-operation basis between the Arab Countries, to cover their needs of steel products by 1980. Due to the abundancy of natural gas and to the fact that these plants will be of the mini-type to suit their needs, it is most probable that they will follow the gaseous reduction-electric steel making route. They will work on imported high-grade pellets and accordingly they will be coastal. However, many Arab countries are studying the possibility of concentrating their iron ores to suit sponge iron manufacture so that they can dispense with imported high-grade pellets if they follow the gaseous reduction route.

On the other hand, many Arab countries are individually at more advanced stages with respect to their plans to follow this modern technology. For example, on the fifth of June 1970 the Moroccan Government issued a letter of intent to a consortium for the erection of an integrated iron and steel plant of 280,000 ton annual production using the HyL process for gaseous reduction and electric steel making furnaces. Iraq has recently placed a tender for establishing a bigger plant, also using the HyL process. A feasibility study was just performed for the Libyan Government to establish a gaseous reduction plant. A one million ton sponge/year project is being studied for Kuwait, for export purposes, on the basis of importing the blue dust from Goa, India, against exporting petroleum to it. Reduction of the ore will be performed by surplus hydrogen produced from their petrochemical industries.

By 1977 there will be a shortage in Egypt of R.C. steel bars amounting to 200,000 ton/year. This amount has to be either imported or manufactured from imported scrap, both of which solutions add to the heavy burden of hard-currency expenses that Egypt is already bearing. By same year the total production of R.C. steel bars in Egypt from the already existing and projected plants and apart from these 200,000 tons/year, will be 500,000 tons/year. They will be produced partly from imported scrap. In the new iron and steel complex near Cairo the L.D. converters will be charged with only 15 % scrap due to shortage in the availability of local scrap, a ratio which, if doubled, would increase the annual production of the plant by about 200,000 tons/year.

Due to all these considerations it has been decided to erect a gaseous reduction plant to provide the local steel industry with its requirements of sponge iron as scrap substitute. The productive capacity will be something between half and one million tons/year and the plant will be located at Alexandria. The proved reserves of natural gas at Abu-Keer, thirty kilometers east of Alexandria, are 42 billion cu.m. and the daily production is three million cu.m. The plant will operate on this natural gas for reduction and electric power generation.

Although the tests performed on the Egyptian Baharia iron ore by Swindell-Dressler proved that it can be concentrated to 60 % Fe and that the pellets formed from the concentrate are suitable to be treated by the HyL process, yet the gangue content of the reduced pellets is so high to render them unsuitable for steel making. Accordingly, the plant will work on imported high-grade pellets until local ores could be proved to produce sponge iron suitable for steel making. It has not been decided yet which process to follow, whether HyL, Midrex, or some other. This plant, if of one million ton/year productive capacity, will result in a saving in our hard currency expenses amounting to about thirty million dollars/year. This is beside the facts that the investment cost of such a plant is about 30% less than that of a plant having the same productive capacity but following the classical route, and the processing cost is also much less due to the big difference in prices between natural gas and coke (total energy requirements in both cases are approximately equal), or between imported pellets and scrap.

In conclusion, it should be mentioned that a local statistical study proved that about 70 % of the equipment and spare parts of the iron and steel industry could be manufactured locally.(11)

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