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AVAILABILITY, COLLECTION, AND PREPARATION OF SCRAP IN DEVELOPING COUNTRIES[1/]

by

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SUMMARY

The paper provides a classification of the types of scrap originating in a given country and outlines the importance of this type of raw material for the iron and steel industry.

It goes on to describe the factors influencing the generation of the internal, industrial, and capital scrap. The study by the European Economic Commission published in 1973 is drawn upon for additional data.

A Brazilian methodology for estimating the generation of scrap is described in detail.

An outline of the methods of scrap recovery and marketing is presented.

More details are provided on the Brazilian situation regarding scrap generation and consumption at the present time and in the future. The paper concludes that for the developing countries the problems of scrap collection, marketing, and utilization are very important and need to be examined thoroughly with a view to better utilisation of this raw material.

1. Introduction

Steel scrap is normally defined as the residue of steel arising from industrial processes, including those of steel production, and goods and products containing steel which are no longer in use. It is therefore the residue from various industrial activities on the one hand and fabricated steel which has reached the end of its usefulness on the other.

As such, scrap is neither a fabricated product nor does it derive from a natural resource exploited at a specific site; it is something which is spontaneously generated, normally in places where civilization has arrived.

The volume of scrap available depends in particular on the degree of development, the population, the level of wealth, and the industrial capacity of a country.

2. Classification

In terms of the form of generation, scrap is classified in three groups according to its origin:

a) Internal or circulating scrap - the scrap is generated in steel plants, from normal losses during the transformation of liquid steel into ingots and from ingots into finished products.

b) Process, industrial or transformation scrap - scrap generated in the mechanical transforming industries in the production process of finished goods.

c) Capital, recovering, or obsolete scrap - scrap resulting from steel products reaching the end of their useful life.

Internal scrap is normally not sold commercially and is used in the plants that generate it. It is the best quality of scrap, as it has known characteristics and is completely clean. Its classification is easy, and it usually represents an average of 15 - 20% of the total ingots production.

Transformation scrap is also easy to obtain as it represents a specific proportion of the consumption of rolled products, usually 6 - 16%. Its location is also easy when the regional and sectorial distribution of consumption is known. Normally this scrap is utilized in its entirety as soon as it becomes available and it is generally obtained directly by the plants alongside the large industrial scrap-generators or through the network of scrap traders.

Estimating the availability of obsolete scrap is problematical and it is practically impossible to locate it, since it is extremely dispersed. Estimations of its availability are generally inferred and vary normally from country to country, as a function of economic and social parameters.

3. The importance of scrap in the iron and steel industry

Scrap is the best raw material for steel production because its utilisation requires only remelting and refining operations.

The survey undertaken by the European Economic Commission at the end of 1969 showed that in the previous year world consumption of scrap was about 320 million tons, corresponding to about 44% of the metallic load utilized in steel furnaces in the world total steel production of 720 million tons.

Since it is a spontaneously generated product as residue from economic activity, scrap sometimes presents paradoxical aspects, representing normally an input into the iron and steel industry, which is highly critical and sensitive to variation of market conditions and to private and governmental policies.

While the generation of scrap in a country is in near-equilibrium with the consumption, its market tends to be stable independently of the variations in other countries and in the international market.

An exaggeratedly high scrap consumption upsets the equilibrium with the generation, normally increasing the price of scrap to disproportionate values, ocmpelling countries to import when there is no control of prices and consumption.

On the other hand, an exaggeratedly low consumption also tends to upset the equilibrium, depressing the price with the risk of creating environmental production problems.

In such situations the best policy to be adopted, especially in the developing countries, should be to maintain the iron and steel industry that is dependent on scrap at levels near to the level of scrap generation, making maximum use of the scrap generated in the country without, however, reaching the stage of depending on imports.

It is therefore important for the good planning of a country's iron and steel industry that as thorough as possible a market analysis should be undertaken periodically.

4. Factors influencing the generation of scrap

The generation of scrap in a country or region depends on various factors directly related to its level of development, and it increases as the country develops.

a) Internal generation

The generation in the iron and steel works itself, resulting from losses during the transformation of steel, varies according to different parameters, such as the type of product, the production process, and quality control.

The rolling of flat products generates more scrap than the rolling of non-flat products, and the average of scrap generation increases with the degree of value and finishing of the product. Thus, the higher the technological content of the product, the larger is the volume of scrap, and it can be stated as a general rule that the products which generate the most scrap are special flat products followed by coated flats, non-coated flats, seamless tubes, special non-flat rails and heavy sections, rods, wire rods, and bars.

In a developing country, iron and steel production normally begins with bars and then follows more or less the reverse of the order indicated above up to the production of coated sheets and of special steels, implying heavy generation of scrap at higher stages of development.

Quality control influences the generation of scrap according to the severity of the specifications of required steels: as tolerances are reduced, large quantities of rolled products deviate from the specification and are scrapped. In this case, too, the amount of scrapping increases with the degree of development and sophistication of the consuming industries, whilst lower technological-content rolled products, such as bars, are less subject to controls on quality and are frequently accepted by the consumers with gross fabricating defects.

Conversely, owing to the use of more modern equipment and better developed technologies, the amount of process scrap normally decreases as the iron and steel industry develops.

Normally light ordinary-grade sections and bars can be produced on discontinuous mills with a low level of mechanisation, whereas the manufacturing of flat products requires heavy equipment that is continuous and automatic, generally uneconomic in small plants. The modern process of continuous casting, which is spreading widely in the world, makes possible for all products an effective increase in yield, reducing the generation of scrap by 7 - 10% in relation to the conventional casting process.

This means that the generation of scrap in the steel plants themselves tends on the one hand, to grow with the country's economic evolution through the greater sophistication of products, and on the other hand, to be reduced by improvements in production techniques, especially the utilisation of the continuous casting process.

b) Industrial scrap

The study published in 1971 by the Economic Commission for Europe 1/ has shown that the generation of process scrap varies according to the industrial sector, and gives the following figures for the United States:

- Building construction - 3%
- Extractive and petroleum industries - 3%
- Automobile industry - 31%

1/ Problèmes Relatifs à la Ferraille de Fonte et d'Acier - Nations Unies - 1971 (ST/ECE/STEEL/33)

- Shipbuilding - [illegible]%
- Engineering industry - 26%
- Agriculture machinery - 19%
- Appliances, tools, and cutlery - 17%
- Domestic equipment and tools - 15%
- Containers - 12%

The same study has shown the following figures relating to the French industry:

- Automobiles - 27.5%
- Gear wheels - 29%
- Machine tools - 27%
- Rough machining - 24.5%
- Agriculture machinery, electric machinery - 25%
- Agriculture tractors, forging plants, printing shops - 24%
- Cylinder grinding, crankshafts - 23%
- Motor parts, compressors - 20%
- Non-electrical machining - 16%
- Locomotives - 12%
- Welded tubes - 9%
- Wire drawing, timming - 7%
- Constructional engineering - 6%

From the above data it can be seen that the percentage of scrap arising from industry increases in accordance with the degree of sophistication and the complexity of the processes. The rate of scrapping of flat products is, on the other hand, larger than that of non-flat products, and this results in heavy generation of scrap in those industries which are large consumers of flat products.

The above-mentioned study has shown that industrial scrapping varies according to the country's industrialisation index in the order of 6 - 16%; it is larger in the countries with developed industries, especially those with automobile industries.

A study undertaken in Brazil in 1963, based on detailed studies in various consuming sectors, showed that for this country in that year the scrapping of flat products reached 17%, whilst that for non-flat products reached only 7%, with a total average of 11%, in perfect agreement with the study undertaken by the EEC, as Brazil is in an intermediate stage of industrialization.

It should, however, be observed that the generation of industrial scrap in a country is a function of its level of industrialization, being larger the more developed the country.

c) Capital scrap

Capital scrap is the scrap resulting from steel products that have gone out of use, ranging from goods of minimal duration such as cans, which become scrap immediately after a single utilization, during a very short cycle, to fixed industrial equipment which remains in operation for periods of 50 years and more.

Assessment of the quantity of capital scrap in a country is extremely difficult, if not impossible, since it is a function of a very wide range of factors, among them the level of income, population, labour cost, etc. It is interesting to mention that a country with a large population consumes more steel products than a country with a smaller population, even if it has a lower per capita income, so that capital scrap is related more to the total income than to the per capita income.

The obsolescence of a steel fabrication, and consequently the end of its usefulness and scrapping, depends on the average time of utilisation, which is a function fundamentally of the income level of the user and of the utilisation of the object itself.

Economic studies of various kinds with different aims usually fix the average utilisation time of steel products at 15 - 25 years in relation to the country's income, assuming that they are instantaneously withdrawn from use. It is obvious that such an approach is also oversimplified since it assumes the instantaneous occurrence of phenomena which are in fact distributed over a very long period.

In Brazil a tentative method of overcoming this difficulty originated from the above-mentioned simplification through the use of a methodology known as "Progessive Five-Year Scrapping", based on statistical considerations.

The methodology consists in estimating, for the total of steel fabrications in use over a period of 5 years, their progressive scrapping rates during this quinquennium and over the following 15 years.

Using this method, it is assumed that of the total of steel used, a part is completely lost, while the scrapping of the balance considered to be recovered as scrap occurs in accordance at the frequency indicated below, where n is the 5-year period from starting to use the steel fabrication and p is the recovered percentage of scrap in each quinquennium.

Period	Recoverable percentage (p)
n	2
n + n	8
n + 2n	10
n + 3n	10
n + 4n	20
n + 5n	25
n + 6n	15
n + 7n	5
out of period	5

As can be observed, according to this method the scrapping of 50% of the material takes place during the first 25 years, 25% between 25 and 30 years, and 25% after 30 years. This quinquennial series is appropriate to Brazilian conditions, taking into account the index of steel consumption, the per capita income, and the level of development. Clearly, countries more developed than Brasil would have shorter series, whilst the less developed would have longer series.

The recoverable part of scrap is, on the other hand, a function of conditions relative to the country itself, among them the territorial extent of the country considering local distances between scrap generating and consuming centres, and in particular the relative lack of this raw material, which will or will not justify higher costs for scrap recovery.

In Brazil it is assumed that 70% of the total steel in use is recovered, bearing in mind that, despite the long distances, the present lack of scrap, and the low cost of manpower, such a high rate of recovery is justified. It seems that in the United States, where the conditions are totally different, the proportion assumed as recoverable does not exceed 35 - 40%.

5) Scrap recovery

The recovery of scrap proceeds, in general, in a similar way in all countries and varies only in relation to the country itself, the effort involved in collection, and the level of processing, normally in terms of the demand and of the scale involved.

Internal arising scrap obviously is normally utilized by the works that generate it, and any sale of a small part occurs only when the works uses the LD process and makes use of its own pig-iron production.

Process scrap is normally completely recovered and almost totally utilised in steel production. Normally scrap generated in the large industrial complexes consuming steel, such as the automobile sector, is received directly by the steel plants, whilst the scrap generated in plants with lower consuming rates normally goes through scrap dealers, or is not used.

Several types of industrial scrap cannot be utilised directly in the steel works, requiring prior treatment, for which the works itself in general is not equipped. This is the case with tinplate scrap utilised in printing and scrap from axle manufacture, spare parts, etc. In the first case, the utilisation is only possible after de-tinning, in countries where tin is expensive and the consumption of tinplate justifies the installation; this is the case of Brasil.

The residue resulting from manufacturing can only be utilised in furnaces when added to the scrap bundles in small quantities or briquetted.

Owing to the small volume generated and its very wide dissemination over many plants, briquetting is viable only when steel consumption in the country reaches reasonable levels. In Brazil this activity did not start until now, when the total steel consumption has reached the neighbourhood of 8 million tons of equivalent ingots, and the total scrap generation is lower than the consumpti thereby justifying the recovery of all available types.

Capital scrap is one of the most difficult to recover, since it generally requires the establishment of a collection network and the frequent use of preparation techniques for use in furnaces, which is largely undertaken in the plants themselves.

This scrap varies widely in shape, dimensions, weight, condition, etc., ranging from small parts and fragments, which require bundling to give good results in the furnaces, to large structures, including ships, which require extensive and difficult dismantling and cutting up.

This scrap is always very scattered. It requires extensive collection networks and the recovery of light scrap occurs only in periods of high consumption, in general in developing countries, since it is not justified in the industrialized countries with a high income level and expensive labour.

For recovering capital scrap countless processes are utilised, from the non-mechanical or simple machines through to highly mechanised processes. The first are in general the only methods used in developing countries, whilst in the more advanced countries the mechanized processes predominate. There is a basic relationship between manpower and capital on the one hand and economies of scale on the other, since the poorer countries always have cheaper labour and expensive money; in the developed countries the situation is the reverse.

In the highly developed countries, where there is high generation of scrap, a significant part of this scrap comes from vehicles, ships, machines, household materials, tanks and other structures and equipment mainly constructed from plates, which justify mechanical treatment in large installations.

These steel fabrications normally undergo some manual preparation treatment, followed by pressing and reduction by cutting and mechanical crushing, with final magnetic separation to eliminate non-ferrous parts and residues. This results in a scrap of excellent quality, of small dimensions and uniform shape, usually known as shredded scrap.

Heavy scrap originating from rails, structures, large machines, ships, etc., where non-flat rolled products or very thick plates predominate, the usual treatment is oxy-acetylene cutting or shearing.

There are even more sophisticated processes, worthy of mention, involving freezing and breaking of the scrap at very low temperatures, which are used in Belgium.

In the developing countries the above mentioned mechanical processes are not used for the reasons given - low economies of scale and a favourable relation between labour cost and capital. Only scrap presses are to be found, more frequently in the steel works than at the dealers, contrary to the developed countries where normally the steel works buy the scrap ready prepared.

6. Marketing of scrap

In developing countries scrap is normally marketed with little or no pretreatment. The collection and sale of scrap is in general regarded as a side-activity undertaken by firms or individuals of small financial capacity

The trading networks are in general formed of small dealers spread around the country who make an initial selection of scrap obtained. Frequently these small dealers sell the scrap to larger dealers in the same region, who in their turn re-sell it to others, still larger, who deliver it to local works or pass it to other scrap merchants in large consuming centres, who finally deliver it to the steel works.

Despite this dispersion, scrap dealers from the large centres are normally small firms, who in Brazil trade quantities ranging between 2000 and a maximum of 5000 tons/month. The majority of these dealers confine themselves to selecting scrap according to the types required by the steel works, without processing it.

Some of the largest dealers undertake some form of processing, in general limited to cutting heavy material to required dimensions, as well as pressing lighter material into bundles.

Important in this group of activities are tinplate processors who already carry out industrial activity ("de-tinning") and tin recuperation in-house, delivering steel scrap in pressed bundles. This activity can only be justified in countries with a reasonable consumption of tinplate, as is the case of Brazil, where de-tinning is carried out with an almost total recovery of scrap sheets. It must be pointed out, however, that the main objective of these plants is always tin and not steel scrap.

Consideration should also be given to dealers who cut up old ships, which represent one of the most important sources of scrap, especially in countries that have considerable sea and river traffic.

7. Brazilian case

Brazil is a country in an intermediate stage of development. Owing to its high population, its per capita income is low, though the total yield is high. Although, by reason of its per capita income, Brazil must still be considered as a country on the threshold of development, its total yield is among the highest of the world, with a highly diversified industry that has in general acquired many kinds of modern sophisticated technologies.

Until World War II, Brazilian steel production was very small. Consumption, however, grew progressively, as did the consumption of industrial goods, which were for the most part imported.

In this way, when Brazilian industrialisation started in the 1950s, the country's iron and steel production was less than 900,000 tons per year of ingots, and the accumulated scrap reserves were more than 5 million tons.

This fact, expressed as favourable scrap prices, allied to the low investment required in semi-integrated steel production units, allowed Brazilian investors to give great emphasis to these units, and this continued until the end of the 1960s. Because of this, by the beginning of the present decade, scrap consumption in Brazil had surpassed generation, resulting in the consumption of accumulated historic reserves.

Recent study has shown that in recent years the specific consumption of scrap in Brazilian steel production has been growing, reaching about 460 kg/ton in 1973 and 470 kg/ton in 1974, and it is expected to increase further to 340 kg/ton in 1980.

Arising scrap in Brazilian steel works nowadays represents 18% of ingot production, and the forecast for 1980 is about 11%, due to the use of continuous casting for almost 90% of the total steel produced, beside the exporting of high quantities of semi-products. Internal scrap at the present time is 46% of the total, and in 1980 will increase to 48%. In relation to consumption, it now represents 36% and in 1980 will represent 31%.

Industrial scrap is also a part of the total consumption of rolled products, without including in the calculation a hypothetical rate of growth of this material, although this would be valid, bearing in mind that Brazilian industry is developing towards greater sophistication and increasing in the major scrap-generating sectors. Industrial generation, which at present amounts to 25% of the total, will in 1980 correspond to some 17%. In consumption terms, industrial scrap corresponds at present to 20% and in 1980 will be about 17%.

Capital scrap now represents 75% of the total market and 25% of consumption, and in 1980 it will represent 83% and 16% respectively.

It can be deduced from the above figures that at present consumption exceeds market availability by 22%, and this deficit will rise in 1980 to 36%. Total consumption in 1973 was calculated to be about 3.9 million tons, with a total scrap availability of 3.0 million tons. For 1980 a consumption of 10.8 million tons and a market of 6.6 million tons have been forecast.

The percentages quoted above show that internal and industrial sources will increase their participation in the total generated, although internal generation will be reduced in relation to the total produced steel owing to the increase in capacity of Brazilian steel works. This will, however, not be the case with capital scrap, owing to the increase of steel consumption to very high rates, which will be used in steel fabrications, the scrapping rate of which will only be slight in the years after 1980.

The deficit of scrap availability which comes from the early 1960s, and which in 1973 will represent about 22% of consumption, has forced Brazil to consume its reserves at an increasing rate, indicating that by 1976 or 1977 reser will be exhausted, compelling the country to import scrap from that time onwards.

The increase in scrap consumption accelerated from 1968. Owing to the speed of this increase, a relative scarcity of scrap was observed in the Brazilia market, due to a lack of collection and marketing, which compelled a rise in pric in June 1971 to US$ 52.00, 3.24 times more than that of December 1967. After June 1971 prices fell again, reaching in June 1972, 90% of the above-mentioned price. At the present time prices are rising again owing to the increase in demand, caused by the coming into operation of three new works with electric furnaces, by the entry into the market of the coke-based works, which traditional

do not buy scrap, and by the growth of export of pig iron, which normally makes up the furnace charges in Brazilian semi-integrated works.

The Brazilian network of scrap collection and trading is still in its infancy, although the marketing of 1.4 million tons was to be observed in 1971. Large Brazilian merchants collect and sell up to 5000 tons per month which is not sufficient to justify basic mechanized processing. For this reason, apart from tinplate processors (for the recovery of tin) and ship-breakers, few scrap merchants in Brazil possess installations for scrap treatment that can cope with the pressing of light scrap as well as the cutting of heavy scrap. These operations are undertaken in Brazil in the iron and steel works themselves.

8. Conclusions

The comments made above, which are basically of a qualitative nature, having regard to the enormous difficulties in obtaining statistical data, especially in developing countries, lead to the conclusion that scrap is a fundamental raw material for iron and steel industry, and, as such requires from all countries producing or intending to produce steel constant attention in their problems of consumption, collection, and marketing.

Scrap disposal in a country is, as observed, a function of numerous parameters; some of these are relatively easy to measure, related to industrial and internal generation, which are direct functions of production and steel consumption, whereas those related to capital scrap are practically impossible to measure exactly.

Scrap disposal in a country is, in any case, function of the degree of development of the country, growing as the country develops.

Scrap collection, preparation and marketing are bound to be seen, in less developed countries, as subsidiary activities. This means that preparation is always primary, without the degree of elaboration found in developed countries, confined in most cases to simple collection and sale to the steel works. Paradoxically, this encourages the utilization of a very disseminated low-grade scrap, which is normally not possible in developed countries.

In developing countries, where normally labour is cheap and money expensive, it may be most convenient that the collection system should be the present one, so as to permit a maximum rate of scrap recovery, rather than the highly sophisticated systems employed in developed countries.

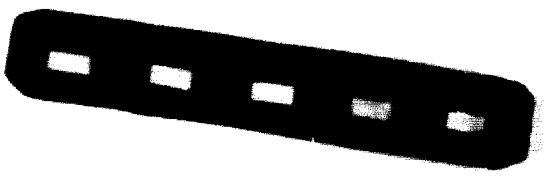
Developing countries are recommended to carry out accurate studies of the evolution of their internal scrap markets, so that the policy applied to its iron and steel industry allows, as far as possible, for a balance between scrap generation and consumption, which is the only possible way of maintaining price stability.

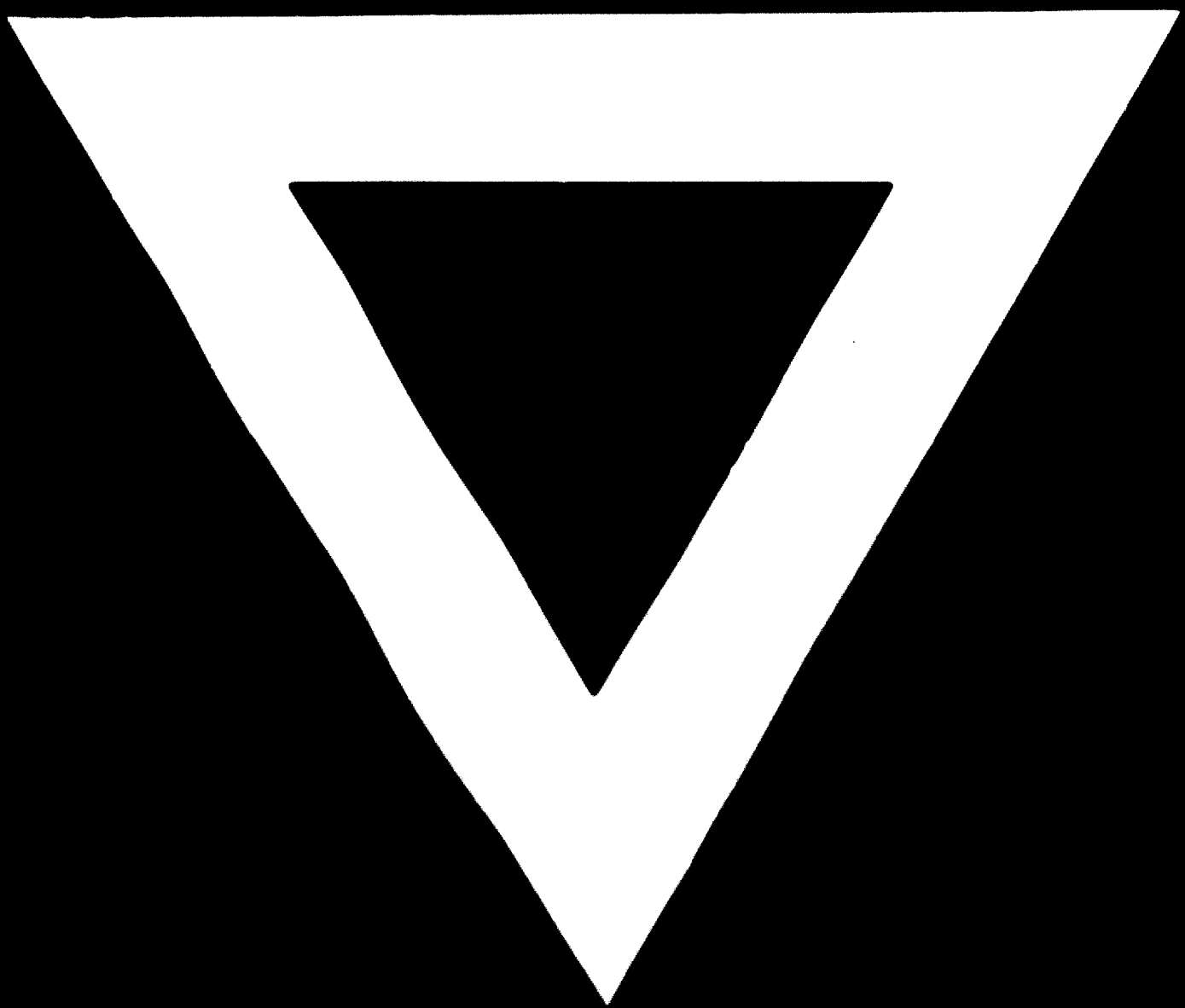
The breakdown of equilibrium between scrap generation and consumption may lead, as will certainly happen in Brazil, to the need to import scrap, which always results in price fluctuations, as well as an increase in relation to internal prices, at least to the level of imported scrap price levels, unless price control is imposed which is normally shown to be very difficult.

The study on scrap published by the European Economic Commission in 1971 shows the monthly evolution of scrap prices in the period from 1955 to 1969, in the USA, Federal Republic of Germany, Italy, Belgium, France, United Kingdom, and Japan. These data show that, apart from the United Kingdom, where the price of scrap is constant for long periods, prices vary with amplitudes that defy any mathematical treatment as far as their logical character is concerned. In the USA in particular prices vary between US$ 34.07/ton in January 1955 to US$ 39.21/ton in December 1969, with a minimum of US$ 23.50/ton in the months of July, August, and September 1968 and a maximum of US$ 63.56/ton in December 1969. In other countries, there were similar variations in the same period. At the present time, as is known, world prices are high, having reached at the beginning of this year US$ 65.00/ton in the USA.

As can be seen from the above figures, the iron and steel industry of a country that is dependent on scrap imports is subject to fluctuations that are completely outside its control, in spite of any kind of co-ordinated planning, especially in countries with a capitalist economy.

It is worth-while to analyze the experience of Brasil which, when faced with the problems enumerated above, recently decided to create obstacles to the expansion of scrap consumption in order to minimise the effects that would certainly be caused by imports, which will be necessary at the end of the present decade, because at the moment it is impossible to avoid them completely.





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