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CHANGING TECHNOLOGY IN THE LIGHT OF THE AVAILABILITY OF NATURAL GAS 1/

by

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Abstract

The aim of this paper is to study the development of the iron and steel industry in the Arab countries, in the light of the lack of coal and the availability of natural gas in those countries. They have very large reserves of natural gas but their coal production is almost non-existent.

The erection of coke-based iron and steel plants will result in the Arab countries becoming economically dependent on coke-producing countries and in a drain on their foreign currency reserves.

However, the availability of large reserves of natural gas will enable the Arab countries to build a viable iron and steel industry, based on the erection of direct-reduction plants.

The paper also deals with the changes in technology brought about by the availability of natural gas and with the impact of such changes on the economic and technical development of the Arab countries.

New technological equipment is beginning to be installed in iron and steel plants. The design of this equipment and of the processes involved permit the plants to operate viably and with great flexibility.

Equipment that is in many ways comparable with direct-reduction process equipment is already in use in chemical and petroleum plants in the Arab countries, and the personnel operating there can be of great value in the operation of the direct-reduction processes.

The future of direct-reduction processes in the Arab countries is closely bound up with the potential that exists in the form of raw materials and human resources.

INTRODUCTION

Direct reduction has made great progress since its advent, and the figures quoted (Fig. 1) for prospective sponge-iron capacity bear witness to the importance of this technology.

Difficulties in coke supply and the availability of natural gas are the fundamental factors behind this development. This situation is characteristic of that in several countries in the third world, and innovatory developments in the iron and steel industry may be anticipated in these countries.

This paper will survey the situation of the Arab countries, which have natural-gas resources and but suffer from a shortage of coke. It will then deal with technological changes that will result from the development of direct-reduction units. Finally, consideration will be given to the possibilities for success for these units in the Arab countries.

COKE IN THE ARAB COUNTRIES

Table 1 shows that coal production in the Arab countries is modest, and often non-existent. This is due to the lack of metallurgical coal or to difficulties in exploiting the sparse reserves, either because exploitation is expensive or because the coal is low-grade. Apart from Morocco, which is the largest producer, it can be stated that coal extraction does not exist in the Arab countries.

The geographical location of the mines and the lack of a transportation infrastructure in most of the Arab countries makes coal prices very high. Moreover, the reserves are low and the rate of production in Morocco, for example, is high. In the near future, there will be no coal production at all in the Arab countries.

The creation of integrated steel plants of the classical type has caused a demand for metallurgical coke, of which the Arab countries are importers. These countries are therefore dependent on the world market to supply their blast furnaces. In addition, coke imports represent a heavy drain on hard currency reserves.

In spite of the improvement in coke rate resulting from the injection of fuel oil or natural gas into the blast furnace, coke remains essential as an element in steel production, using the conventional route. Thus, so

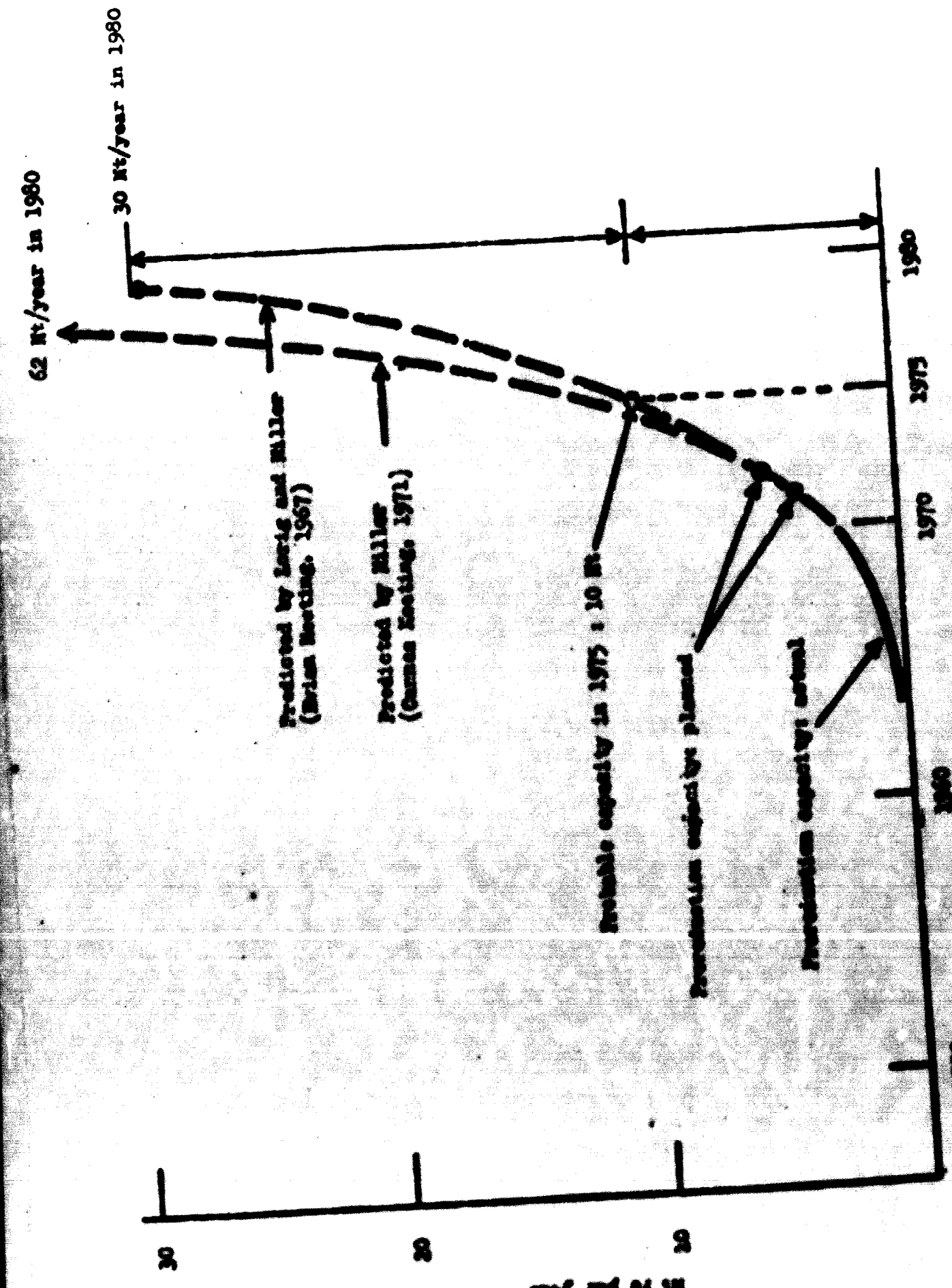
62 Mt/year in 1980
30 Mt/year in 1980
Predicted by Lewis and Miller (Atlas Service, 1967)
Predicted by Miller (Science Services, 1971)
1980
1975
1970
1965
1960

Table I : PRODUCTION OF BITUMINOUS COAL, ANTHRACITE, AND LIGNITE *

(Thousands of short tons)

	1963	1964	1965	1966	1967
Algeria (Bituminous & lignite)	42	51	50	55	55
Zaire (Bituminous)	101	110	126	121	147
Malagasy Republic (Bituminous)	2	4	2		2
Morocco (Anthracite)	445	441	462	497	531
Mozambique (Bituminous)	312	270	262	325	311
Nigeria (Bituminous)	636	771	816	703	220
Rhodesia (Bituminous)	3,020	3,355	3,863	3,350	3,019
Republic of South Africa (Bituminous & anthracite)	46,797	49,513	53,418	52,847	54,344
A.R. of Egypt (Bituminous)			22	22	
Zambia (Bituminous)				126	433

* Minerals Yearbook, 1967

long as the basic technology of iron and steel plants is not changed, the problems of the Arab countries will remain linked with the supply of coke.

Moreover, the demands of miners and the coke requirements of the industrialized countries, in terms of current forecasts of increases in production, will cause coke prices to rise and for this raw material to become scarcer.

It is in the interest of the Arab countries to start adapting their industrial development to methods that are best suited to their available resources.

NATURAL GAS IN THE ARAB COUNTRIES

The Arab countries are large producers of natural gas. Table 11 shows the reserves and production at the present time. This gas is high in quality (the Algerian gas contains almost no sulphur) and has a wide range of potential applications.

Since it was discovered in the Arab countries, natural gas, exploited by foreign companies, has supplied European energy producers, gas-based chemical plants, etc. However, since the Arab countries have begun themselves to participate in the exploitation of natural gas directly, proper industrialization schemes have been started in these countries. Natural-gas based fertilizer plants have been set up in several Arab countries (Algeria, Saudi Arabia, Kuwait, and Iraq).

However, these industries have not absorbed the total production, and the major consumer of natural gas has continued to be export, the gas being liquefied in new plants in the exporting countries and shipped in this form. Since European industry is very dependent on natural gas, it is a reliable source of foreign exchange, and provides the major assistance to the industrialization of the exporting countries, since they can buy plant and equipment in this way.

CHANGES IN TECHNOLOGY

Direct-reduction processes have introduced into the iron and steel industry a new type of technology, formerly restricted to petrochemical plants. For example, the coke oven, one of the main process stages in the conventional steel plant, is replaced by the catalytic reforming furnace, the starting point for the production of ammonia, methanol, and plastics. Compressors are used for the supply of raw materials and catalytic tubes replace coke ovens. There is no dust problem nor any loss of reductant.

Table II : NATURAL GAS IN THE ARAB COUNTRIES* (Reserves and Production)

Country	Reserves (thousand million m³) 1970	Production, million m³			
		1967	1968	1969	1970
Algeria	4,106	2,158	2,478	2,954	2,859
A.R. of Egypt	40	58	56	71	-
Iraq	510	522	771	897	789
Kuwait	1,133	2,708	3,339	3,720	4,041
Libyan A.R.	736	-	-	-	-
Morocco		11	11	42	48
Qatar	208	99	119	-	-
Saudi Arabia	2,365	-	-	-	-
Tunisia	14	8	6	9	12

* Statistical Yearbook, 1971

Since there is a continuous supply of gas from the compression stations, there is no need for the handling or storage of raw materials. Although more vulnerable to variations in operating conditions and more hazardous (risk of tube bursting, risk of carbon deposit on the catalyst) than the coke oven, the reforming furnace is simpler in design and its maintenance is easier. Many developing countries possess equipment of this kind (especially in fertilizer plants) and local operatives who have acquired valuable experience in this field may be of great use in direct-reduction units.

The construction of direct-reduction plants in Arab countries that lack an industrial infrastructure will create a training school for personnel working in the reforming section, enabling them later to work in chemical plants.

The blast furnace, one of the basic items of plant of an iron and steel works, is replaced by reactors that are simple in design. On the basis of the material produced, the different parts of the equipment are more accessible and problems of tapping pig iron and slag no longer exist.

The design of the processes employing shaft reactors gives great flexibility in starting up and shutting down the reactors. This avoids complete stoppage of production when maintenance of the reactors is necessary.

At the product-handling stage, the use of belt conveyors to transport the sponge iron simplifies problems associated in blast furnaces with casting, the notches, runner quality, etc.

Gas heater furnaces replace hot blast stoves; they are cleaner, more efficient, and easier to operate.

These direct-reduction units, though not producing the same type of material, can be considered to be true gas-based chemical units in view of their design and appearance.

[illegible] AND THE ARAB COUNTRIES

Direct reduction has evolved to meet a situation that is becoming increasingly unfavourable to the conventional iron and steel making process :

- Difficulties in coke supply
- Availability of natural gas or liquefied hydrocarbons
- Fluctuations of the scrap market, affecting supplies for electric or open-hearth furnaces
- The possibility of transforming fine ores into sponge iron without prior preparation

- Demand for high-quality steels, which require a raw material that is purer than pig iron or scrap.

Many processes have been developed. Some of these, such as Hyl, Midrex, Nu-Iron, etc., are already in operation on an industrial scale, whilst others, still at a semi-industrial scale, seem to be likely to achieve success (e.g. Novalfer, FIOR).

The advent of such processes put the Arab countries in a favourable position for the development of their heavy industries.

Economic Aspects

The use of resources that are locally abundant in the Arab countries will guarantee the independence of those countries in relation to the countries producing and exporting coke. It will avoid an important drain on foreign currency reserves, which is a problem that developing countries are finding more and more crucial.

At the steel making stage, the lack of steel scrap in newly industrialised countries and the fluctuations of price on the scrap market have put the developing countries in a weak position. This problem can be solved by using sponge iron mixed with the small amount of domestic scrap.

From the point of view of investments, it should be noted that the sponge iron-electric furnace combination is more favourable than the conventional blast furnace-BOF combination. Up to a certain limit, the larger the plant is, the lower is the product cost.

The construction of large plants in the Arab countries will help their iron and steel industries, and this should be their aim. The sponge iron produced will supply steel making units spread over several Arab countries, and part of it could be exported outside the Arab group.

The existence of personnel with experience on petrochemical plants and familiar with the operation and maintenance of reforming furnaces and heaters will be of great help for the direct-reduction units. The number of technical assistance personnel will decrease and foreign currency will be saved.

Technological Aspects

The common factor between the various gas-based direct-reduction processes is the preparation of the reducing agent. This is done by reforming natural gas into hydrogen and carbon monoxide. This technology is already in use in fertilizer plants in many Arab countries and has been developed considerably. The reforming furnace has become a standard item

of plant and most of the problems associated with it have been solved. It is capable of ensuring continuous production and its design permits easy maintenance. Failures are rare in reforming furnaces.

The technological problems associated with the reduction reactors are not yet fully integrated, but the simplicity of design of these plants and their flexibility in operation (e.g. four reactors in Kyl) are of great importance in terms of productivity and maintenance.

Social Aspects

The production of sponge iron for supplying electric furnaces will lead to the construction of several steel making plants in the Arab countries. The availability of such material will create a regional industry, mainly in the large states that are expecting a major industrial development.

Other factories, producing screws, nuts, domestic implements, etc., will be set up close to the steel making plants.

Transportation and trade activities will solve the problem of unemployment. The need for qualified personnel will lead to the establishment of training centres and to social and cultural improvements for the population.

THE FUTURE OF DIRECT REDUCTION IN THE ARAB COUNTRIES

The success of direct reduction in the Arab countries is dependent on the possibilities of financing, the existence of an appropriate industrial infrastructure, the quality of the raw materials, and the degree of skill of the personnel. This success can be ensured by joint action in terms of materials and manpower.

It would be advisable for countries such as Mauritania, Algeria, and Morocco on the one hand and Sudan, Egypt, and Saudi Arabia on the other to combine their efforts to build a reliable and economic iron and steel industry.

The high-Fe Mauritanian ores and the sulphur-free Algerian gas, together with the access that Morocco has to the Atlantic, are favourable conditions for these countries. The sponge iron produced will supply the steel plants in all three countries. Financing will cover roads and ports as well as a training centre specialising in iron and steel production.

It is obvious that such projects entail detailed studies in order to determine the conditions needed for them to be put into effect.

CONCLUSION

As a basic factor in economic, technical, and social development, the iron and steel industry will play a deciding role in the future of the Arab countries. The shortage of coke and the abundance of natural gas in these countries will direct the choice towards direct-reduction processes. Raw materials and human resources demanded by this industry could have a unifying influence on the potentialities of the Arab countries within the limits of profitable co-operation. It is possible that in the next five years the Arab countries will build a direct-reduction plant of 3 to 5 million tons capacity.

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