METALLURGICAL COAL UTILIZATION IN BRAZIL

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1 - INTRODUCTION

As a result of the remarkable development of its iron and steel industry, Brazil has now become the world's seventh largest steel producer.

It has been a long way from the construction of its first blast furnace in 1801, in São João de Ipanema, county of Sorocaba, in the state of São Paulo, to the inauguration of Aço Minas Gerais S/A Works, with many different expansion programs having been carried out with the purpose of giving the Brazilian steel industry the necessary competitive power.

The Brazilian steel industry is now made up of 40 steelmaking companies which are mainly located in southeastern Brazil (Fig. 1).

All in all, the steel industry has an installed production capacity of 23 million tons per year distributed according to Fig. 2.

Most of Brazil's pig iron production capacity is found in the coke integrated steelworks belonging to Siderbrás Group, which are responsible for the whole production of flat steel products. The blast furnaces located in 5 large steelworks make this production possible (Fig. 3).

2 - SIDERBRÁS - Siderúrgica Brasileira S.A.

With five large coke steelworks and four smaller ones, of which two of direct reduction, Siderbrás has now become the world's second top steelmaker.

The five coke integrated steelworks are the following:

Companhia Siderúrgica Nacional - CSN

Profile:

Companhia Siderúrgica Nacional-CSN is a mixed government and private ownership corporation founded on April 9, 1941, which belongs to the SIDERBRÁS System since 1973.

The company produces ordinary coated and uncoated flat rolled products as well as rails and heavy structurals.

The activities of the company cover various fields connected to the iron and steel industry, such as the mining of iron ore, fluxes and coal, and the fabrication of steel structures.

The plant, which went into operation in 1946, with a capacity of only 270 thousand t/year of raw steel, is today expanded and modernized. It produced 3 million tons of raw steel in 1983 and will reach in the near future its full capacity of 4.6 million t/year.

The company's pioneer performance in the Brazilian iron and steel sector and its sucessive expansions and modernizations required a vast acquisition and development of know-how. Thanks to this, CSN holds today a privileged position with regard to the sale of technology too.

The quality of the CSN products and services is worldwide acknowledged, thanks to its exports to more than 50 countries.

Description of Main Production Units:

The President Vargas Plant is strategically located in Volta Redonda, a city near the largest industrial centers of the Country, about 100 km NW of the city of Rio de Janeiro.

It is served by an excellent railroad and highway network that links it to its sources of supply and the main ports of the Country.

The company possesses moreover its own fleet of bulk-carriers and railroad wagons.

The plant is an integrated one, with the following main production units:

Coke Plant: 5 coke-oven batteries (198 ovens, 1.9 million t/year);
Sintering Plant: 4 sintering machines (18.7 thousand t/day);
Blast Furnaces: 3 blast furnaces (11.2 thousand t/day);
Oxygen Plant: 3 plants (2.3 thousand t/day);
Steel Plant: 3 LD converters (220 t/heat each);
Casting: 3 two-strand each continuous casting machines; conventional casting equipment;
Blooming Mill: 1 blooming mill (1.5 million t/year);
Hot Rolling-Flat Products: 2 hot-strip mills (4.7 million t/year);
Hot Rolling-Non Flat Products: 1 rolling mill for rails and track accessories, shapes and bars (400 thousand t/year);
Cold Rolling: 3 cold strip mills (1.9 million t/year); supplementary equipment such as continuous and box annealing; coiling lines and temper mills;
Tinning Lines: 4 Electrolytic Tinning lines (640 thousand t/year);
Continuous Galvanizing Lines: 2 lines (320 thousand t/year);

Companhia Siderúrgica Paulista - COSIPA

Profile:

Companhia Siderúrgica Paulista - COSIPA is a company belonging to the Siderbrás Group and was founded on November, 23, 1953. Its plant "José Bonifácio de Andrada e Silva" is located near the Port of Santos and is 60 km away from the city of S. Paulo, the State capital. The Company started operating in 1965 with a production capacity of 500,000 tons of steel per year. At present, COSIPA is constructed on a site of 10.5 million m^2 and its production capacity is 3.7 million tons of steel per year.

Description of Main Production Units:

- 5 batteries of 203 ovens, with a production capacity of 150,000 tons of coke per month; by-products plant; gas treatment including phenol removal; benzol plant and tar plant.
- 3 Sinter Plants with a production capacity of 5.1 million t/year.
- 5 Oxygen Plants with a production capacity of 61,000 Nm^3/hour.
- 2 Blast Furnaces with a production capacity of 3.2 million t/year.
- 2 Steel Plants (6 LD converters) with a production capacity of 3.9 million t/year. 3 continuous casting machines with a capacity of 1.2 million t/year. Desulfurizing station composed of 2 units with a capacity of 4.2 million t/year. Two degassing units of the RH continuous recirculation type with a production capacity of 3,375 t/day. Two calcium silicon injection units with a capacity of 460 thousand t/year.
- Rolling Mills:

Item	Annual Capacity (tons)
Plate Mill	0.9 million
Hot Strip Mill	2.1 million
Cold Strip Mill	1.0 million

- Heat Treatment Furnace of the radiant tube type with a capacity of 120 thousand t/year.

Usinas Siderúrgicas de Minas Gerais S.A. - USIMINAS

Profile:

USIMINAS - Usinas Siderúrgicas de Minas Gerais S.A., a company belonging to the SIDERBRÁS Group, was founded on April 25, 1956. Its

Intendent Câmara Plant is at present the largest producer of uncoated flat products in Brazil. The plant is located in the Municipality of Ipatinga, State of Minas Gerais, in a site with 10.5 million sq.m. It has been through three expansion stages, having reached currently an installed capacity of 3.5 million tons of steel per year. USIMINAS supplies a significant share of the domestic market of uncoated flat products and exports its products to several countries in South America, Europe and to the U.S.A.

Description of Main Production Units:

4 batteries of 210 ovens, with a production capacity of 1,68Mtons per year.

3 blast furnaces (3,1 M tons/year) and 2 steel mills.

Steel Mill I (3 LD converters) produces ingots weighing 11 to 20 tons and Steel Mill II (2 LD converters) produces slabs in 3 two strand continuous casting machines, with sizes varying from 200 to 300 mm thickness, 940 to 1910 mm width and 3600 to 7200 mm length.

Steel Mill I is furthermore equipped with an RH vacuum degassing system.

Slabs: This unit has the following equipment.

6 soaking pit lines, with 19.4 sq.m. each, and a production capacity of 60 t/hour per line. Each line consists of 4 BFG/COG fired furnaces;

1 two-high reversing mill;

1 hot scarfing machine;

1 slab shear;

1 slab cooler,

Cooling bed and storage.

Plates:

The plate rolling mill of Intendent Câmara Plant has a production capacity of 1,200.000 t/year and is equipped with one four-high reversing mill 160" (4100 mm) width.

Hot Rolled Strips:

The capacity of the hot strip mill reaches 2,400,000 t/year.

Cold Rolled Strips:

These products are mainly designed to the automotive, packing and and household appliance industries.

The installations at Intendent Camara Plant comprise still other equipment, such as normalizing, hardening and tempering furnaces, electrolytic cleaning and a HC temper mill.

Companhia Siderúrgica de Tubarão - CST

Profile:

Companhia Siderúrgica de Tubarão - CST, founded on June 11, 1976, is an integrated steelworks designed to produce 3,000,000 metric tons/year (nominal capacity) of steel slabs during its stage I, employing the most advanced technology accumulated over the years by its main shareholders, namely, the Brazilian group led by Siderurgia Brasileira S.A. - SIDERBRÁS (51%), and the Japanese and Italian groups led by Kawasaki Steel Corporation and Societá Finanziaria Siderúrgica Finsider P.AZ (24,5% each), respectively.

CST is situated in the neighbourhood of the city of Vitória (about 500 km northeast of Rio de Janeiro), State of Espírito Santo, Brazil, in a strategic location with an infrastructure of essential services which allows the receiving of raw materials by sea and railroad and the flow of its production through the port of Praia Mole. It went into operation on November 30, 1983.

Description of Main Production Units:

Coke Plant:

The coke is produced in 3 batteries each one with 49 ovens. The production capacity is 1,650,000 t/year.

Sinter Plant:

The Lurgi-type sintering machine has a capacity of 4,856,000 tons/year, and a suction area of 440 m^2.

Blast Furnace:

Blast furnace nº 1 is equipped with 4 regenerators and gas cleaning systems. It has an inner volume of 4415 m^3 and a diameter of 14 m. It is the biggest blast furnace in America and ranks amongst the 10 biggest in the world, with a production capacity of 10,000 tons of pig iron/day (or 3,400,000t/year). There are 16 torpedo cars, with a capacity of 450 tons each, to carry the pig iron to the steel making shop.

Steel Making Shop:

The steel making shop has a production capacity of 3,371,000 tons/year. It is equipped with 2 BOF converters of 280 tons, with an inside volume of 490 m^3 each.

Slabbing Mill:

The slabbing mill (universal type) has an annual production capacity of 3 million tons of finished slabs. There are 30 (140 tons each) soaking-pits.

Aço Minas Gerais S.A. - AÇOMINAS

Profile:

Aço Minas Gerais S.A. - AÇOMINAS, founded on August 18, 1975, is an iron and steel company integrating the SIDERBRÁS GROUP. The plant is located in the Rio-São Paulo-Belo Horizonte triangle and is in the final construction stage, with 91% of the project already completed, up to the billet and bloom mill, and 79% up to the medium section mill and heavy section and rail mill. It went into operation in the second half of 1986. The plant's initial capacity is of 2 million steel t/year but its 10 sq.km layout will permit to reach 10 million t/year.

Description of Main Production Units:

The AÇOMINAS non-flat producers steel mill is integrated and comprises the following principal units:

- Coke Plant with 2 coke-oven batteries with 53 ovens, with an inner volume of 39,48 m^3, including a complete gas primary treatment system. The rated capacity is 1,300,000 tons of coke/year.
- Carbochemical Plant with: a Light Oil Absorption and Distillation Unit producing benzol, toluol and xylol; a Tar Distillation Unit producing pitch, naphthalene, creosote oil and anthracene; a Coke-oven Gas Ammonia Recovery Unit, producing anhydrous ammonia; an Ammonia Recovery Unit from Ammonia Liquor.
- "Dwight Lloyd" Sintering Plant with a 292 sq.m. useful area layer and a rated capacity of 3,495,000 tons of sinter/year.
- Blast Furnace with an inner volume of 2,761 m^3, 11.50 m hearth diameter and a total height of 101 m. The blast furnace is equipped with 28 tuyeres, 3 iron tap holes and 1 slag tap hole. The charging system is "Paul Wurth" (bell-less top).

- Calcination installation with a horizontal rotating furnace with a rated capacity of 600 tons of lime/day and 198,000 tons/year.

- LD Steel Plant with 2,200 t/heat converters, with a rated capacity of 2,000,000 t/year, and a R.H. vacuum degassing equipment. The ingot casting system is conventional.

- Slabbing and Blooming Mill composed of 2 two-high reversing mills and a semi-continuous train with 3 vertical and 3 horizontal stands alternately displayed. The rated capacity is 1,700,000 t/year of finished products (slabs, blooms and billets).

- Heavy Section and Rail Mill, composed of 2 roughing mills, 3 universal mills and 3 edgers, with a rated capacity of 440,000 t/year of finished products (heavy shapes and rails) in stage I and 900,000 t/year finished products (heavy shapes and rails) in stage II.

- Medium section mill composed of 1 two-high reversing mill, 2 two-high non-reversing mills, 1 continuous finishing mill(1 two-high stand, 7 universal stands and 4 tilting stands),with a rated capacity of 710,000 t/year of finished products (medium shapes) in Phase I and 860,000 t/year of finished products in Phase II. The rolling mills have a high degree of automation through a process control system.

With the end of the Group's expansion stage - conclusion of Stage III at Cosipa, CSN and Usiminas - Siderbrás is now taking the necessary steps for the implementation of the Second National Steel Plan, with the object of increasing Brazilian production of crude steel to 40 million tons a year until the beginning of the year 2000.

3 - BRAZILIAN COKE PLANTS DISTINGUISHING CHARACTERISTICS

With a coke production installed capacity of 8.3 million tons per year, absolutely necessary to the consumption of the coke blast furnaces, the Brazilian coke plants have their distinguishing characteristics described in Figure 4.

4 - MAIN CHARACTERISTICS OF THE COKE BLAST FURNACES

Most of the pig iron production capacity is found in the coke integrated steelworks belonging to Siderbrás Group, the results being the product of 10 blast furnaces whose main characteristics are described in Figure 5.

Pig iron production by the coke steelworks of Siderbrás Group reached 12.3 million tons in 1986 with the start-up of the blast furnaces of CST and Açominas in 1983 and 1986, respectively (Fig. 6).

In the same way coke production reached 7.3 million tons in 1986 with the start-up of the coke plants of CST and Açominas in 1983 and 1985, respectively (Fig. 7).

5 - METALLURGICAL COAL IMPORTS

Notwithstanding the large metallurgical coal fields in southern Brazil, it has been necessary to import metallurgical coal, since the utilization of the Brazilian coal has been restricted in favor of a higher productivity of the blast furnaces, having in view the high ash (approx. 17%) and sulphur (approx. 1.6%) content in the Brazilian products.

Until 1974 nearly all the coal necessary to production was imported from the United States; however, due to the strike in the American coal industry, which almost paralyzed the Brazilian coke blast furnaces, Brazil turned to other sources of supply. Nowadays the following countries supply metallurgical coal to Brazil: United States, Canada, Poland, Australia, Colombia, Soviet Union and China. As regards Soviet Union and China, they entered the Brazilian market in 1987, as Cosipa suppliers.

Figure 8 shows Brazil's total metallurgical coal imports from 1982 to 1986. Out of a total of 36.0 Mt, the United States got 20.0 Mt, the largest import share, followed by Poland with 8.8 Mt.

Such a volume of imports is distributed according to Fig. 9 (a,b).

The evolution per source of supply of metallurgical coal imports is shown in Fig. 10 (a, b).

From 1983 to 1986 there was an increase in the amount imported from Australia (67%), USA (61%), Canada (48%) and Poland (40%).

6 - DIVERSIFICATION OF THE IMPORTS PER TYPE OF COAL

Brazilian Metallurgical Coal is of the high-volatile type (32.5% VM), but domestic production is not enough to meet the consumption of high-volatile coal in the mixtures, the reason why Brazil imports metallurgical coal of the high-, low- and medium-volatile types.

As regards the high- and low- volatile coal types, Brazil still depends to a high degree on the American market.

Diversification per type and source of supply is shown in Fig. 11 (a, b, c, d, e) while its evolution is shown in Fig. 12.

As regards the high- and low-volatile coal types, it can be observed that the United States still has a significant share of the Brazilian market, the sources of supply being more diversified when it comes to the medium-volatile type. The tendency is to increase the sources of supply of the high- and low-volatile types.

Supplier's share of the Brazilian market in the different kinds of metallurgical coal is shown in Fig. 13 (a, b, c).

7 - METALLURGICAL COAL CONSUMPTION

Metallurgical coal consumption by the steelworks with coke blast furnaces doubled in the period from 1982 to 1986 due to the start-up of the coke plants of CST and Açominas Works in the years 1983 and 1985, respectively. However, there was practically no change in the consumption of Brazilian metallurgical coal, having in view the same amount mined by the Brazilian companies, with domestic coal participation in terms of percentage being virtually reduced to half.

Evolution in terms of consumption is shown in Fig. 14 (a, b).

The coal imported from the United States still shows the highest rate of consumption (approx. 50%), followed by the Polish (approx. 22%), Canadian (approx. 9%) and Australian (approx. 8%) coals, with the Colombian coal appearing on a smaller scale (approx. 0.3%).

Distribution per country as regards coal consumption in the Brazilian coke plants is shown in Fig 15 (a, b, c).

Every coking coal mix used by Siderbrás Group has the following goals:

- To meet coke specification parameters required by the blast furnaces.
- Lower costs.
- To diversify the sources of supply.

Having in view the above-mentioned goals and the fact that Brazilian coal production did not meet the demand favoring a lower coke ash content, there was a progressive decrease in the consumption of low-volatile coal, but even so it was possible to attain higher coke quality rates in the last years.

Reduction in consumption of low-volatile and domestic coal was counterbalanced by a subsequent increase in consumption of medium-volatile coal (Fig. 16).

8 - COAL SELECTION

The companies of Siderbrás Group use mathematical models to select the types of coal best suited to cost minimization based on the following: quality x diversification x market.

Each company has its own equations in the model in order to predict the parameters of coke quality, such equations being obtained by means of operating tests and analysis of the results observed in the company's equipment.

The companies have different parameters of coke quality having in view the differences among their blast furnaces; thus coal selection is something peculiar to each company since besides variation of parameters of coke quality there are also many differences among the coke plants.

Notwithstanding the peculiarities of each company, coal selection follows Siderbrás guidelines on the subject.

9 - COAL EVALUATION

Coal is evaluated by each company, each one of them with its own model, according to its operating conditions; however, all the companies of Siderbrás Group take the following parameters into account: price, transportation, source of supply, immediate analysis, chemical analysis of the ash content, dilatometry, formability, petrographic analysis, coking power, granulometric analysis and diversification policy.

Having met the above-mentioned parameters, the previously selected coal is integrated to the other types of coal used by the company, being then analysed, not on an individual basis, but as regards its competitive power in relation to the other types of coal utilized by the company.

After technical-economic (theoretical) approval samples are required for the undertaking of coking furnace tests on a pilot and/or industrial scale.

10 - ANALYSIS OF THE COAL RECEIVED

The coal received by the companies is analysed in laboratories owned by the companies, including issuing of the respective analysis certificate. The following analyses are made: ash, sulphur, volatile matter, moisture, FSI, fluidity, expansion, petrographic and macerating analysis, granulometry and chemical analysis of the ash content.

These results are followed in every shipping so that one can better analyse the performance and periodic deviations of the analysis.

11 - CONTROL PARAMETERS OF THE PRODUCTION COKE

With the object of meeting the coke specifications required by the blast furnaces and of detecting possible deviations from quality, the companies employ process and product control systems in their quality control and production units.

As control parameters of the production coke one should mention the following: ash, sulphur, granulometry, moisture, cold mechanical resistance (Drum Index). Some companies have introduced tests of coke strength after reaction and coke reactivity index.

12 - CONCLUSION

Siderbrás has invested a considerable amount of money to increase its installed capacity, through the purchase of equipment and technology in order to follow the developments of the Iron and Steel Industry.

Presently, coal represents the largest item of Siderbrás costs, aggravated by the Brazilian coking coal, wich is not sufficient and has a high ash content.

Natural gas and coal's fine injection through the tuyeres are two technologies that are being employed to reduce coke consumption in Blast Furnaces by CSN and USIMINAS respectively.

Finally, Siderbrás policy of flexible diversification of coal sources is heavily influenced by the delivered cost of coal. Coal is evaluated in terms of physical, chemical and petrographic analysis.

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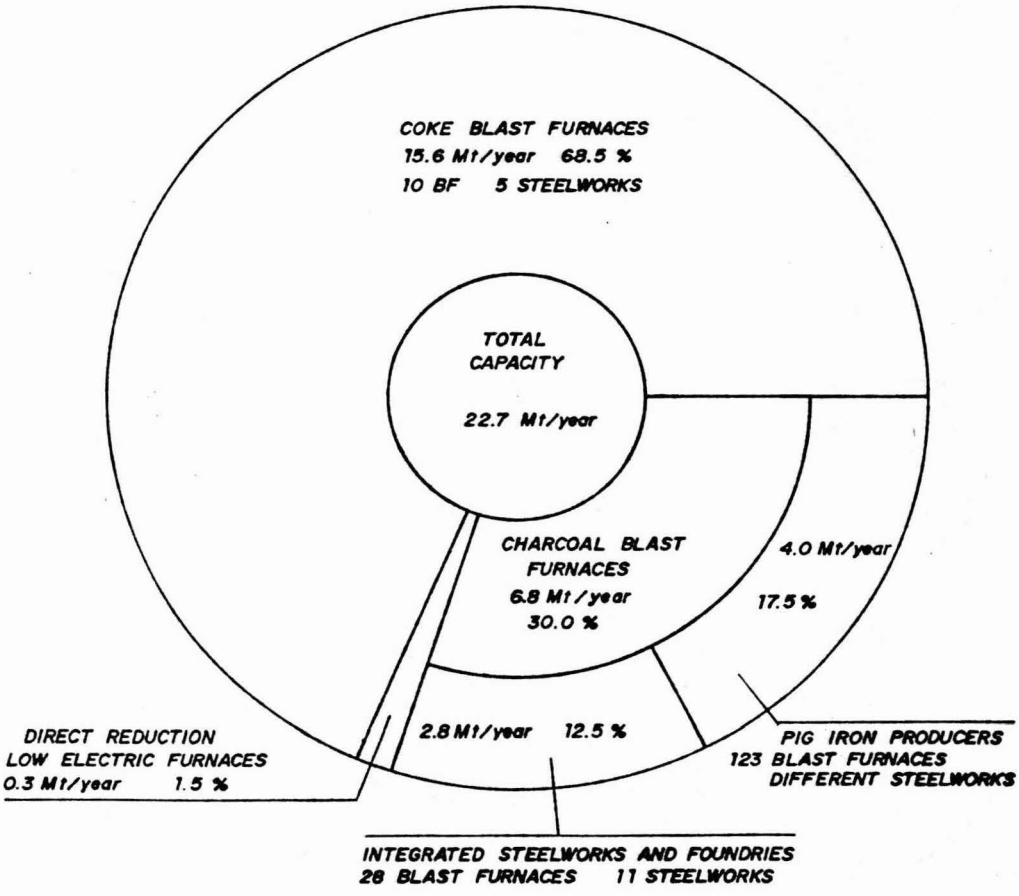
(2) Júnior, Amaro Lanari - Brazilian Iron and Steel Industry, ABM, vol 42, nº 348, Nov 86, 808-831.

(3) Monteiro, Mário Raimundo - Coking Coal, the Brazilian Growth Demand, Siderbrás, Brazil, Jun 86.

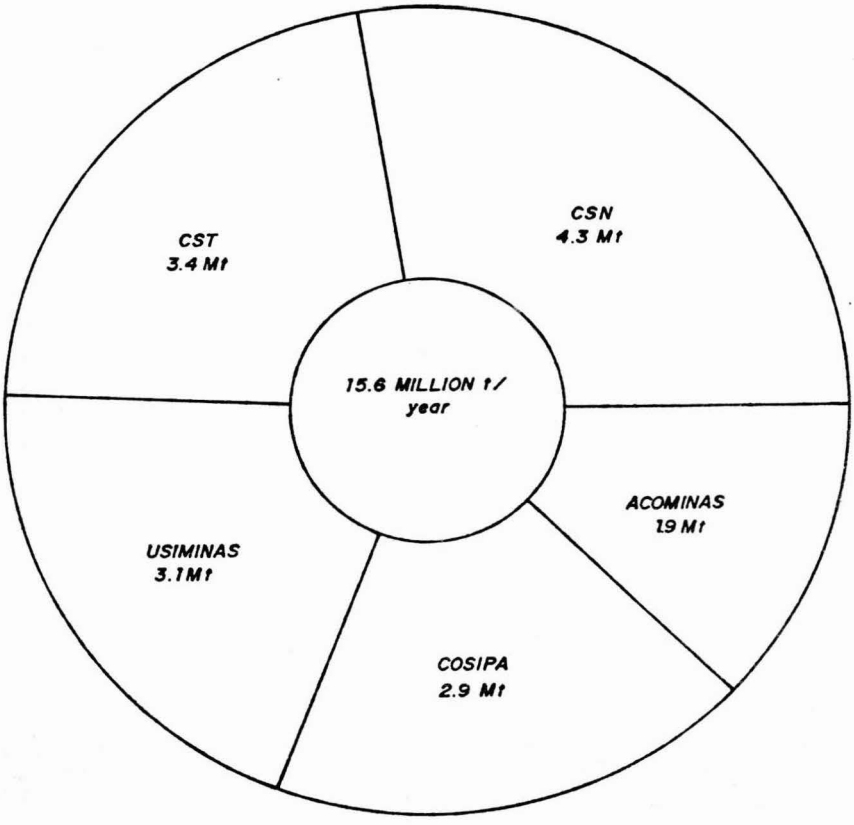
SOURCE: ABM, VOL 43, Nº 351 - FEB/87

FIG: 1 - LOCATION OF THE BRAZILIAN STEEL COMPANIES.



SOURCE: ABM, VOL 43, Nº 351 - FEB/87

FIG: 2 - BRAZILIAN PRIMARY IRON PRODUCTION CAPACITY



SOURCE: ABM, VOL 43, Nº 351 - FEB/87

FIG:3 - PIG IRON PRODUCTION CAPACITY OF THE COKE INTEGRATED STEELWORKS.

COMPANY	Nº	TYPE	START UP	CAPACITY 1000t/y	OVEN NUMBERS	LENGTH m	HEIGHT m	WIDTH mm	VOLUME m^3
CSN	1	Underjet	1946*	350	55	12.33	4.5	438	23.0
	2	Underjet	1953/61	440	68	12.33	4.5	438	23.0
	3	Underjet M	1976	470	45	14.90	6.0	450	38,0
	4	Underjet M	1980	630	60	14.90	6.0	450	38.0
	5	Underjet M	1983	630	45	14.90	6.0	450	38.0
COSIPA	1,2	Underjet	1965	380	62	13.48	4.1	450	22.0
	3	Underjet	1973	215	35	13.48	4.1	450	22.0
	4	Underjet	1976	600	53	15.56	6.2	430	37.4
	5	Underjet	1983	600	53	15.56	6.2	430	37.4
USIMINAS	1,2	Gun-Flue	1962	300	50	13.20	4.0	400	18.35
		Underjet	1965	300	50	13.20	4.0	400	18.35
	3	Underjet M	1975	540	55	15.70	6.0	450	37.6
	4	Underjet M	1979	540	55	15.70	6.0	450	37.6
CST	1,2	Carl Still	1983	1100	98	16.00	6.5	420	39.5
	3	Carl Still	1985	550	49	16.00	6.5	420	39.5
AÇOMINAS	1,2	Underjet	1985	1300	106	14.61	6.2	457	39.8

SOURCE: ABM, VOL 43, Nº 351 - FEB/87

Fig. 4 - Main Characteristics of Brazilian Coke Batteries

* Out of operation in 1985

SOURCE: ABM, VOL 43, Nº 351 - FEB/87

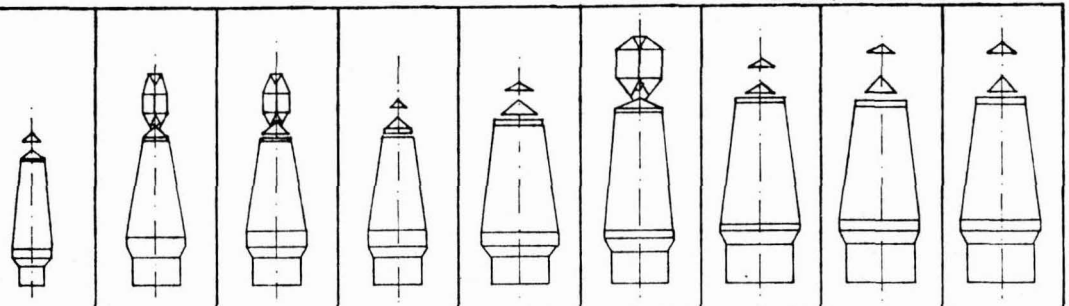
Characteristics									
Company	USIMINAS	CSN	CSN	COSIPA	USIMINAS	AÇOMINAS	COSIPA	CSN	CST
Blast Furnace No.	1 e 2	1	2	1	3	1	2	3	1
Crucible Diameter (m)	7.00	8.38	8.53	9.8	11.5	11.5	12.4	13.0	14.0
Inner Volume (m^3)	885	1335	1556	1829	2700	2761	3180	3815	4415
Number of Tuyeres	16	20	18	24	28	28	33	34	38
Annual Capacity(1000t/year)	630	750	850	1130	1850	1850	2100	2650	3400
Start-up	1962/65	1965	1954	1965	1974	1986	1976	1976	1983
Campaign	4ª 3ª	7ª	4ª	4ª	2ª	1ª	2ª	2ª	1ª
Last Campaign	1982/1984	1984	1982	1987	1980	1986	1982	1985	1983

Fig. 5 - Main Characteristics of the Brazilian Coke Blast Furnaces

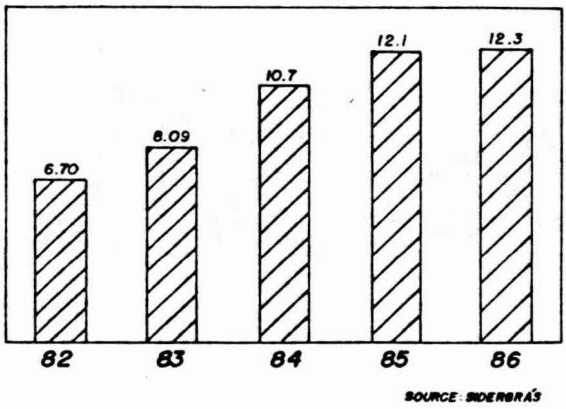


FIG: 6 - PIG IRON PRODUCTION IN Mt/YEAR.

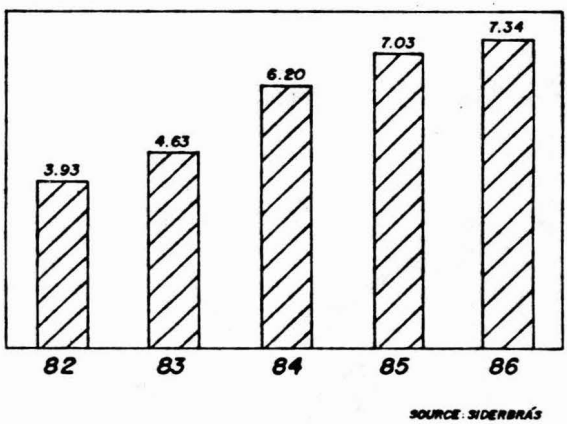
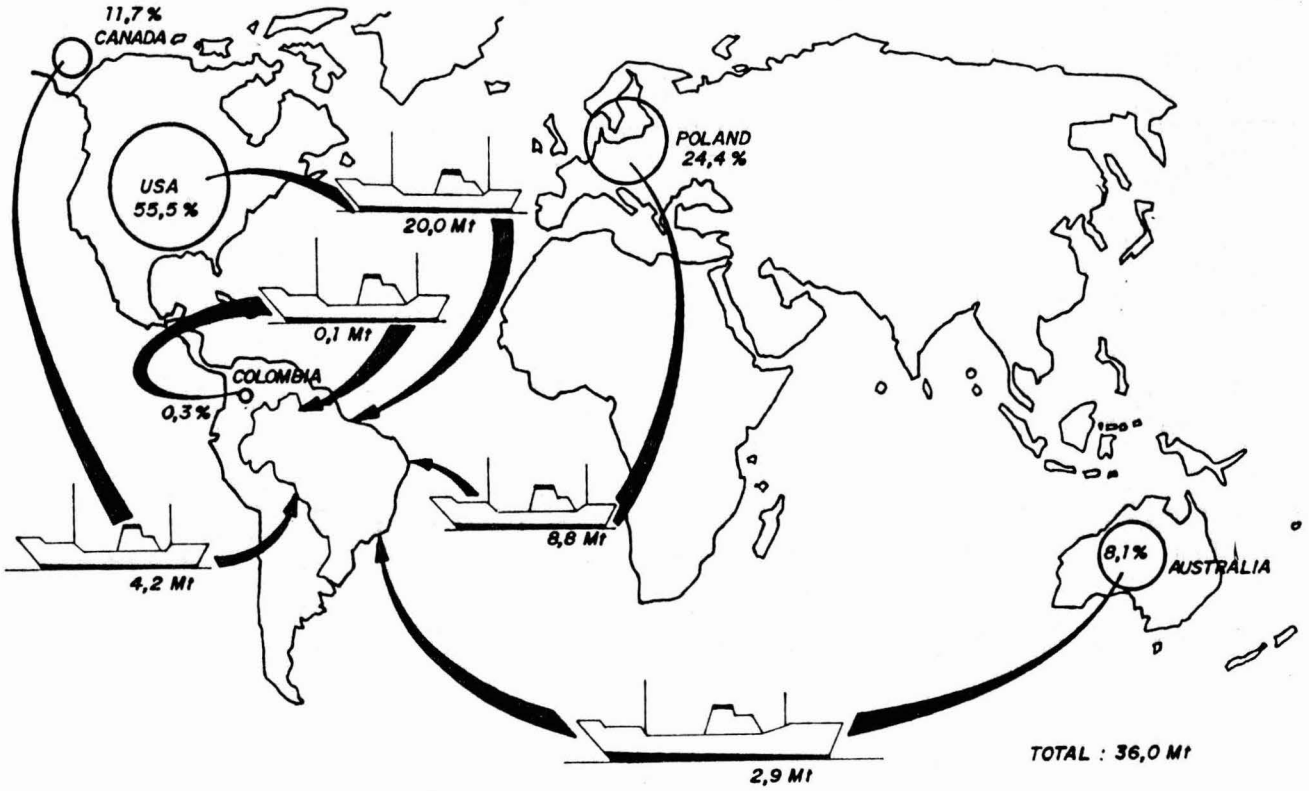


FIG: 7 - RAW COKE PRODUCTION IN Mt/YEAR. (DRY BASIS)



SOURCE: ABM, VOL 43, Nº 351 - FEB/87 AND SIDERBRÁS

FIG: 8 - BRAZILIAN IMPORTS OF COKING COAL FROM 1982 TO 1986

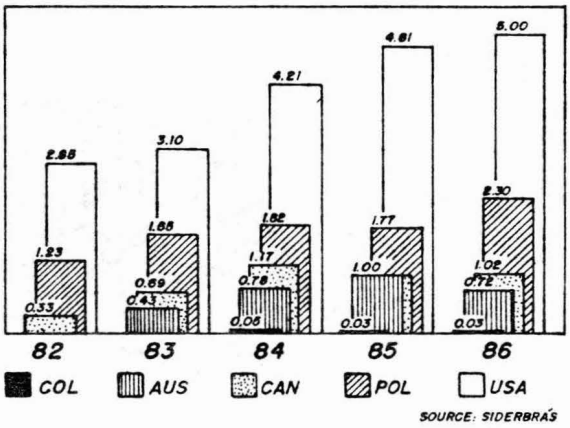


FIG: 9a - THE AMOUNT RECEIVED OF METALLURGICAL COAL IMPORTED FROM 1982 TO 1986 - AS RECEIVED IN Mt/YEAR.

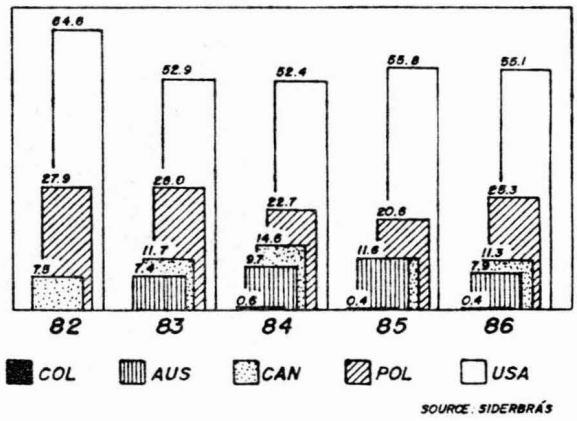


FIG: 9b - THE AMOUNT RECEIVED OF METALLURGICAL COAL IMPORTED FROM 1982 TO 1986 - AS RECEIVED IN % / YEAR.

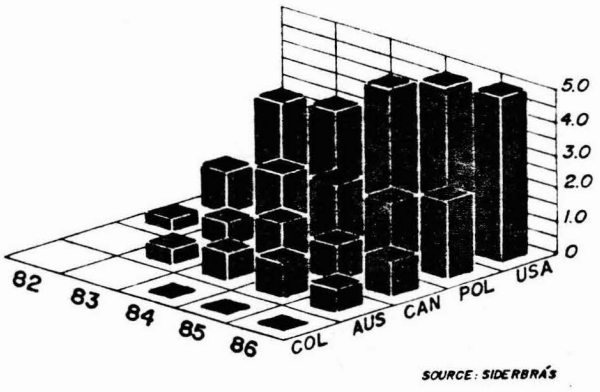


FIG: 10a - EVOLUTION OF METALLURGICAL COAL IMPORTS IN Mt/YEAR (AS RECEIVED)

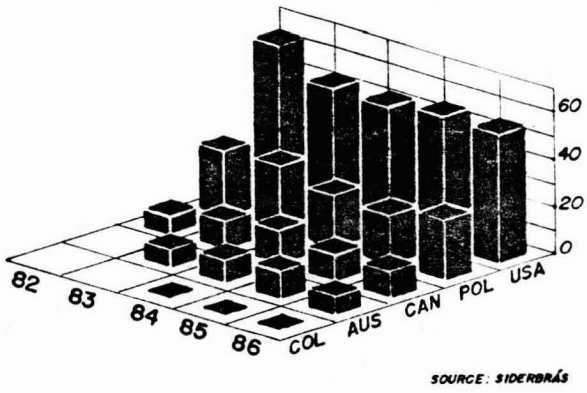
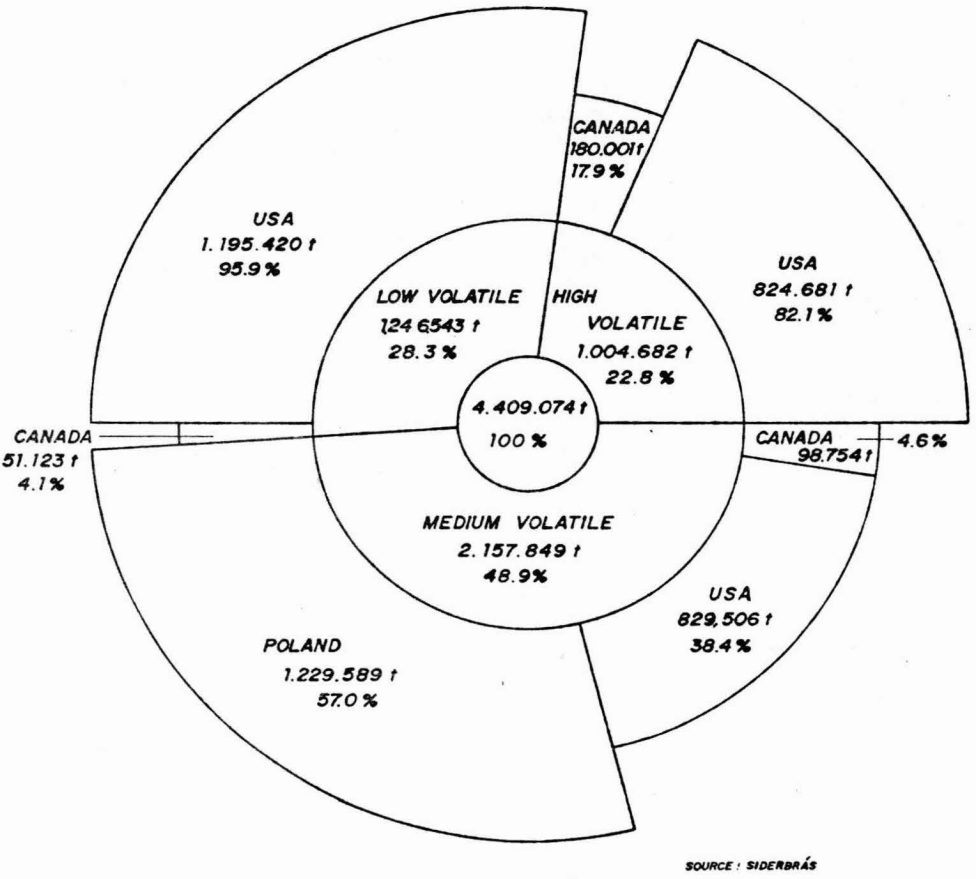
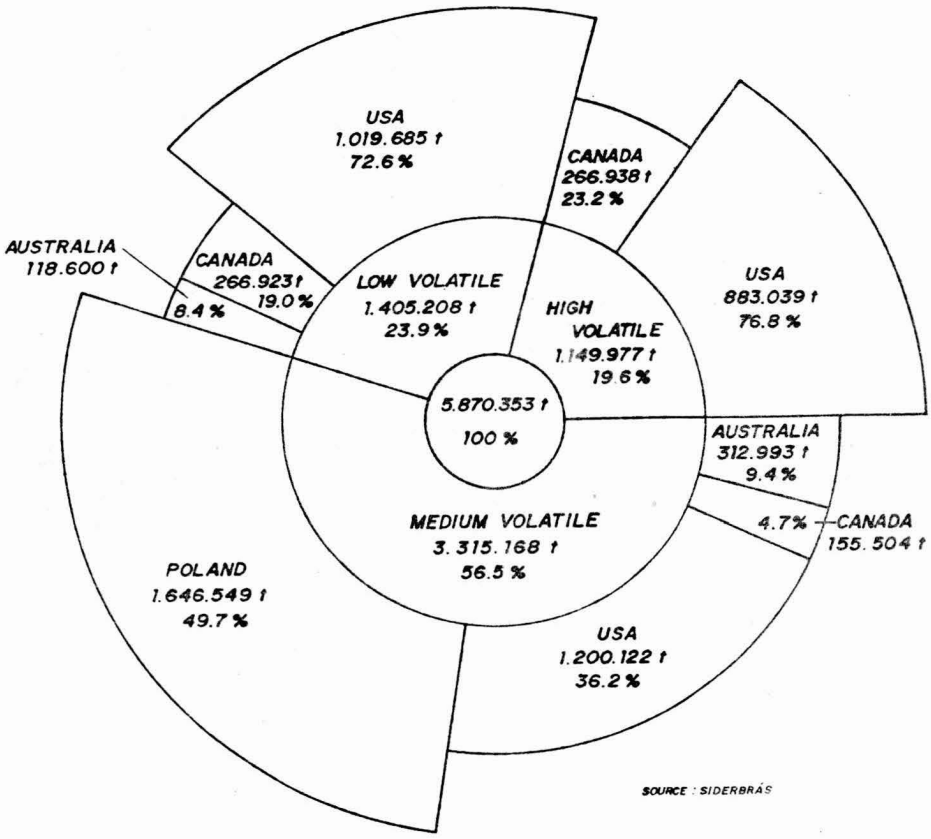


FIG: 10b - EVOLUTION OF METALLURGICAL COAL IMPORTS IN % / YEAR (AS RECEIVED)

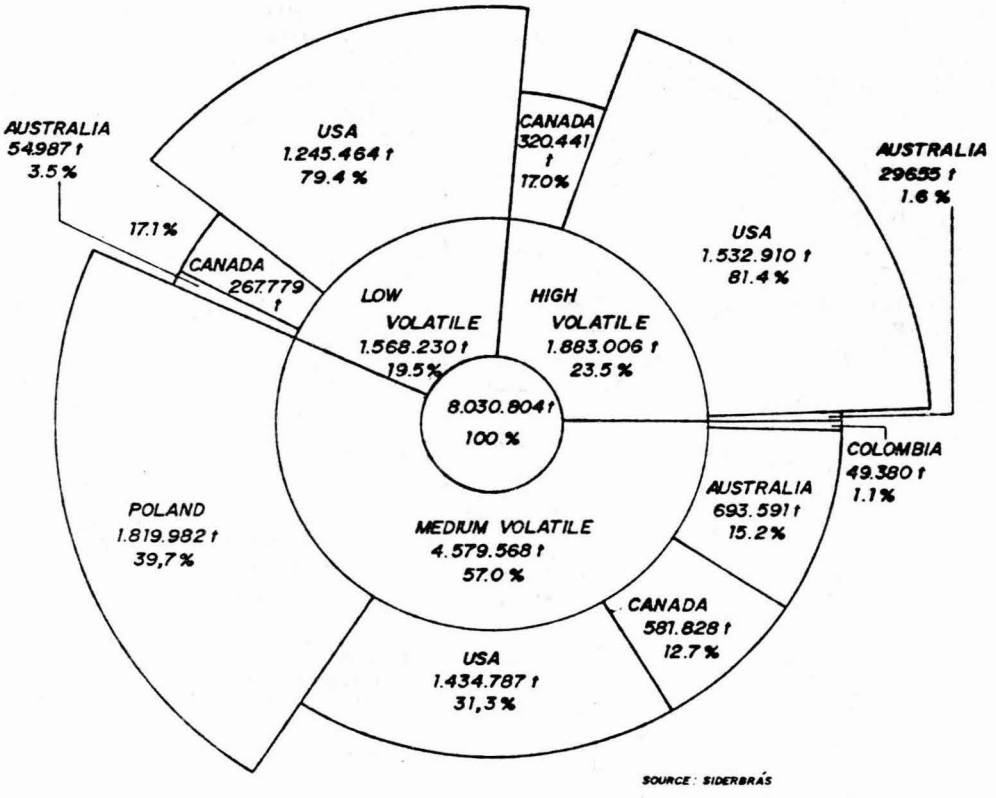


A - 1982

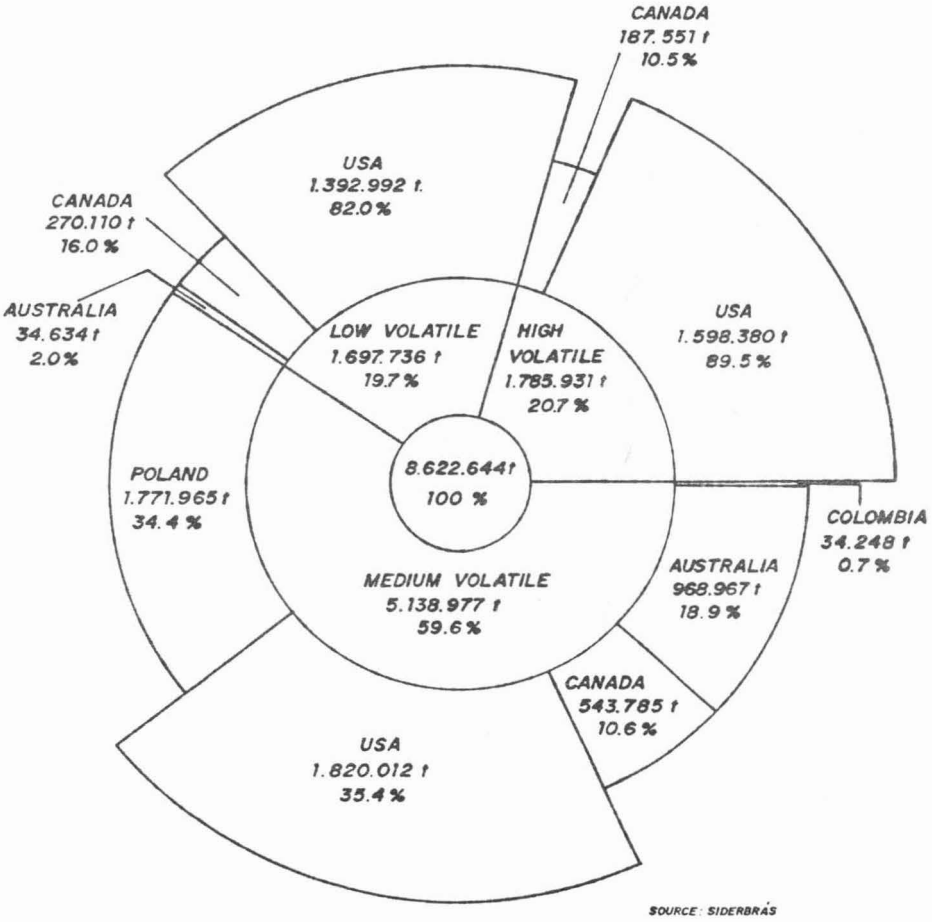
FIG: 11 - THE AMOUNT RECEIVED OF COAL IMPORTED (AS RECEIVED) IN:
A - 1982 B - 1983 C - 1984 D - 1985 E - 1986


USA
1.019.685 t
72.6 %
CANADA
266.938 t
23.2 %
AUSTRALIA
118.600 t
8.4 %
CANADA
266.923 t
19.0 %
LOW VOLATILE
1.405.208 t
23.9 %
HIGH
VOLATILE
1.149.977 t
19.6 %
USA
883.039 t
76.8 %
5.870.353 t
100 %
AUSTRALIA
312.993 t
9.4 %
4.7% CANADA
155.504 t
MEDIUM VOLATILE
3.315.168 t
56.5 %
POLAND
1.646.549 t
49.7 %
USA
1.200.122 t
36.2 %
SOURCE : SIDERBRÁS

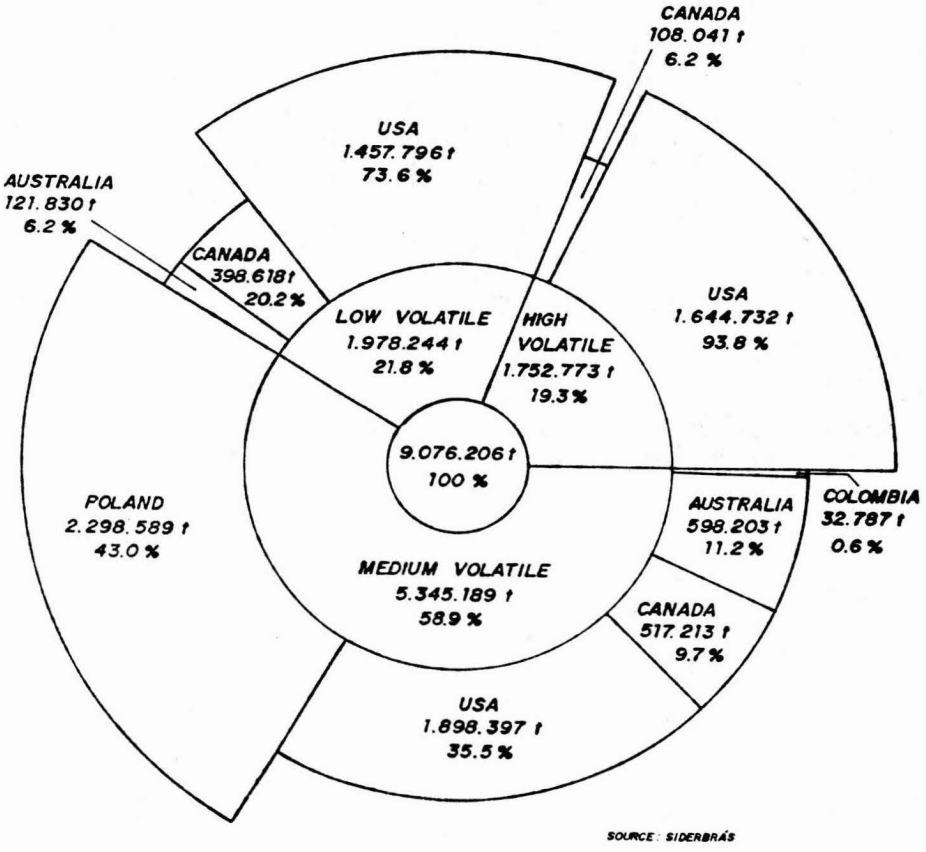
B - 1983


AUSTRALIA
54.987 t
3.5 %
17.1 %
CANADA
267.779
t
USA
1.245.464 t
79.4 %
CANADA
320.441
t
17.0%
AUSTRALIA
29655 t
1.6 %
USA
1.532.910 t
81.4 %
LOW
VOLATILE
1.568.230 t
19.5%
HIGH
VOLATILE
1.883.006 t
23.5 %
8.030.804 t
100 %
COLOMBIA
49.380 t
1.1%
AUSTRALIA
693.591 t
15.2%
POLAND
1.819.982 t
39,7%
MEDIUM VOLATILE
4.579.568 t
57.0 %
CANADA
581.828 t
12.7 %
USA
1.434.787 t
31,3 %
SOURCE : SIDERBRÁS

C - 1984


CANADA
187.551 t
10.5%
USA
1.392.992 t.
82.0%
CANADA
270.110 t
16.0%
AUSTRÁLIA
34.634 t
2.0%
LOW VOLATILE
1.697.736 t
19.7%
HIGH
VOLATILE
1.785.931 t
20.7%
USA
1.598.380 t
89.5%
8.622.644t
100 %
POLAND
1.771.965 t
34.4%
COLOMBIA
34.248 t
0.7%
AUSTRALIA
968.967 t
18.9%
MEDIUM VOLATILE
5.138.977 t
59.6%
CANADA
543.785 t
10.6%
USA
1.820.012 t
35.4%
SOURCE: SIDERBRÁS

D - 1985


CANADA
108.041 t
6.2 %
USA
1.457.796 t
73.6 %
AUSTRALIA
121.830 t
6.2 %
CANADA
398.618 t
20.2 %
LOW VOLATILE
1.978.244 t
21.8 %
HIGH
VOLATILE
1.752.773 t
19.3 %
USA
1.644.732 t
93.8 %
9.076.206 t
100 %
POLAND
2.298.589 t
43.0 %
AUSTRALIA
598.203 t
11.2 %
COLOMBIA
32.787 t
0.6 %
MEDIUM VOLATILE
5.345.189 t
58.9 %
CANADA
517.213 t
9.7 %
USA
1.898.397 t
35.5 %
SOURCE : SIDERBRÁS

E – 1986

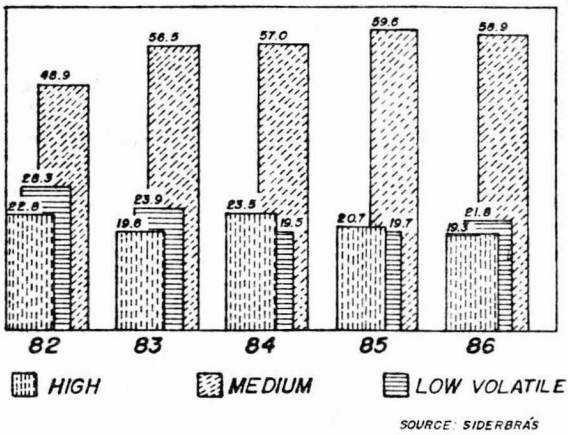


FIG: 12 - EVOLUTION OF METALLURGICAL COAL IMPORTED PER TYPE — AS RECEIVED IN % / YEAR.

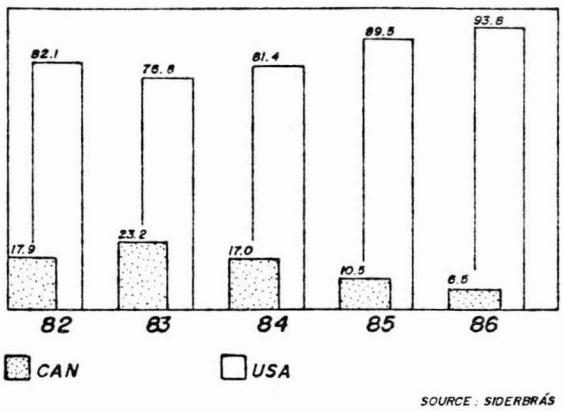


FIG: 13a - EVOLUTION OF THE DISTRIBUTION OF METALLURGICAL COAL IMPORTED PER TYPE AND SOURCE OF SUPPLY — AS RECEIVED — HIGH VOLATILE IN % / YEAR.

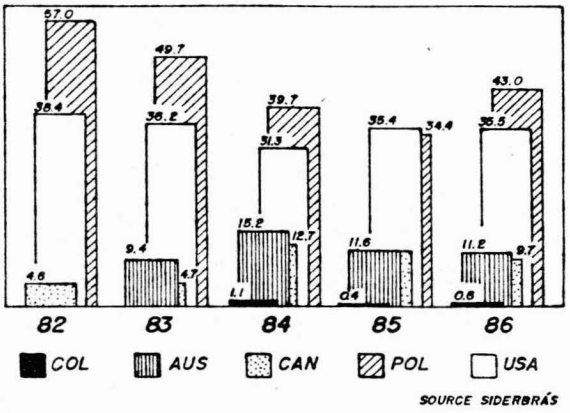


FIG. 13b - EVOLUTION OF THE DISTRIBUTION OF METALLURGICAL COAL IMPORTED PER TYPE AND SOURCE OF SUPPLY - AS RECEIVED MEDIUM VOLATILE IN %/YEAR.

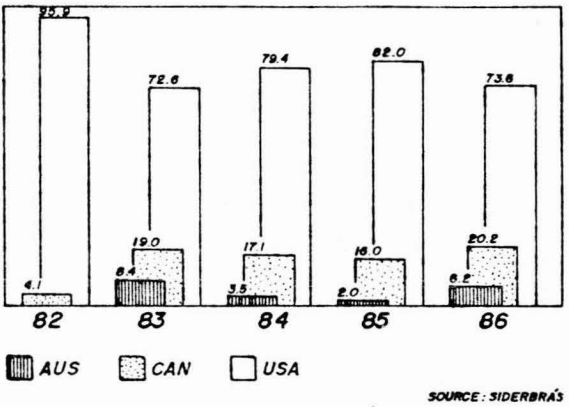


FIG. 13c - EVOLUTION OF THE DISTRIBUTION OF METALLURGICAL COAL IMPORTED PER TYPE AND SOURCE OF SUPPLY - AS RECEIVED LOW VOLATILE IN %/YEAR.

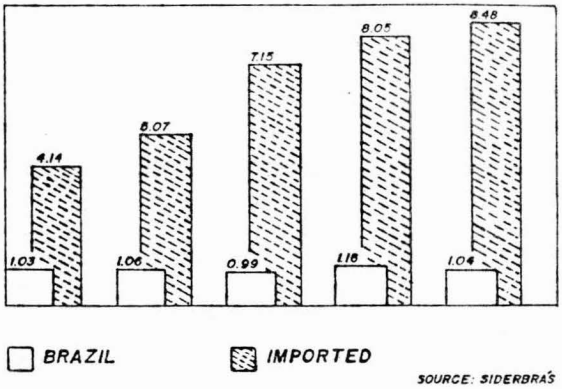


FIG. 14a – METALLURGICAL COAL CONSUMPTION (DRY BASIS) – IN Mt/YEAR.

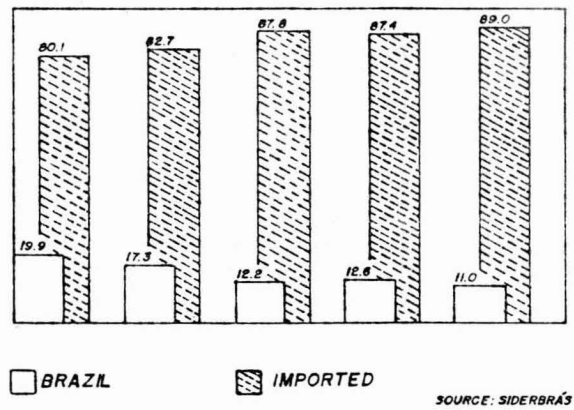


FIG. 14b – METALLURGICAL COAL CONSUMPTION (DRY BASIS) – IN %/YEAR.

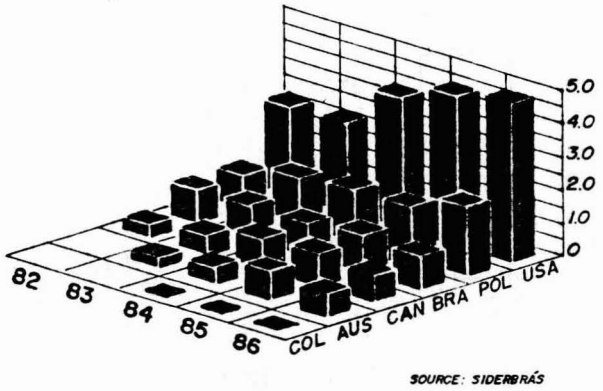


FIG: 15a - METALLURGICAL COAL CONSUMPTION PER COUNTRY (DRY BASIS) IN Mt/YEAR.

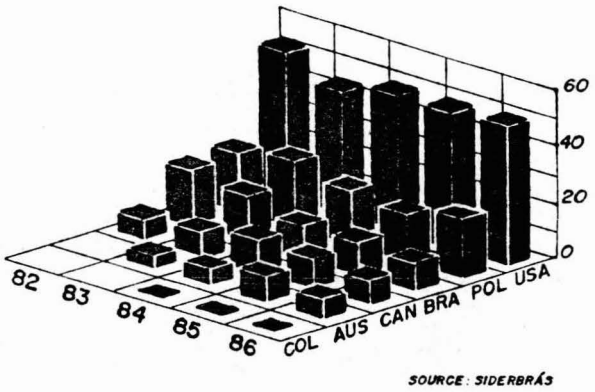


FIG: 15b - METALLURGICAL COAL CONSUMPTION PER COUNTRY (DRY BASIS) IN % /YEAR.

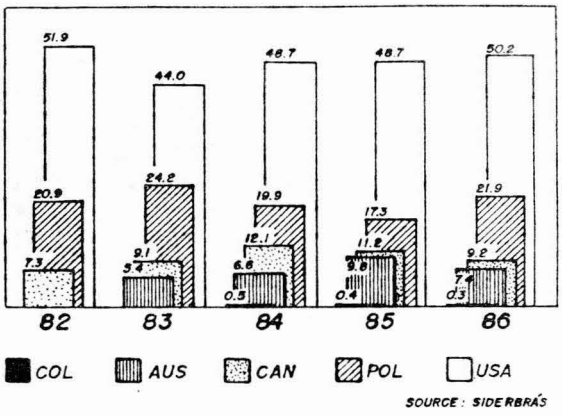


FIG. 15c - METALLURGICAL COAL CONSUMPTION PER COUNTRY (DRY BASIS) IN % / YEAR.

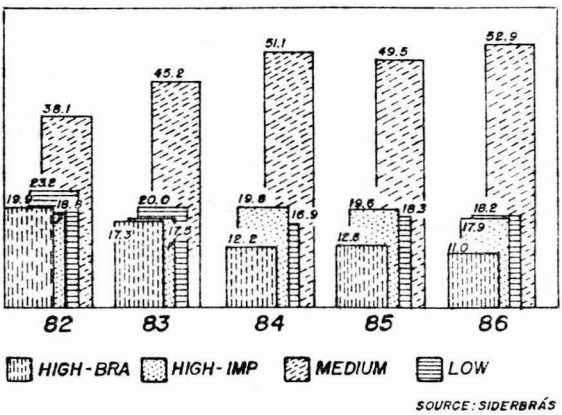


FIG. 16 - CONSUMPTION PER TYPE IN BLEND - DRY BASIS - IN % / YEAR.