UNITED NATIONS

ECONOMIC
AND
SOCIAL COUNCIL

SUMMARY OF
E/CN.12/293
30 March 1953

ECONOMIC COMMISSION FOR LATIN AMERICA
Fifth Session
Rio de Janeiro, Brazil
9 April 1953

SECRETARIAT PAPER

A SUMMARY OF

STUDY ON IRON AND STEEL INDUSTRY AND REPORT ON MEETING OF EXPERTS HELD IN BOGOTA AND SPONSORED BY THE ECONOMIC COMMISSION FOR LATIN AMERICA AND TECHNICAL ASSISTANCE ADMINISTRATION

Volumes I and II

BACKGROUND DOCUMENT FOR
ITEM 6 OF PROVISIONAL
AGENDA

STUDY ON IRON AND STEEL INDUSTRY AND REPORT ON MEETING OF EXPERTS SPONSORED BY THE ECONOMIC COMMISSION FOR LATIN AMERICA AND TECHNICAL ASSISTANCE ADMINISTRATION

INTRODUCTION

The first industry systematically studied by the Economic Commission for Latin America, has been iron and steel making. 1/

The following considerations have influenced this preference:

a) The importance of iron and steel making for the economic development of the countries;

b) The interest in the industry shown by several Latin American governments, which has resulted in the formulation of several projects during the last half century, and

c) The frequency of discussions without uniform criteria, regarding the advantage or disadvantage of installing such an industry in specific countries.

In order not to unduly extend the scope of this survey, the analysis has been restricted to seven countries of the region, in which either an integrated steel making industry exists or which possess, according to a preliminary investigation, the best possibilities for the establishment of such an industry. These countries are Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

The investigation has been directed towards five main objectives:

a) Analysis of the evolution of consumption and supply of iron and steel products; 2/

b) Study of the hypothetical costs of steel production in selected Latin American countries. These would be compared with hypothetical production costs in industrialized countries and with prices of imported steel as delivered to Latin American markets;

1/ The study on productivity of labour in the textile industry of five countries of Latin America, undertaken in 1951, refers only to some special aspects of textile industry.

2/ For the purpose of this paper, and all documents related to the Meeting in Bogota, the expression "steel products" refers to products of the rolling mill and the primary transforming industries. It excludes, therefore, the steel contained in manufactured goods, equipment, etc.

c) Approximations of

materials, there are many special problems in the region, a few applying exclusively to Latin America while others are also frequently found in other countries. The variety of cases is so large that, in order to encompass them all, it is necessary to resort to the knowledge and experience accumulated in those countries which have a well developed steel industry.

The main conclusions of the study can be summarized as follows:

1. Analysis of consumption in Argentina, Brazil, Colombia, Cuba, Chile and Mexico, shows that during most of the past 25 years, almost all of them have been unable to obtain the steel products which they needed. Instead, they secured only such amounts as their capacity to import would permit them to buy abroad, supplemented by existing local steel production. The majority of the countries whose markets have been investigated show deficits in their supply of steel products.

2. The size of the plant is the single most important influence bearing on costs. If the scale of operation is small, the costs and the investment per unit of production are high and productivity is low.

3. The consumption rates of even those Latin American countries using the largest amount of steel, are too small to justify the installation of modern specialized plants capable of taking advantage of all the improvements which increase productivity.

4. Regarding costs, a detailed analysis of the influence of the most important factors affecting Latin American steel industry, has been prepared. For that purpose, plants have been hypothetically assumed, of sizes appropriate to the respective markets in different Latin American countries, and their costs compared with plants of the same sizes but located in Sparrows Point, United States. In this comparison, results have generally been favourable for Latin America.

In reality, the steel making plants in the industrialized countries, and specially in the United States, are much larger and their costs, therefore, are smaller than those which have been calculated for the Latin American plants. Nevertheless, with the exception of Peru and Venezuela, these differences are compensated by the higher transport cost of steel from the industrialized countries to the Latin American

/markets.

to be admitted that in order to secure certain substitutions of imports, investments may have to be made, with a lower product per unit of capital than the average of the investments prevailing in the economy.

1. Fuel Problems

a) In most Latin American countries, with probably the sole exception of Colombia, known coal reserves are scarce;

b) Few of the known deposits contain coking coals;

c) Several of the good coking coals of Latin America are difficult to wash, because the ashes they contain are finely disseminated. This means an increase in the cost of washing, or, alternatively, of high transportation costs of the coal, and operation costs of the blast furnace.

d) The raw materials which exist in Latin America and can be used for blending to improve the coking property of coals, or as substitutes for coke making, are little known in general. Their properties and possible applications have not been sufficiently investigated.

e) The distances between coal mines and steel plants, are generally excessive and produce an increase in the cost of pig iron, although the influence of this loss varies as between the different countries.

f) Quality limitations in the coke which can be manufactured with local raw materials without increasing fuel cost excessively, in several of the countries of the region, has resulted in some instances in the limitations of the height of the blast furnaces, which in turn, reduces their productivity.

g) Some of the coals, blending materials or substitutes for coal known in Latin America, have such a high sulphur content, that either the possibility of their utilization has been excluded altogether, or the operating costs of the blast furnace have been substantially increased.

2. Technical Problems Caused by the Composition of the Iron Ores

Problems posed by the quality or availability of iron ores, are considerably less important than those resulting from fuels. Latin

/America in

scale of operations increases costs. As has been stated, not even their total market would be sufficient to justify large-scale modern plants which alone ensure the maximum productivity found in industrialized countries.

A special technical problem seems to exist, therefore, in Latin America, which consists in finding iron and steel making processes, which could attain a higher productivity with small scale operations. Such processes would find suitable application in isolated regions in some of the aforementioned countries. In addition they would permit the establishment of small steel making industries in other countries of the region, which have not been included in this survey since the small size of their markets would result in excessive cost of steel produced under classical processes.

3. Technical Problems Arising from the Uses of Steel

In countries where the steel transforming industries have not been developed, the largest proportion of the metal is used in the building industry. In such a case, the main quality requirements which steel has to satisfy are resistance and ductility. Chemical composition becomes of almost no importance. The requests made by some consumers that such building materials should conform to narrow variations of chemical compositions, unnecessarily increase production costs, and result in a higher cost of steel for all consumers. It may also induce unnecessarily high investments in additional plant facilities.

In view of the rapid growth of steel making in Latin America in recent years, it seems advantageous to establish, as soon as possible, standards and specifications for such steels as are being produced. When preparing these standards, consideration should be given to the use to which the steel will be applied, the existing raw materials and facilities, and the avoidance of unnecessary increases in production costs.

The conclusions of ECLA's preliminary studies, especially concerning the considerable number of technical problems which tend to increase the costs of Latin American steel production, suggested that great advantage could be derived from a meeting of experts. An agenda could be submitted

/to them,

The substantive matters dealt with have been summarized in chapters III, IV and VI of this report, and included:

a) Fuel problems:

Washing of coal; improvement of coking properties of poorly coking coals; substitutes of coal for the manufacture of metallurgical coke;

b) Iron ore reduction problems:

Comparative advantage of the use of better coke in blast furnaces contrasted with increased costs of coal washing; economic problems of the charcoal blast furnace; reduction of iron ore by processes other than the blast furnace.

c) Steel making problems:

Comparative costs of different steel making processes; alternative processes to the rolling mill which combine higher productivity with low scale operation; range of application of steels made by different kinds of steel used in various countries.

d) Economic problems:

A special section of the meeting was devoted to the study of four working papers presented by the Economic Commission for Latin America:

Document L.86: "Factors Influencing Iron and Steel Consumption in Latin America";

Document L.87: "Influence of Local Factors on the Iron and Steel Industry in Latin America";

Document L.88: "Structure of the Steel Transforming Industry in Latin America";

Document L.0 : "Brief Outline of Steel Industries in Some Latin American Countries".

The dates at which the various items of the substantive matter were discussed, appear in the agenda attached as Annex III. All discussions took place in plenary meetings. Only three problems which had not been included in the programmed list of substantive matter were presented by

/non Latin

specialists resulted in many valuable suggestions. Their contributions, in addition to conveying definite suggestions for solving some of the Latin American problems, provided inspiration to other technicians to conduct studies which could result in future progress.

Judging by the number of participants, and of papers presented, the meeting was also very successful. To a great extent this was due to the excellent co-operation obtained from universities, research centres, professional associations and many private steel plants. Through consultation with internationally-known professional associations, names of the most representative equipment manufacturing firms and consulting engineers were obtained. The co-operation of a considerable number of these equipment manufacturing and engineering firms was then requested and obtained, some of them contributing in the form of working papers, some through actual participation of their officials, or both. This group of private firms, it might be added, provided the meeting with some excellent working material.

The Empresa Siderúrgica Nacional de Paz de Río, of Colombia, contributed with a series of papers prepared by either its own staff, or by the firms that provide it with equipment and technical advice. It also contributed a substantial amount of material help.

Not every problem of interest to the Latin American steel industry was included in the agenda. The restrictions that were imposed resulted from two main factors. For one thing, there was the limitation of time, and the desire that the material under discussion should receive an exhaustive treatment. Secondly, the desire to present the largest possible number of divergent opinions on each topic necessitated the elimination of some agenda items which were considered insufficiently covered by the contributions which were obtained. Such a coverage seemed especially indispensable in those cases in which the analysis was prepared by private commercial sources.

In view of the composition and the organization of the Bogotá Meeting, the basic objective was not one of reaching specific agreements nor recommendations. Rather, the primary purpose was to discuss the different problems thoroughly, covering as many angles as possible, but always with the focus directed towards the Latin American industry.

SUMMARY OF THE MAIN CONCLUSIONS OF THE BOGOTA MEETING

1. Resources, Present Position and Future Trends of Iron and Steel Industry in Latin America

According to information presented to the Meeting, the Latin-American situation as regards resources available for steelmaking may be summarized as follows:

a) There are plentiful reserves of high-grade iron ore, the region up to now having been one of the main iron ore exporters. Brazil takes first place in this respect, as its deposits in the State of Minas Gerais alone amount to some 15 thousand million tons of high-grade ore. These reserves, together with others in different parts of the country, constitute over one sixth of the world's known probable reserves.
Exploration in Venezuela up to the present time indicates proven reserves of 477 million tons, and probable ones of 670 million tons of high-grade ore (55 to 65 per cent).

b) Regarding coal, the position is not favourable, as most Latin-American countries have no sizeable reserves of coking coal. Many of those available have high sulphur and ash contents, so that washing is necessary. Furthermore, coal formations are usually far from steel consuming centres.
Colombia is a notable exception to this general rule. Its coal reserves have been estimated at 12 thousand million tons of widely differing types of coal, some of which are highly coking. In the Paz de Río District, 18 million tons of coking coal have been proven close to the iron ore mines, while the probable reserves rise to 130 million tons. A remarkable combination of favourable factors exists in Colombia, where all basic raw materials for steelmaking are found in a radius of only 50 kilometres, within the Paz de Río area.

Latin-American steel production has developed rapidly in recent years. Three countries already have integrated industries, i.e. Brazil, Chile and Mexico. Their joint production, together with Argentina's rolling mill output, amounted to slightly under 300 thousand tons of finished steel in

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1940, this figure rising to 760 thousand tons in 1946 and to 1,700 million tons in 1951. New facilities planned or under construction will increase capacity by 1955 to over 3,300 million tons of finished steel a year.

Brazil is at present the largest producer, having produced about 850 thousand tons in 1951. Immediate plans provide for a considerable increase in the capacity of the Volta Redonda Plant, owned by the Companhia Siderurgica Nacional, to a million tons of crude steel by 1957. Expansions are also under way for the Companhia Belgo Mineira and for several other existing facilities, while several new plants will be built; the latter include substantial projects in Belo Horizonte, Santos and São Paulo. These additions will raise the country's output to a million and a half tons of finished steel within the next few years.

Mexico takes second place, having several plants, which produced 460 thousand tons of finished steel in 1951. The Compañía Fundidora de Hierro y Acero de Monterrey S.A. and Altos Hornos de Mexico, S.A. own integrated plants, their joint output being 235 thousand tons in 1951. So far, the capacity of existing plants has not been fully utilized, mainly due to difficulties in transporting raw materials. Once these difficulties have been overcome, and the new expansion plans are executed, production may reach 700 thousand tons of finished steel a year.

Special reference should be made to the small plant, Hojalata y Lámina, S.A., in Monterrey, where a tunnel kiln has been installed for making 12 thousand tons of sponge iron a year. This is the first plant in the world to use this specific process on a commercial scale, and it is also the first plant in Latin America using a method other than the blast furnace for reducing iron ore. In view of the success achieved, the company is trebling its capacity.

Argentina has concentrated mainly on rolling mills, basing their supply of raw materials on the small output of charcoal pig iron from Zapla, on domestic supplies of scrap iron and on imports of billets, pig iron and scrap. Production in 1951 was estimated at about 300 thousand tons of steel. Present plans envisage considerable expansion at the Zapla unit and the installation of an integrated plant at San Nicolas, which should raise total capacity to over 700 thousand tons of finished steel a year.

/Chile became

behind the rate of industrial development, particularly in relation to progress made in recent years in mechanical industries using iron and steel as raw materials.

Similarly, consumption of some special types of steel products shows a marked retrogression in relation to specific factors with which it might logically be associated. Building activity, which consumes a large amount of steel, has shown considerably more favourable evolution during the last quarter-century than consumption of bars and shapes. Between 1925-29 and 1945-49, the relationship between consumption of bars and shapes and cement consumption has deteriorated appreciably, to the detriment of the former; the decline was 58 per cent in Argentina, 21 per cent in Brazil, 35 per cent in Chile, 16 per cent in Colombia, 40 per cent in Cuba, and 25 per cent in Mexico. Furthermore, tinplate consumption increased to a much lesser degree than the rate of development of food preserving industries, while consumption of rails was, in most cases, insufficient to cover normal replacements.

The above comparisons indicate that there has been a certain degree of compression in iron and steel consumption. A further indication of this is provided by the fact that in many cases steel products had to be rationed, while there was a growing utilization of substitutes.

The chief reason for this unfavourable development of steel consumption in Latin America seems to lie in an equally adverse evolution of the capacity to import. Actually, for most Latin-American countries, imports are the only source of supply. Argentina, Chile, Brazil and Mexico are exceptions in that respect. The first two have, since before the war, had a restricted source of domestic supply for some of these products, and the relative importance of imports has remained high. As regards Brazil and Mexico, even though they have older-established steel industries, they have also had to continue importing large quantities of steel. Under these conditions, fluctuations in the capacity to import has greatly influenced steel consumption.

The six countries used as examples show an impressive correlation between fluctuations in imports of iron and steel and in the capacity to import. During the last twenty-five years, the unfavourable evolution of the former coincides almost exactly with an equally adverse evolution in the latter. In Mexico, where there is an upward trend in steel imports, the capacity to import has also shown a more favourable development than in the other Latin-American countries considered.

/These comparisons

3. Influence of Local Factors and the Size of the Plants on Steel Production Costs in Latin America

In view of the bearing steel has on economic development, it is important to achieve satisfactory costs for steel production in Latin America. Moreover, the assumption that costs would necessarily be high has led to discussions concerning the desirability of installing local industries. The Secretariat analysed this problem, taking as examples seven sites located in seven different countries.

First of all, an analysis was made of the influence of purely local factors, chiefly: wage rates, quality of raw materials and haulage distances on costs. These were calculated for imaginary plants with equal capacity (250 thousand tons a year of finished steel), and then compared with a similar imaginary plant located at Sparrows Point, in the United States.

Next, similar calculations were made for plants appropriate to the size of the respective markets. This second set of calculations, in addition to purely locational factors, stressed the influence of plant size on costs.

The first series of estimates provided a picture of what Latin America's relative position would be when, as a result of considerable expansion of local markets (or of exports to other countries in the region) the operation of optimum size plants became justified. The second series, by contrast, illustrates the present position, in which industries are being planned for supplying only the relatively small local markets.

a) Hypothetical costs in plants of equal capacity

The following locations were selected for the imaginary plants:

a) San Nicolás, Argentina, using domestic iron ore from Sierra Grande[1/] and imported coking coal;

b) Volta Redonda, Brazil, using domestic ore from Lafaiete and a blend of 70 per cent of coal imported from the United States and 30 per cent of domestic Barro Branco coal;

1/ Other alternatives considered were: the use of Zapla ore and ore imported from Itabira (Brazil).

Table 1 Production Costs at the Different Locations

Plant	Assembly costs	Pig iron	Steel ingot	Finished steel A	Finished steel B
San Nicolás a/	59.15	68.63	85.17	128.14	144.34
San Nicolás b/	42.74	52.43	68.44	109.78	123.83
San Nicolás c/	33.88	48.52	64.40	105.34	119.03
Volta Redonda	37.33	46.85	62.09	102.08	114.02
Huachipato	23.05	32.25	46.21	83.62	93.73
Belencito	17.62	27.96	38.47	76.12	81.30
Monclova	26.74	36.12	51.29	89.91	98.90
Chimbote	18.80	31.12	44.91	81.79	93.32
Barcelona d/	21.68	37.95	57.58	116.47	101.10
Barcelona e/	26.40	38.57	58.23	117.20	104.78
Sparrows Point	27.14	35.89	52.63	100.25	100.25

a/ Using Zapla ore.

b/ Using ore from Itabira (Brazil).

c/ Using Sierra Grande ore.

d/ Using coke made from asphalt and petroleum residues.

e/ Using coke made from imported coal.

A. With wage rates and capital charges corresponding to each location.

B. With wage rates and capital charges corresponding to the United States.

Except for San Nicolás and Volta Redonda, assembly costs are lower for the Latin-American locations than for Sparrows Point. Belencito and Chimbote stand out particularly in this respect. In the cases of San Nicolás and Volta Redonda, the higher figure is due to coal costs, which are equivalent to 59 and 67 per cent, respectively, of assembly costs, whereas at Sparrows Point they are only 36 per cent thereof. For Monclova, by contrast, the higher cost is due to the long railway haulage distances of iron ore.

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Taking into consideration the influence of locational factors alone, it may be concluded that Latin America is, generally speaking, in a favourable position compared with conditions prevailing on the United States Atlantic seaboard. Even those plants with costs higher than those of the imaginary ones at Sparrows Point, are favourably placed for supplying their own markets, when freight costs for imported steel are taken into account.

b) Hypothetical costs in plants appropriate to the size of the markets

In view of the influence of plant size on costs, the prevailing position would require consideration of units suitable for the size of the respective local markets. In order to relate the data thus obtained with conditions prevailing on the world steel market, it would be necessary to compare them with plants located in some of the exporting centres, which take advantage of large-scale operation and specialization.

Production costs for different sizes of plants in the Latin-American locations described before, have been compared with an imaginary one million ton a year plant, located at Sparrows Point. For the former, hypothetical capacity was generally selected on the basis of actual consumption, reduced by 20 per cent to cover special products, local manufacture of which is not justified. Two alternative capacities were considered for Colombia, Peru and Venezuela, the first on the basis described, and the second on an estimate of potential consumption once there was a domestic source of supply. The million ton annual capacity of finished steel for the imaginary plant at Sparrows Point, was selected because above that size no considerable economies would arise, except those due to specialization.

In general, calculations were similar to those prepared for equal size plants. An exception was the use of reduced maritime freights, to the extent that larger-scale operation may result in economies arising out of the use of more adequate means.

A summary of the results obtained is given below:

/Table 2

Local plants enjoy some advantages as against imported steel, due to the lower carrying costs for their products to the principal domestic consumption centres. The table below compares production costs calculated for the former with those of Sparrows Point, plus the latter's disadvantages in transportation costs to the respective Latin-American markets. In order to obtain a more realistic impression, the figures for the "Composite Finished Steel Price" in Pittsburgh in 1948 ($6.20) dollars) have been included, plus similar surcharges, including transport between Pittsburgh and the United States Atlantic seaboard (estimated at 10 dollars per ton).[1/]

Table 3 Latin-American Steel Production Costs Compared with Prices of Steel Imported from the United States

(dollars of 1948 per ton)

Location		Production costs	Costs from Sparrows Point c.i.f. Latin-American market	Minimum price of Pittsburgh steel c.i.f. Latin-American market
San Nicolás	(850,000 tons)	92	91	115
Volta Redonda	(716,000 tons)	85	86	110
Huachipato	(230,000 tons)	84	89	111
Belencito	(250,000 tons)	76	88	108
Monclova	(430,000 tons)	93	84	108
Chimbote	(50,000 tons)	102	86	110
Chimbote	(150,000 tons)	90	86	110
Barcelona	(200,000 tons)	121	82	106
Barcelona	(300,000 tons)	105	82	106
Sparrows Point	(1,000,000 tons)	72		

Cost in Latin-American locations thus falls to the same level, or lower, than the price of imported steel delivered in the respective markets, Belencito being the most favourably placed. The two alternatives considered for Peru show costs higher than imported steel prices, although the margin is slight for the 150 thousand ton plant; but in both cases the cost is still

1/ The Composite Finished Steel Price corresponds to an assortment of products very similar to that considered for the imaginary plants analysed. Apart from additional transport costs, the possibility of the selling price for Latin America being different from that for the United States domestic market has not been considered, nor the existence of additional middlemen's profits.

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The relative importance of steelmaking and steel transforming industries varies considerably from one country to another. The former has existed for some time in Brazil and Mexico, since 1950 in Chile, and is only incipient in Argentina. Among the transforming industries, the primary ones are more developed in Chile and Mexico, and transport equipment industries are more advanced in Argentina, whereas the development of mechanical industries is usually small.

Steelmaking and transforming industries require a larger quantity of labour than the average of all manufacturing industries. For the former, wages and salaries represent about 27 per cent of the value of the products (except in Brazil where the figure is lower), as against raw materials costs representing about 40 per cent thereof.

Labour productivity in the steel sector is, in most Latin-American countries, from a third to a tenth that of the United States. While in the United States it is usually constant for the various sectors of manufacturing activity, and for the different groups of the iron and steel sector, there is a wide range of variations in Latin America.

On an average, the number of persons employed per firm is several times less in Latin America than in the United States. By contrast, the percentage of workers among this personnel is slightly higher in the former.

The ratio between investments and the value added per year is higher in steel producing than in the transforming industries. Among the latter, in turn, primary transformation shows a higher coefficient of investment than secondary transformation.

Steel transforming industries (except foundries) represent 30 per cent of total consumption of ferrous metals in Mexico. In this country, at least two thirds of its raw materials are flat products. This explains how development of steel transforming industries and steel consumption in general is favourably influenced by the existence of flat products rolling facilities.

a) Technical conclusions concerning the fuel problem

According to several papers presented at the meeting, there are abundant unexplored coal deposits in several parts of the Andes Cordillera. Moreover,

/the varying

As many Latin-American countries face import difficulties, processes and blends which improve the coking properties of coals were then reviewed. Effects were studied of using blends of anthracite breeze, coke breeze, sawdust, low-temperature char, asphalt, pitch and tar. Data comparing their behaviour and efficiency were also presented. In addition to blending materials, there was discussion of the influence of different methods of operation of the coke ovens: degree of crushing, compression in the retort, carbonization temperature, etc.

For use in zinc smelting, Argentina is making good metallurgical coke in horizontal ovens, of asphalts or petroleum residues. On the other hand, designs for vertical ovens were presented, in which it is possible to coke blends of coal with up to 30 per cent of such petroleum by-products. There are therefore ways of making coke with blends of coal and petroleum derivatives in any proportion, from coal to pure petroleum. Because of this, in such countries where difficulties (whether technical or due to distances) arose in making metallurgical coke with existing coals, collaboration with the petroleum industry appears to be indicated.

The use of asphalts or petroleum by-products often results in an increased sulphur content of the coke, beyond tolerable limits. In this connexion, interest was aroused by the presentation of a new process for desulphurizing liquid pig iron. 1/ Once desulphurization in the blast furnace becomes unnecessary, use of fewer fluxes and lower operating temperatures are possible, so that the coke rate per ton can be substantially reduced. Moreover, if expectations regarding this process are verified in practice, it will be possible to add to the coking coal reserves, many formations not presently considered as such, due to their high sulphur content.

b) Technical conclusions relating to iron ore reduction

Almost all pig iron made all over the world, is produced in coke blast furnaces. Since the second half of the last century, the process had to a certain extent become stabilized. Productivity was increased and operating costs reduced through the use of ever larger units. Recently, however, a number of improvements have been developed and are becoming widespread: increasing the temperature and pressure of the blast; concentration; sizing and sintering of the ores.

1/ It consists in tapping the blast furnace into a kiln, which can be rotated at great speed. The liquid pig iron exposed in this way to contact with lime, loses its sulphur very efficiently and at low cost.

smelting and refining in steel shops similar to those used for pig iron. The only exception is a new process, by which variable density steels can be produced, permiting the elimination of steel smelting and refining.

The usual characteristics of these processes are: units have much smaller capacities than the blast furnace; investment requirements per unit of production are lower; and greater use is made of labour. They, therefore, seem better suited to the resources available in Latin-American countries, where capital is short, markets are small and there is plenty of cheap labour. Even with high wage rates such as those prevailing in Venezuela, it is cheaper to manufacture pig iron on a small scale, say 100 thousand tons a year — using some of these methods instead of the classic blast furnace. This is due to the fact that in such case, the effect of small-scale operations on blast furnace costs is greater than the additional cost involved in the alternative process by the greater use of expensive labour. A restriction to their use lies in the fact that almost all processes of this type are adapted only to raw materials of specific composition or are suitable for producing steels having special properties, and therefore with limited applications.

In the course of debate it was established that as the ferrous metal made by these processes in large installations had higher costs than those resulting in blast furnaces, the industrialized countries already having blast furnaces will undoubtedly not experiment on a commercial scale with methods known beforehand to be more onerous. On the other hand, the Latin-American countries, with scarcity of capital and few technological and mechanical resources, will naturally hesitate to build plants based on processes which have not previously been tested on an industrial scale in other countries.

c) Conclusions in relation to steel refining

Several papers were presented to the meeting on the subject of comparative costs for installing and operating steel plants having different annual capacities, based on the classic steel refining process: converters, open-hearth or electric furnaces. Through shortage of scrap and non-development of alternative reduction methods, raw material for steelmaking in Latin America consists almost exclusively of liquid pig iron, so that there is justification

/for the