Text No.25

ENERGY CONSERVATION IN THE IRON AND STEEL INDUSTRY

鉄鋼産業における省エネルギー推進状況

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1. Introduction

Iron manufacturing plants include the following three types:

(1) Integrated steel works where iron ores are processed to make pig iron by a blast furnace, which is processed into steel and further into steel products such as steel sheets.

(2) Electric furnace plant where steel scraps are molten by an electric furnace without using the blast furnace, to make steel which is processed into steel products.

(3) Rolling plant where the steel semi products supplied from another plant are rolled into steel products, without using the blast furnace or the electric furnace.

An integrated steel works has several features. The largest one must be that the steel works as a whole has a rational and economical production system. For example, since the molten pig iron produced by a blast furnace can be charged into a converter in the subsequent steel making process, without being cooled, the heat loss is small and the operational efficiency is high. All the gases evolved from the blast furnace, converter, coke oven, etc. can be perfectly used as energy sources in the steel works. The slag separated in the production of pig iron and steel can be used for preparing cement, concrete aggregate, etc. Since shops for producing various types of steel products from steel are located in the steel works, transport cost can be saved.

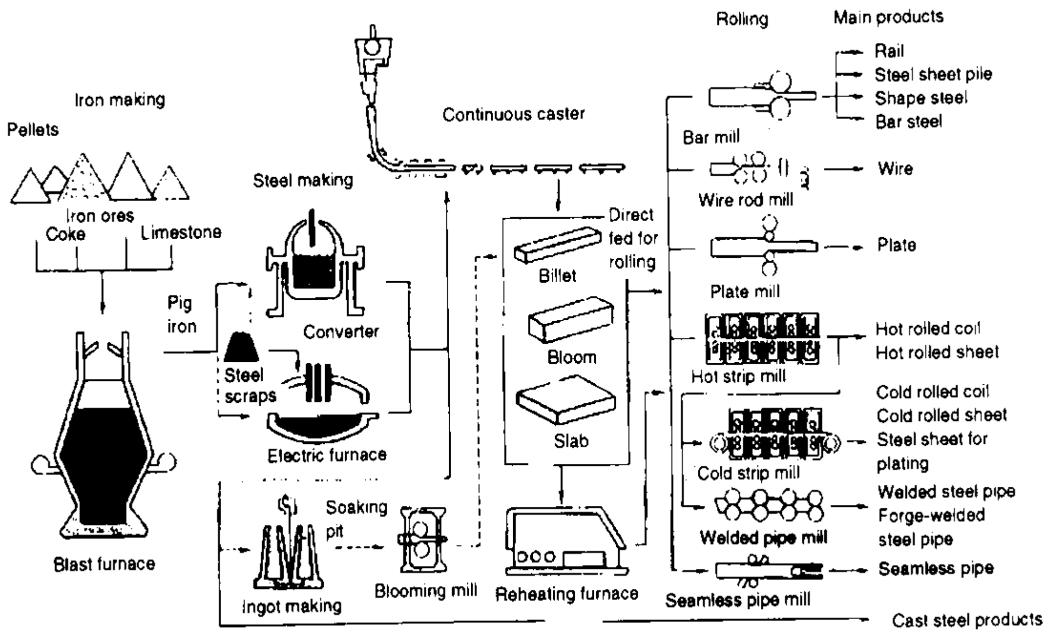
On the contrary, an electric furnace plant or a rolling plant has such features as being relatively small in equipment and other capital costs, and being easy in quick change of operation, to be suitable for producing many kinds in small quantities.

In Japanese iron and steel making industry, there exist many levels of steel works size, such as big integrated steel works producing more than ten million tons of steel per year, medium size or small size steel works respectively producing hundreds of thousands tons or tens of thousands tons per year.

This chapter introduces major processes in an integrated steel works and describes the rationalization in the use of energy in the iron and steel industry.

2. Outline of Major Processes in an Integrated Steel Works

Fig. 2-1 shows the flow of raw materials and products in an integrated steel works.



* Fed to surface treatment equipment, to be made into the products such as electrolytic tin plated steel, electrogalvanized steel, zinc hot dipped steel, etc.

Fig. 2-1 Flow of raw materials and products in an integrated steel works

The following describes the outline of major production processes and major energy conservation measures.

2.1 Sintering process

The sintering process produces the sintered ore which accounts for more than 70% of the charged raw materials for securing the internal gas permeability in the blast furnace.

Sintered ore is prepared by burning and solidifying iron ore powder, coke and limestone, and the sintering process consists of a sintering machine and a sintering cooler. The sintering machine carries the raw materials using a conveyor called pallets and gets them ignited, with air supplied by an induced draft fan. The sintered ore delivered from the sintering machine is air-cooled by the sintering cooler, into a final product.

The energy consumption in the sintering process accounts for about 10% of all the energy consumption in the integrated steel works.

One means for energy conservation is waste heat recovery which includes the waste heat recovery from the exhaust gas from the induced draft fan of the sintering machine (sensible heat of main exhaust gas) and the waste heat recovery from the exhaust gas from the sintering cooler (sensible heat of the sintered ore). The former is low in recovery efficiency since the exhaust gas is low in temperature, though large in the quantity of heat, and has a problem of corrosion. On the contrary, the latter is high in exhaust gas temperature and good in recovery efficiency.

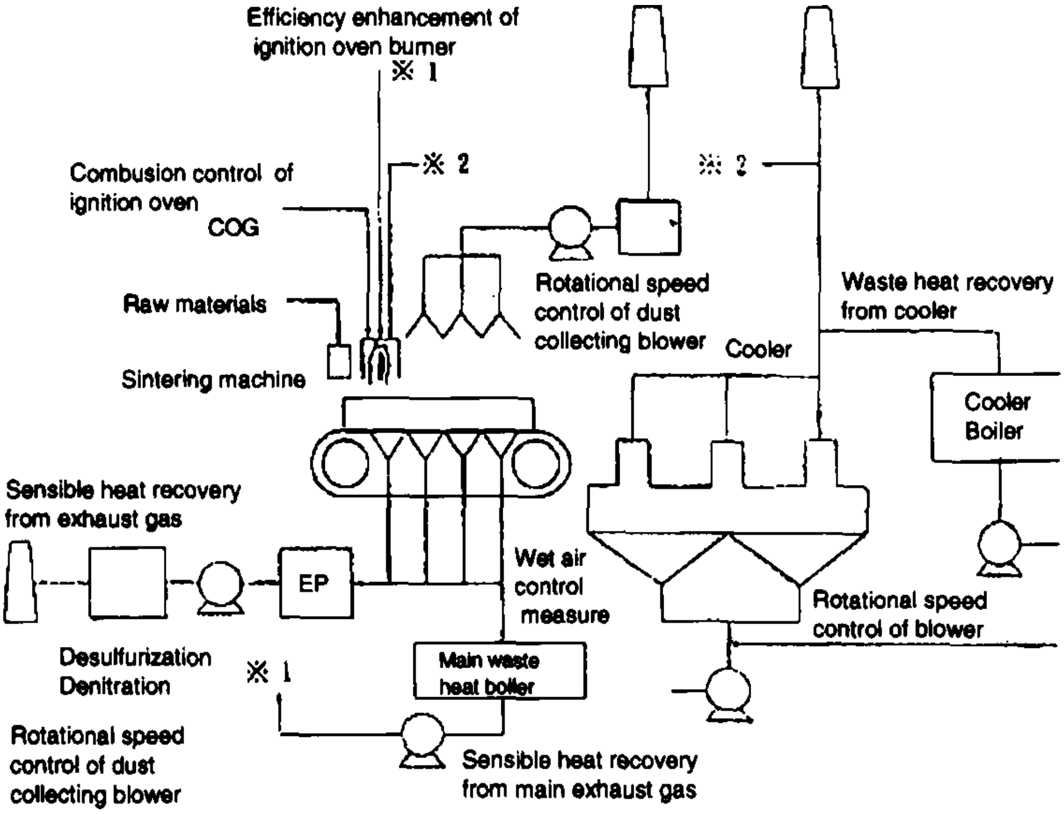


Fig. 2-2 Flow and energy conservation measures of sintering process

For electricity conservation, the speed control of the induced draft fan and the dust collector and the wet air control measure for the sintering machine are major items.

2.2 Coke process

In the coke process, raw coal is carbonized in a coke oven, to produce the coke for reducing the iron ore. The coke oven has carbonization chambers and combustion chambers arranged alternately on a regenerator. The raw coal is adjusted, ground, mixed and carried on a belt conveyor, to be charged into the carbonization chambers, and usually in 15 to 20 hours, carbonization is completed, to deliver hot coke. The coke is quenched into a product in a quenching tower. The product is sieved and fed on a belt conveyor into a blast furnace.

The energy in the coke process is mainly consumed for heating the raw coal and carbonization. Recently, waste heat recovery such as CDQ is more widely adopted, and the energy consumption accounts for 5.6% of the overall energy consumption of iron making.

Major energy conservation measures in the coke process include coal moisture control system, coke dry quenching (CDQ), COG sensible heat recovery, exhaust gas sensible heat recovery and electricity conservation.

Coal moisture control system preheats and dries the raw coal by heat sources of plant waste heat, etc., before charging the raw coal into the coke oven, and can decrease the heat consumption for carbonization.

Coke dry quenching (CDQ) quenches the hot coke delivered from the coke oven, continuously by a circulating gas, and recovers the heat as steam by a waste heat boiler. The temperature of the hot coke is higher than 1000°C, to allow recovery as high pressure steam, and so recovery as electricity can also be effected by using an existing power generator or a newly installed power generator attached to CDQ.

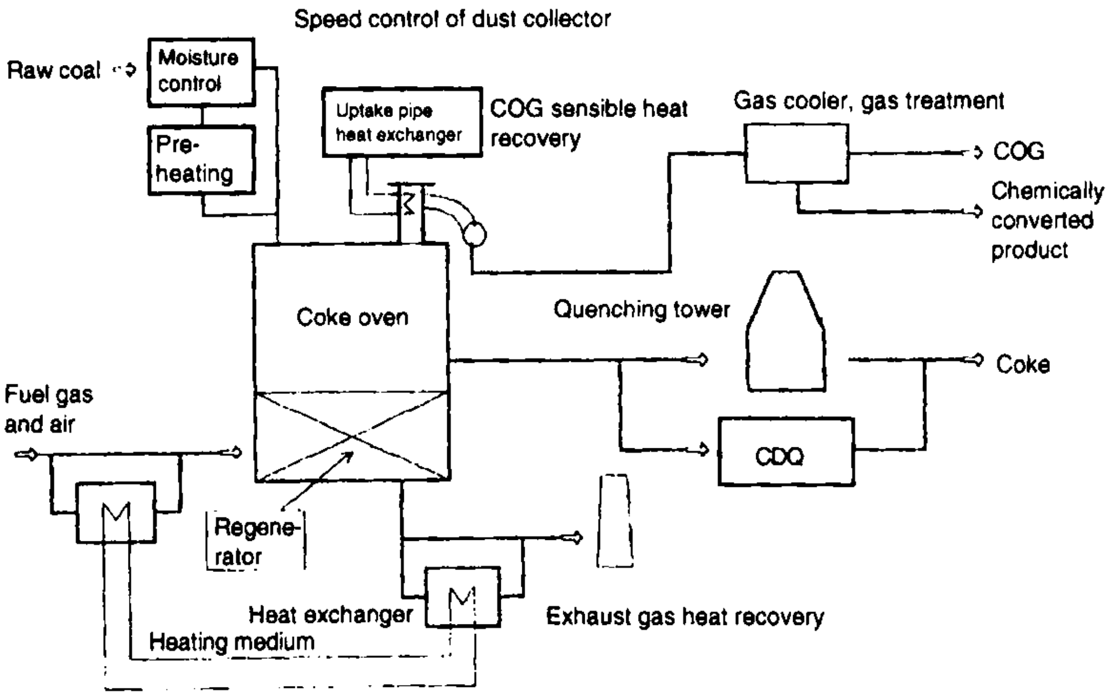


Fig. 2-3 Flow and energy conservation measures of coke process

2.3 Iron making process

In the blast furnace process, pig iron is produced using iron ore, sintered ore prepared by pretreating the iron ore, etc. as the raw materials and using the coke and pulverized coal charged simultaneously, as a melting heat source and a reducing material.

The raw materials, coke, etc. supplied from the top of the blast furnace make reduction reaction with the hot air blown in from many tuyeres formed in the lower part of the furnace, and the molten iron produced is collected at the furnace bottom. It is taken out of the furnace through an iron outlet. The impurities in the iron ore are taken out as molten slag.

On the other hand, as a result of the above reaction, blast furnace gas (BFG) is discharged from the furnace top, and is dedusted, to be effectively used as a fuel.

In the iron making process, the energy used for melting and reducing the iron ore is enormous, and accounts for 57% of the overall energy consumed for iron making. In recent years, to reduce the fuel cost of the blast furnace and to extend the life of the coke oven, PCI mass injection technique is increasingly adopted, and the quantity is estimated to reach 177 kg/t-p in 2010.

The most remarkable energy conservation means for the blast furnace is dry TRT (dry Top gas pressure Recovery Turbine) for recovering the temperature and pressure energy of the blast furnace gas. The replacement of wet type by dry type is expected to be promoted sequentially taking the opportunities of blast furnace refurbishment.

The HS heat recovery for recovering the combustion exhaust gas energy of the hot stove (= HS) used for making hot air has already reached about 97% in adoption rate, and this level is predicted to be maintained also in future.

The heat recovery of granulated slag can be considered to be achieved by various methods such as hot water sensible heat recovery and steam recovery, but the adoption rate is 0% at present because of low level of recovered energy and low economic efficiency.

Electricity conservation can be achieved mainly by rotational speed control of dust collectors, HS combustion fans and pumps.

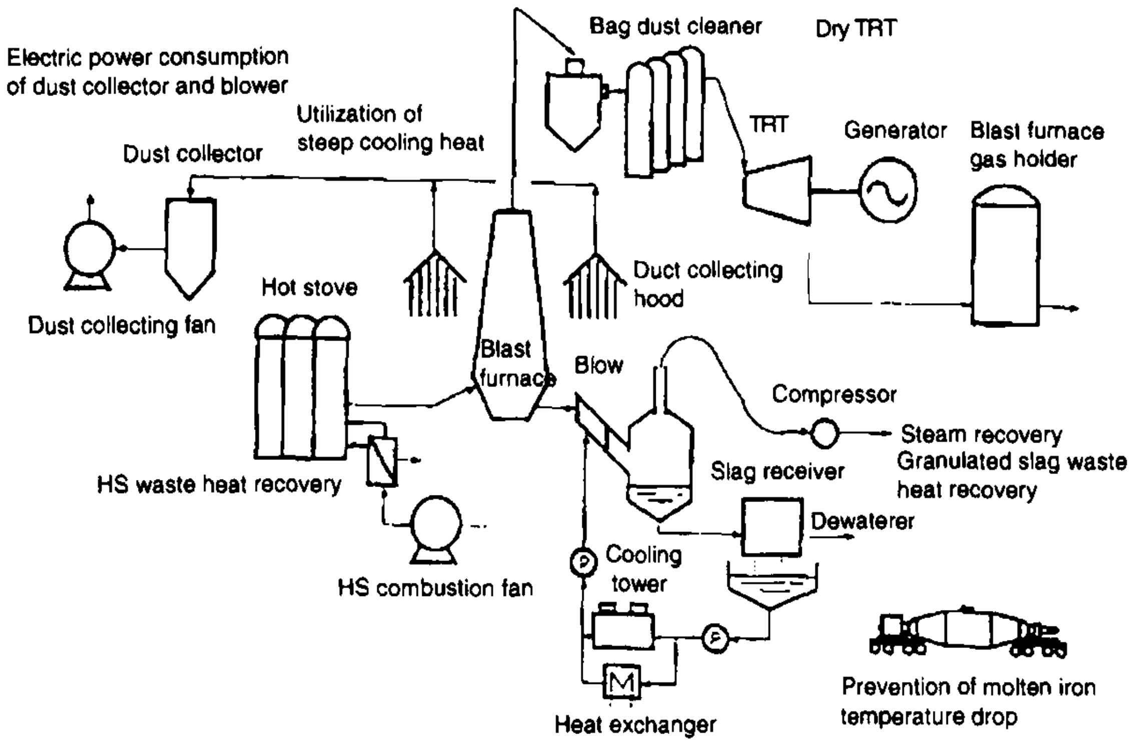


Fig. 2-4 Flow and energy conservation measures of iron making process

2.4 Steel making process

In the steel making process, impurities such as carbon, silicon and sulfur are removed from molten iron by a converter, to make steel which is then continuously cast into a strand to allow easy rolling.

Molten iron is delivered at about 1500°C and charged into a converter at about 1350°C, to bring in sensible and latent heat of about 3081 MJ/t-crude steel. The latent heat in the molten iron is converted into the sensible heat of molten steel and molten slag and the sensible and latent heat of exhaust gas by oxidation reaction.

More than 70% of the exhaust gas evolved during the smelting in the converter is CO gas, and the total sensible and latent heat of 1042 MJ/t-crude steel corresponds to about 5% of the energy purchased by the steel works. At present, 75% of it is recovered, and for further enhancing the efficiency, an enclosing method to keep the converter structurally enclosed at its port is developed. Moreover, since the recovered converter gas is as high as 1500°C at the outlet of the converter, an increasing number of converter gas sensible heat recovery apparatuses for recovering the sensible heat as steam are being adopted.

The sensible heat of molten slag is as high as about 209 MJ/t-crude steel, but only one energy recovery apparatus has been put into practical use. In this apparatus, air is jetted against slag, for cooling and solidifying it, and the hot air generated in this case is used for recovery as steam. The waste heat recovery of converter slag is not practiced at many places for the reasons that converter slag is generated in batch, that converter slag is higher in viscosity than blast furnace slag and inconvenient to handle, and that the properties of slag are different from kind to kind of steel produced. So, it is highly expected that any effective recovery technique is successfully developed for it.

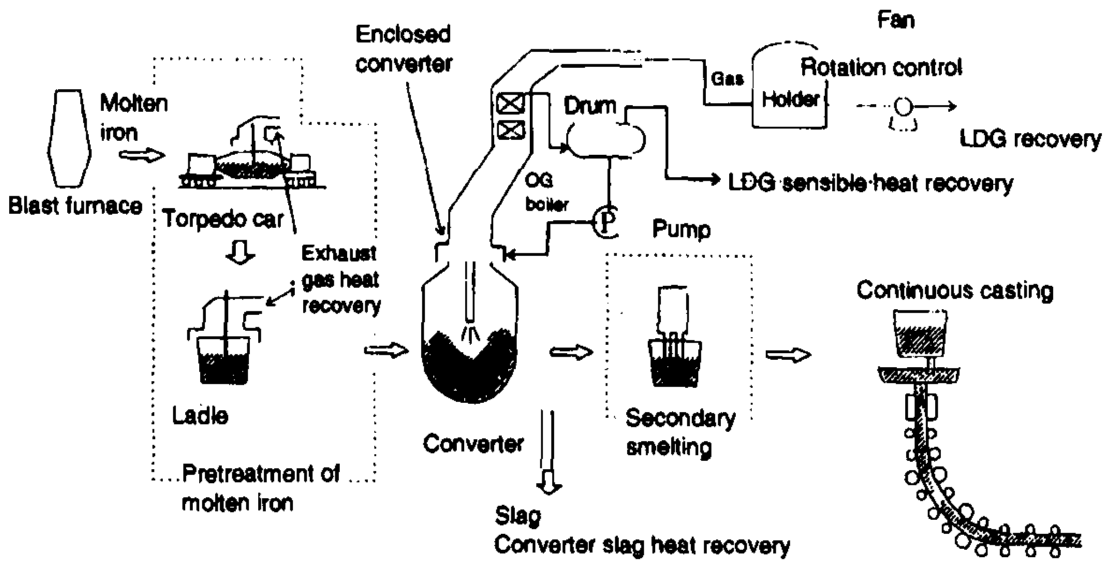


Fig. 2-5 Flow and energy conservation measures of steel making process

2.5 Rolling process

Various kinds of steel prepared in the steel making process are fed as slabs to the rolling process.

In the rolling process, a slab is held between upper and lower rolls, to be pressed and stretched into a form to allow easy use for each application. The steel products include steel plates, hot rolled steel sheets, cold rolled steel sheets, steel bars, steel pipes, etc.

The rolling includes hot rolling for heating, pressing and stretching a slab and cold rolling for stretching a slab further at room temperature. The methods for producing the respective steel products are generally described below.

2.5.1 Rolling into plate or sheet

(1) Steel plates

Steel plates are used for ships, bridges, buildings, etc. A steel plate production process is shown in Fig. 2-6. The plate is produced by hot rolling. A slab heated to higher than 1000°C by a reheating furnace is rolled into a plate with a certain thickness by a roughing mill, and is passed to finishing mill several times to achieve the intended thickness. The toughness and microstructure of the plate are controlled by the reduction power of the rolls and the temperature of the plate.

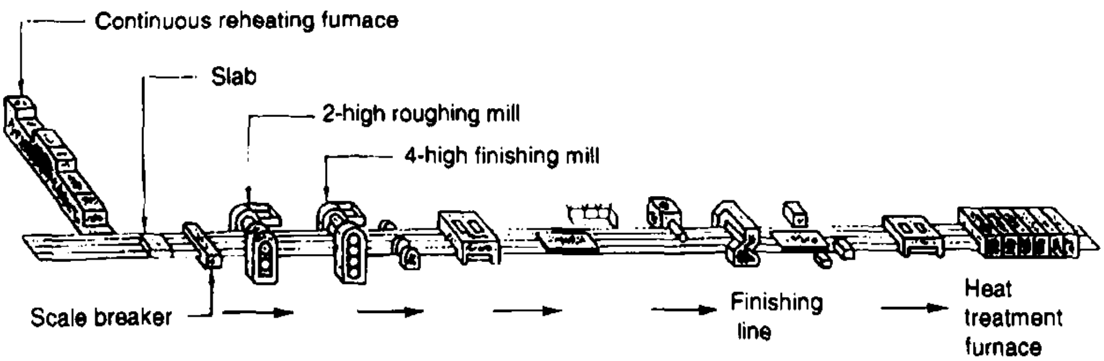


Fig. 2-6 Steel plate production process

(2) Steel sheets

Steel sheets are used for automobiles, household electric appliances, cans, galvanized steel sheets, etc. The electrical steel sheets used for iron cores of transformers and motors are also included in this category. A steel sheet production process is shown in Fig. 2-7. A steel sheet is prepared by allowing a slab to travel in one direction once only through aligned plural roughing mills and plural finishing mills. Slabs of 190 to 260 mm in thickness are pressed and stretched into about 2 to 3 mm thick strips. A long strip (which may be 1 km in length) is coiled like a giant toilet paper roll at the end after having passed all the rolling mills. These mills are hot strip mills. The strip is usually subsequently cold-rolled. The cold rolling makes the strip further thinner and can also make it beautiful and uniform on the surfaces. In this step, the steel sheet is fed through linearly arranged 5 to 6 rolling mills, to be made into a paper-like sheet of zero point zero several millimeters in thickness. Since the rolling mills are set to be higher in speed downstream, the sheet is pressed and pulled by the rolls of the rolling mills, to be reduced in thickness.

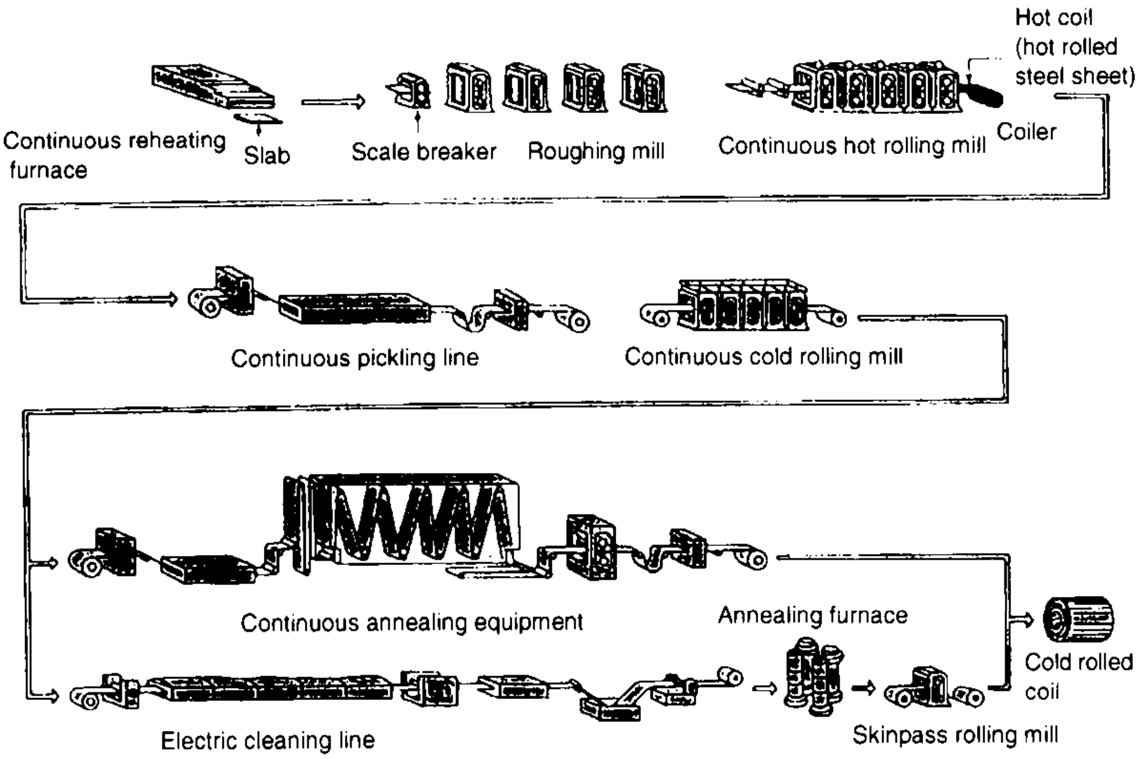


Fig. 2-7 Strip production process

Rolling acts not only to press and stretch the sheet but also to determine the internal properties of the steel. Iron crystals remarkably change in form in response to external force and temperature, and so if the external force and temperature are elaborately controlled, a tough and fine structure can be obtained. Furthermore, in the hot rolling line for steel sheet, a large amount of water is sprayed against the sheet immediately after finish rolling, and the properties of the sheet are affected also by how to spray water. Moreover, the rolled steel sheet has strain internally accumulated by the applied rolling force, and is hardened. The force can be released by annealing to restore the softness suitable for working, and the annealing is achieved by heating and cooling the steel sheet. In the past, the coil was put into a furnace, to be annealed for about one week, but at present, continuous annealing which can achieve the desired processing only in ten-odd minutes is generally adopted. In the continuous annealing, a cold rolled steel sheet coil is unwound and fed through a long furnace as a long strip at a high speed. While the sheet is fed through, it is subjected to a heat cycle of heating, soaking, slow cooling and quenching, to have various properties as intended. The continuous annealing is absolutely required for production of high quality products such as high tension steel sheets for motor vehicles and steel sheets for cans.

2.5.2 Rolling of bar steel

Bar steel refers to steel products with various sectional forms as shown in Fig. 2-8 and can be roughly classified into shape steel, bar steel (round bar and square bar) and wire rods. These bar steel products are produced by hot rolling using top and bottom rolls formed to correspond to the sectional form of each product, but H-steel only is differently produced.

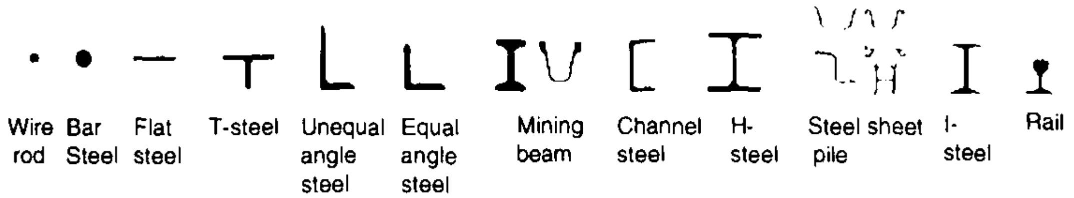


Fig. 2-8 Major forms of bar steel

H-steel is produced by holding the billet on four sides, using horizontal rolls and vertical rolls arranged to form H shape. Fig, 2-9 shows an H-steel production process, and Fig. 2-10 shows the rolling steps for it.

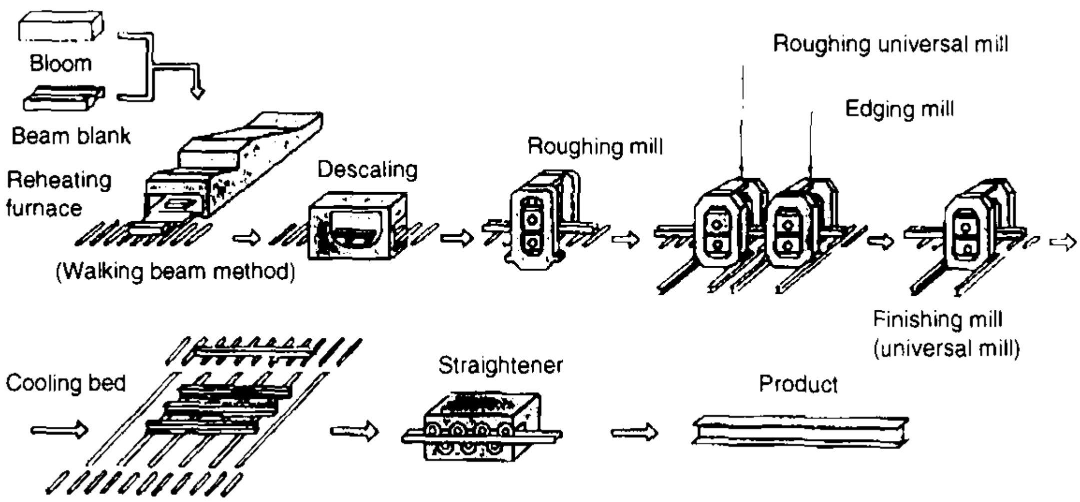


Fig. 2-9 H-steel production process

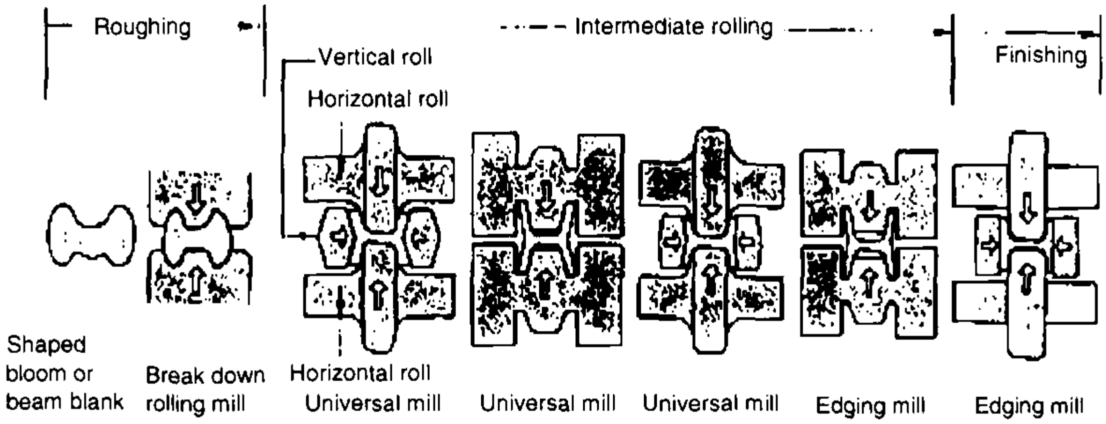


Fig. 2-10 H-steel rolling steps

2.5.3 Production of steel pipes

Steel pipes include those of more than 3000 mm to several millimeters in diameter, and are produced by various methods for various applications. They are used as water feed pipes, gas pipes, boiler tubes, electric wiring tubes, oil well tubes, oil and natural gas transport pipes, etc. In addition to these applications where they are used for allowing any medium to pass through them, they are also increasingly being used as structural members for building scaffoldings, street lighting poles and revetments.

In reference to production methods, they can be roughly classified seamless steel pipes and welded or forge-welded steel pipes. Respective production processes are shown in Fig. 2-11.

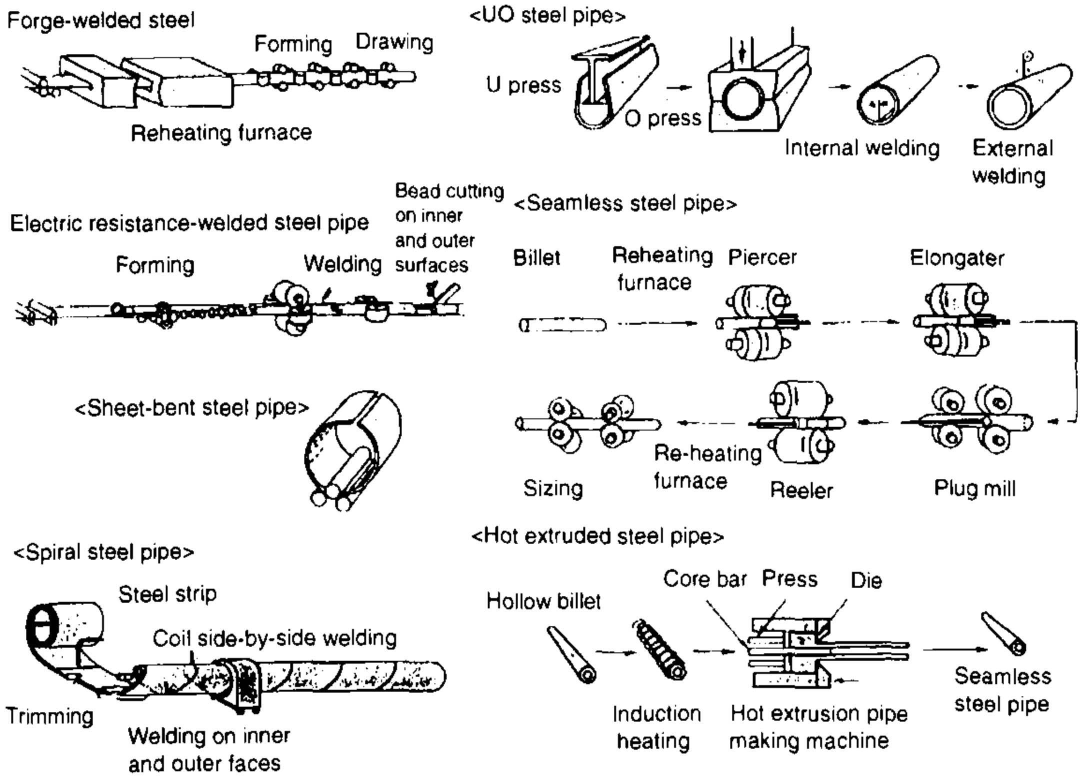


Fig. 2-11 Respective processes of steel pipes

(1) Seamless steel pipes

The raw steel is usually a billet formed to be round in section, and it is heated and bored by a piercer, to be hollow. Subsequently, a long core bar is inserted, and in this state, the hollow material is rolled by a rolling mill, being held between the core bar and the rolls, to be made thinner and longer. The steel pipe produced is polished by rolling and corrected dimensionally, into a product. It is very strong against pressure and torsion, and often used as an excavation pipe for oil.

(2) Welded or forge-welded steel pipes

A sheet is bent to form a steel pipe by welding or forge-welding at the seam. Depending on how to make, steel pipes can be classified into electric resistance-welded steel pipes, spiral steel pipes, UO pressed steel pipes, sheet-bent steel pipes, forge-welded steel pipes, etc.

2.6 Steel products not rolled

Steel products not rolled include cast steel prepared by pouring the molten steel delivered from the steel making process into a mold, to be made into something similar to the intended product in form, forged steel prepared by heating the steel ingot produced by ingot making and hitting it by a powerful hammer or press, for forming as desired, and powder metallurgical steel prepared by packing a mold with fine iron powder, compressively molding, and burning at a temperature lower than the melting point for preparing the intended product at a time.

Cast steel is used for preparing complicatedly formed products which cannot be prepared by rolled steel products, for example, underframes, wheels and couplers of rolling stock, anchors, gears of machines, etc. Forged steel is used for applications requiring high performance such as containment vessels and pressure vessels of nuclear reactors, crank shafts of engines for ships, axles and gears of motor vehicles, etc. Powder metallurgical steel is increasingly adopted in recent years since complicated formed parts can be produced very easily compared to the conventional machining and forging. This is used most for automobile parts.

2.7 Quality improvement of products

2.7.1 Countermeasures against rust

As a countermeasure against the nature of iron susceptible to oxidation, various measures such as painting have been taken from old times. Rust resistant steel products include many surface-treated steel products such as galvanized sheet, tin plate, tin-free steel and coated steel sheets. Moreover, steel changed in properties includes stainless steel internally resistant against steel and anti-weathering steel covered on the surface with the rust generated from itself for preventing further progression of rust. General processes for preparing zinc hot dipped steel and stainless steel as typical steel products are described below.

(1) Zinc hot dipped steel

Fig. 2-12 shows the process. A cold rolled steel sheet is immersed in molten zinc, to have zinc deposited on the surfaces. In this case, a strip unwound from a coil may be continuously plated or sheets cut to have the same size may be immersed one by one, to

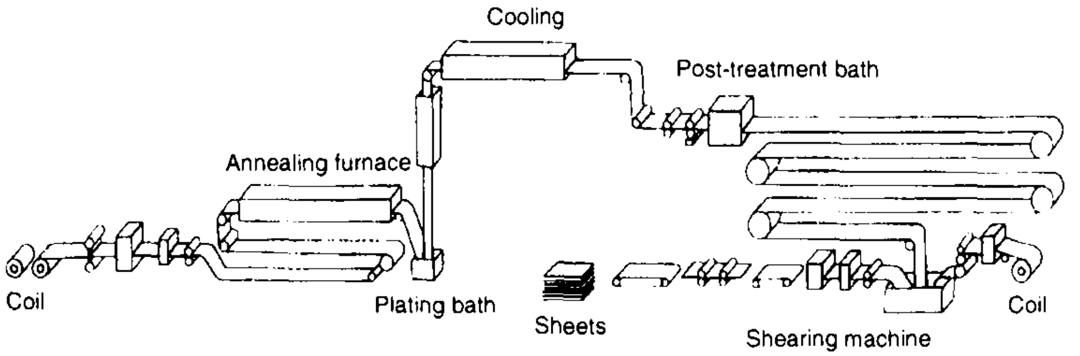


Fig. 2-12 Hot zinc dipping line

(2) Stainless steel

Stainless steel is alloy steel consisting of iron, chromium and nickel. The capability of chromium to form a powerful thin oxide film is used. Three kinds of stainless steel are available; 18-chromium 8-nickel (austenite) steel containing 18% of chromium and 8% of nickel, 18-chromium (ferrite) steel containing 18% of chromium only, and 13-chromium (martensite) steel containing 13% of chromium.

In general production, the process up to hot rolling is quite the same as that for preparing the above mentioned ordinary steel sheet. For cold rolling, since the stainless steel is very hard, a Sendzimir mill using 10 rolls each for top and bottom, i.e., 20 rolls in total is used, for reciprocating the steel sheet several times, for stretching to a desired thickness. Recently, it is also practiced to align several Sendzimir mills, for allowing the steel sheet to travel in one direction for continuous rolling, and also to prepare stainless steel using the rolling mills for ordinary steel at lower cost.

2.7.2 Special steel

The ordinary steel described above contains iron and slight amounts of carbon, silicon, manganese, phosphorus and sulfur. Special steel contains special elements other than these, and also called alloy steel. The classification of special steel is shown in Fig. 2-13. Tool steel is used for cutting tools, etc., and contains carbon, and also tungsten, chromium, vanadium, etc. as required for respective applications. Structural steel is used for machine parts subject to large forces such as shafts and gears, and contains a large amount of carbon, and also nickel, chromium, molybdenum, etc. Among the structural steel, bearing steel is used for rotating portions of machines and contains a large amount of carbon and also chromium. Spring steel is used for making leaf springs, coil springs, power springs, etc. and is highly resilient. High tension steel was developed for weight reduction and cost reduction, and is used for structures, motor vehicles, etc.

Processes for preparing final steel products and applications of steel products have been briefly described. The iron and steel industry pursues technological development in response to the needs of respective industries using steel products as their raw materials, and it can be said that the efforts contribute to the energy conservation in the respective industries of motor vehicles, energy, household electric appliances, construction, etc.

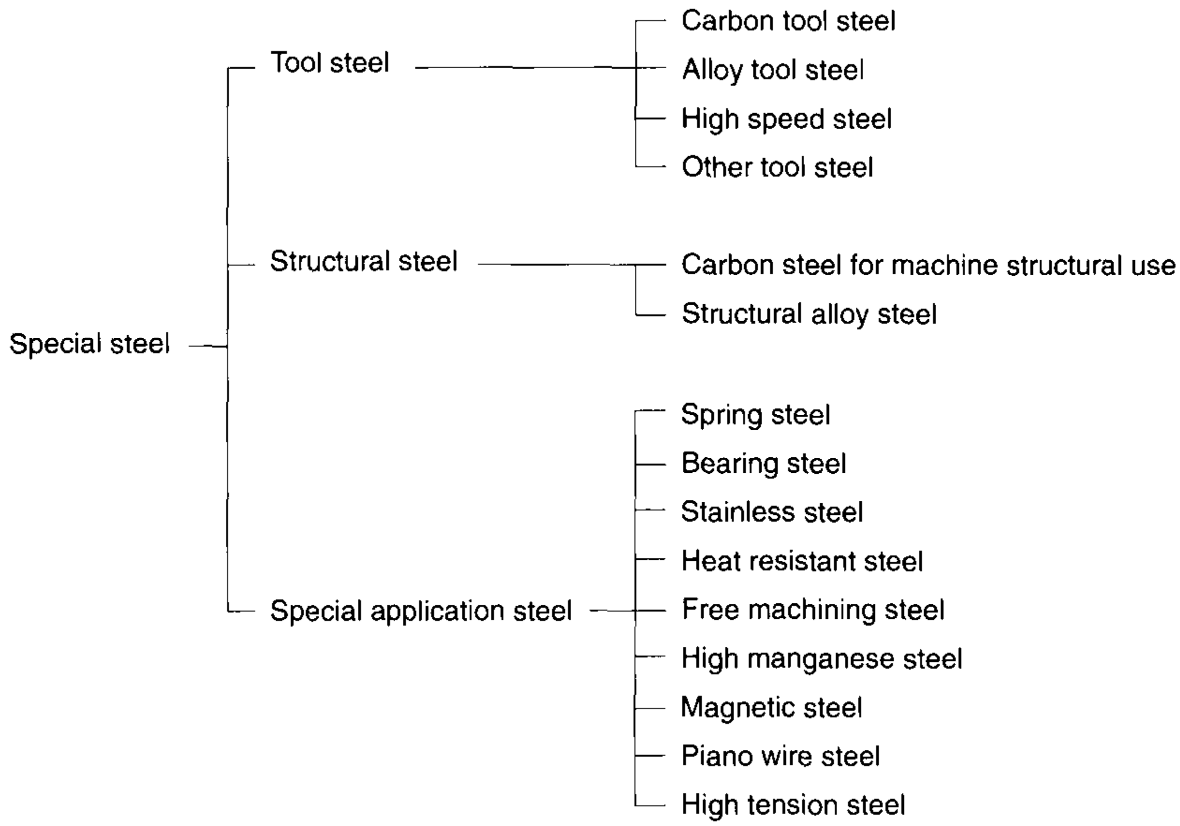


Fig. 2-13 Classification of special steel

3. Outline of Energy Consumption in Japanese Iron and Steel Industry

3.1 Features of energy consumption in Japanese iron and steel industry

The iron and steel industry is the largest energy consumption industry which accounts for 11.6% (66.9 million kl of oil equivalent, FY 1998) of Japanese energy consumption.

An integrated steel works generates large quantities of various by-product gases as coal energy. These gases are a high calorie gas from the coke oven, a low calorie gas from the blast furnace and a medium calorie gas from the converter.

In an integrated steel works, these by-product gases are recovered for use as the fuels for the heating furnace and power generation, to keep the fuel oil consumption rate as very low as about 3%.

The consumption percentages of respective energy sources in the entire iron and steel industry are 80.0% of coal, 12.4% of purchased electricity and 7.7% of oil in FY 1997 showing a large drop in the oil fuel consumption percentage from 9.8% of FY 1980.

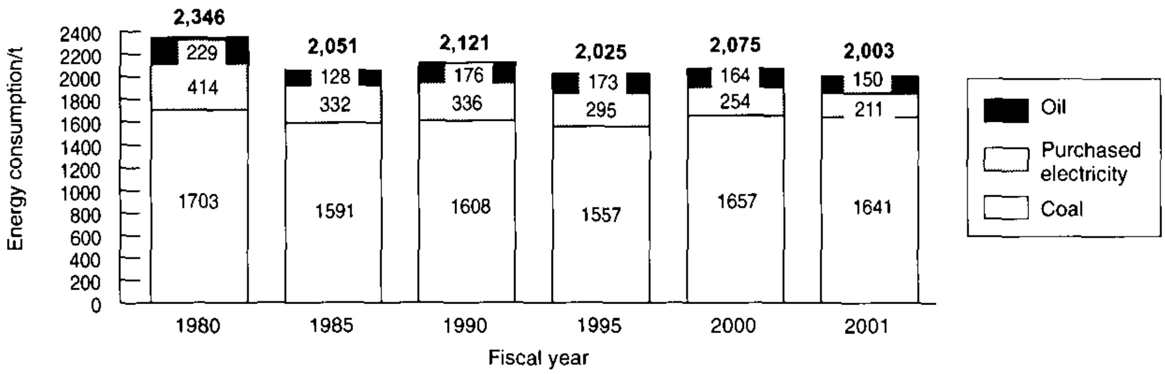


Fig. 3-1 Change in the consumption rates of respective energy sources in the iron and steel industry

3.2 Energy conservation in Japanese iron and steel industry

The iron and steel industry consumes much energy and efforts have been being made to conserve energy.

The specific energy consumption per ton of crude steel dropped to 93.8 in FY 1997 with that in FY 1980 as 100, to show the effect of the efforts.

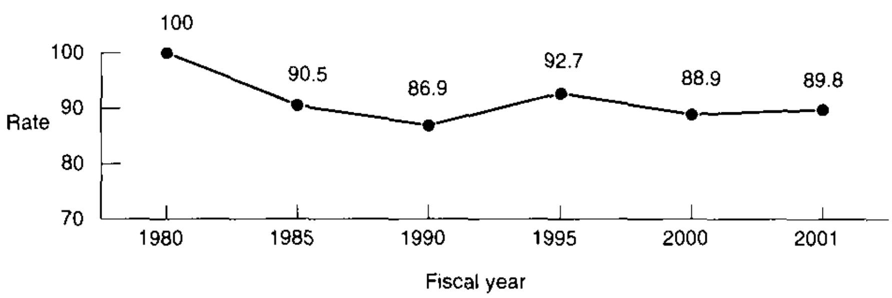


Fig. 3-2 Change in specific energy consumption

The total amount of investment in energy saving equipment in the iron and steel industry in 13 years from FY 1982 to FY 1994 reaches 1,623 billion yen, and accounts for 15.5% of the total investment of the same period in the iron and steel industry.

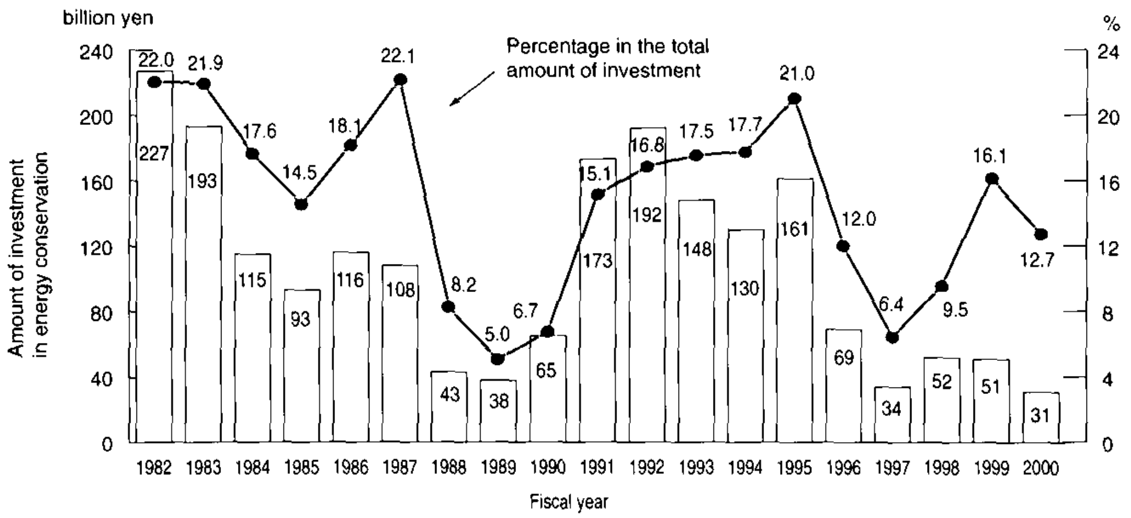


Fig. 3-3 Amount of investment in energy saving equipment and percentages to the total amounts of investment in the iron and steel industry

The specific energy consumption in Japanese iron and steel industry tends to level off recently, but compared to the specific energy consumptions of major steel making nations in the world, with the specific energy consumption of Japan as 100, USA shows the highest consumption level of 118 being followed by 112 of United Kingdom, 111 of France, 106 of Brazil, 104 of Spain and 103 of ex-West Germany. Japan remains at the highest level in the world in the energy consumption efficiency.

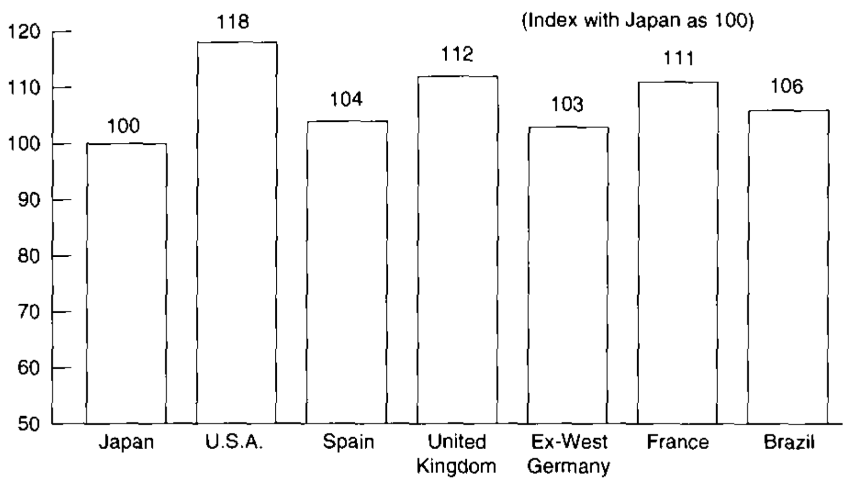


Fig. 3-4 Specific energy consumptions of major steel making nations (1994)

3.3 Energy conservation of Japanese integrated steel works

At present, an average integrated steel works consumes 23,000 to 24,000 MJ of energy per ton of crude steel.

Percentages of respective energy consumption items in an integrated steel works consuming 23,780 MJ of energy per ton of crude steel are, for example, 30.8% for reduction of iron ore (endothermic reaction), 22.6% for electricity used for rolling, blowers, pumps, lighting, etc., 13.0% for exhaust gas sensible heat, 11.1 % for steel product sensible heat, etc., 3.6% for slag sensible heat and 18.9% for cooling water, etc.

Of the above, the items which can be first of all considered to be taken up for recovery of waste energy in future are exhaust gas sensible heat, slag sensible heat and steel products sensible heat.

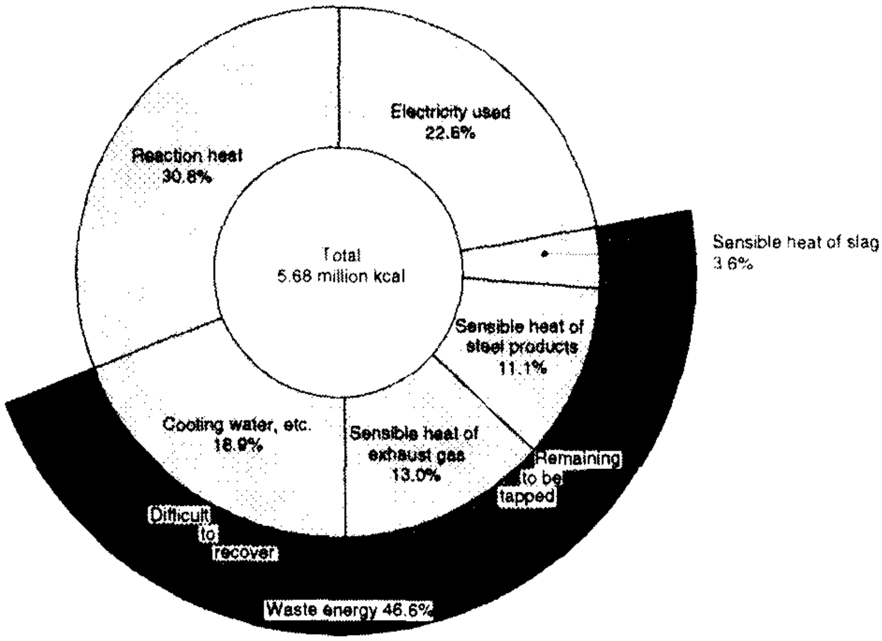
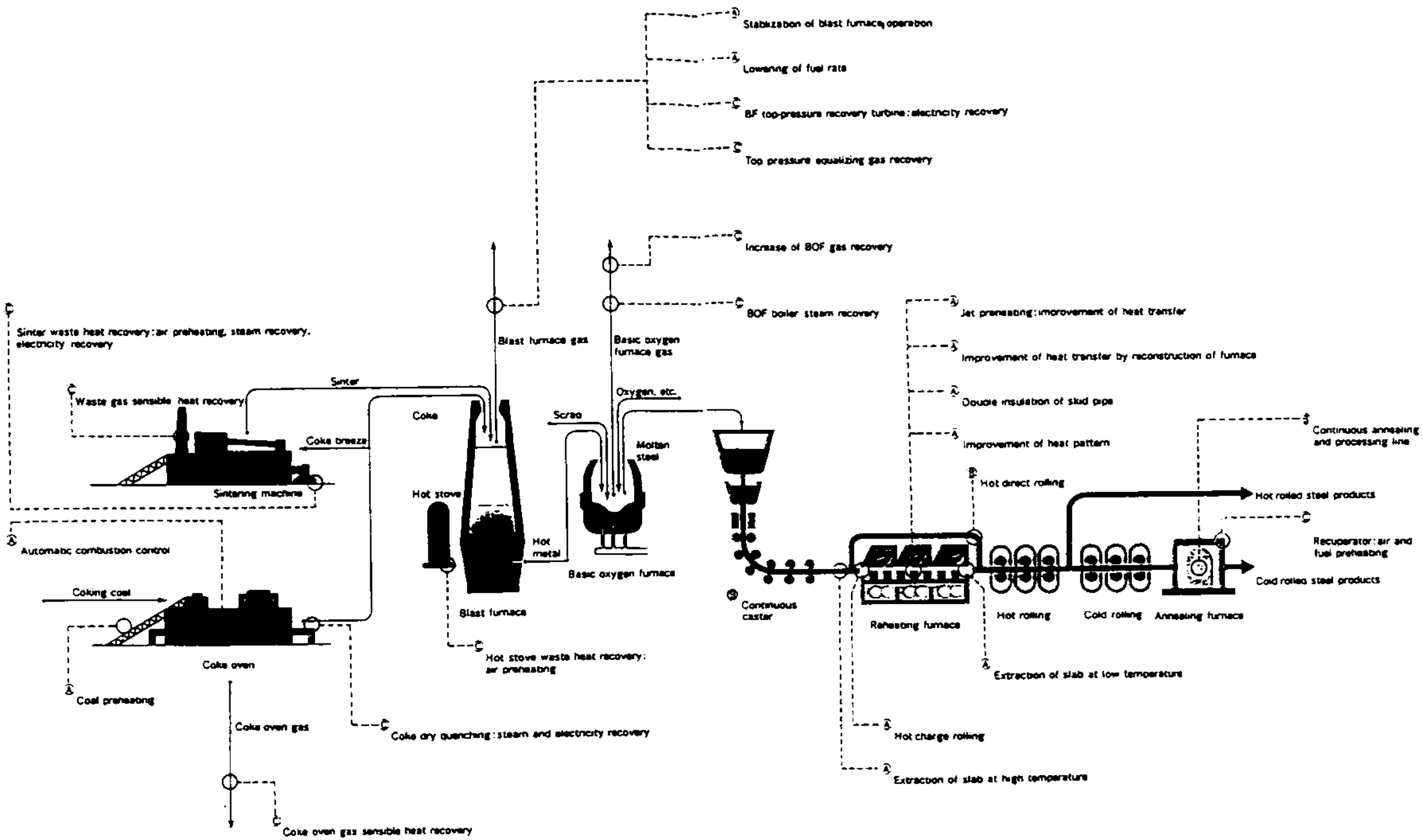


Fig. 3-5 Energy consumption per ton of crude steel (a case of integrated steel works)

3.3.1 Present situation and problems of energy conservation measures

The energy conservation measures in the iron and steel industry can be classified into the following three major categories:

<1> Introduction of more efficient equipment and improvement of operation
<2> Omission and integration of production steps
<3> Recovery of waste energy



VARIETY OF ENERGY SAVING MEASURES

Generally, energy-saving measures taken by the steel industry break down into three groups:

A Introduction of highly efficient equipment and improvement of operational techniques.

B Elimination and concatenation of production processes.

C Recovery of waste energy.

Implementation of these measures has led to impressive energy conservation results. Specific measures taken for each process are illustrated above in process sequence.

(Symbols A to C in the diagram correspond to those for the three groups of energy saving measures described on the above)

Fig. 3-6 Energy saving measures in an integrated steel works

After the first oil crisis in 1973, energy conservation measures were taken mainly by improving the operation till the sudden energy price rise due to the second oil crisis in 1979, and in the period of sudden energy price rise after the second oil crisis, energy conservation measures were taken mainly by adopting more efficient equipment including the introduction of waste energy recovery equipment, to achieve a large energy conservation of about 20% in FY 1985.

However, the subsequent strong yen, large drop of energy prices and growing consumers' needs for higher value added products requiring more energy consumption for production have caused the reduction of specific energy consumption to be stalemated.

3.3.2 Typical energy conservation measures

Table 3-1 Typical energy conservation equipment and energy conservation techniques

(1) Energy conservation equipment and energy conservation techniques adopted hitherto

Item	Content	Adoption rate	Quantity of saved energy
Continuous caster	Ingot making and blooming are not required, to enhance the yield. Furthermore, the slab delivered at high temperature decreases the fuel used in the heating furnace.	95%	628–837 MJ/t
Direct rolling or hot charge rolling	The heating furnace in the rolling process is not required, or the slab remaining hot is charged into the heating furnace to allow the decrease of fuel.	50–60%	1047–1256 MJ/t
Continuous annealing process	The annealing of cold rolled steel sheet is effected in one step, to enhance the yield.	—	293–419 MJ/t
Blast furnace top-pressure recovery turbine	When gas is recovered from the top of blast furnace, the pressure of the gas is used to drive a turbine for power generation.	92%	377–502 MJ/t
Coke dry quenching	An inert gas is used for cooling the hot coke delivered from coke oven, to recover the heat as steam.	72%	837–1256 MJ/t
Converter gas recovery	The gas evolved from converter is recovered as fuel gas.	90%	837–1005 MJ/t
Scrap pre-heating	The raw scraps are preheated by the sensible heat of electric furnace exhaust gas, etc., to decrease the power consumption of electric furnace.	60 units	293–460 MJ/t
Water cooled wall type electric arc furnace	Furnace wall is cooled by water, to realize highly efficient and high voltage operation.	—	293 MJ/t

(2) Energy conservation equipment and energy conservation techniques in future

Item	Content	Adoption rate	Quantity of saved energy
Coal moisture control system for coke oven	The moisture content in the coal to be charged is decreased beforehand, to decrease the fuel used for heating in the coke oven.	40%	107 MJ/t
Dry blast furnace top-gas pressure recovery turbine	Bag dust cleaner from blast furnace gas is effected to enhance power generation efficiency.	26%	63 MJ/t
Enclosed converter gas recovery equipment	The converter port is structurally enclosed, to reduce the loss of recovery.	2%	84 MJ/t
Slag sensible heat recovery process	The sensible heat of hot slag delivered from blast furnace, converter, electric furnace, etc. is recovered.	0%	117 MJ/t
DC arc furnace	Conventional AC type is replaced by DC type, to enhance the specific power consumption.	1%	209 MJ/t

(1) Continuous caster

A continuous caster is typical equipment for decreasing production steps, to achieve the conventional three steps of ingot making, soaking pit and blooming by one step, and thus is a rationalization apparatus for achieving energy conservation and product yield enhancement.

The quantity of saved energy reaches 628–837 MJ per ton, and the adoption rate is 95% at present.

(2) Direct rolling or hot charge rolling

Conventionally the continuously cast slab is cooled and conditioned, and heated to be rolled. However, the direct rolling does not require the cooling or heating, and is practically applied in a few plants at present.

Hot charge rolling is to charge the continuously cast slab into the heating furnace while it remains as hot as possible.

Direct rolling and hot charge rolling almost halved the fuel consumption of heating furnaces, and the quantity of saved energy is 1047–1256 MJ per ton. The adoption rate is 50% to 60%.

(3) Continuous annealing process

The continuous annealing process effects the electric cleaning, annealing, skinpass rolling and conditioning of cold rolled steel sheet by one unit of continuous equipment for contributing to the enhancement of yield and productivity.
The quantity of saved energy is 293–419 MJ per ton.

(4) Blast furnace top-pressure recovery turbine

The blast furnace top-pressure recovery turbine is rotated by the pressure of the gas discharged from blast furnace top and recovered as a fuel, for power generation. The quantity of saved energy is 377–502 MJ per ton.
Recently, to enhance the power generation efficiency, some blast furnaces adopt a dry method instead of the conventional wet method for collecting dust from the gas. The quantity of saved energy increases further by about 63 MJ per ton.
The adoption rate is 92%.

(5) Coke dry quenching

The coke dry quencher quenches the hot coke (about 1000°C) by an inert gas such as nitrogen, to substitute the conventional wet quenching, and the heat is recovered as steam of 300° to 500°C by a boiler.
The quantity of saved energy is 837–1256 MJ per ton, and the adoption rate is 72%.

(6) Hot stove waste heat recovery

The combustion exhaust gas of hot stove is discharged at 220° to 280°C. The sensible heat of the exhaust gas is recovered by heat exchange between the exhaust gas and the air for combustion, etc. The adoption rate is almost 100%, and the quantity of saved energy is 84–167 MJ per ton of pig iron.

(7) Scrap pre-heating

The exhaust gas sensible heat of electric arc furnace is used for heating raw scraps up to about 300°C before charging them into the electric are furnace. The quantity of saved energy is 293–419 MJ (30–45 kWh) per ton of crude steel.

4. Afterword

Thirty years have passed since the first oil crisis. In this time span, the changes in the environment surrounding the iron and steel industry, that is, changes in production as found in iron and steel production equipment and operation techniques, changes in products in relation with the changes in demand structure, and changes such as the tendency toward higher value added products to meet changing consumers' needs brought about large changes in energy consumption in the iron and steel industry.

In these changes, we, the iron and steel industry, took various energy conservation measures to maximize the energy utilization efficiency in iron and steel production.

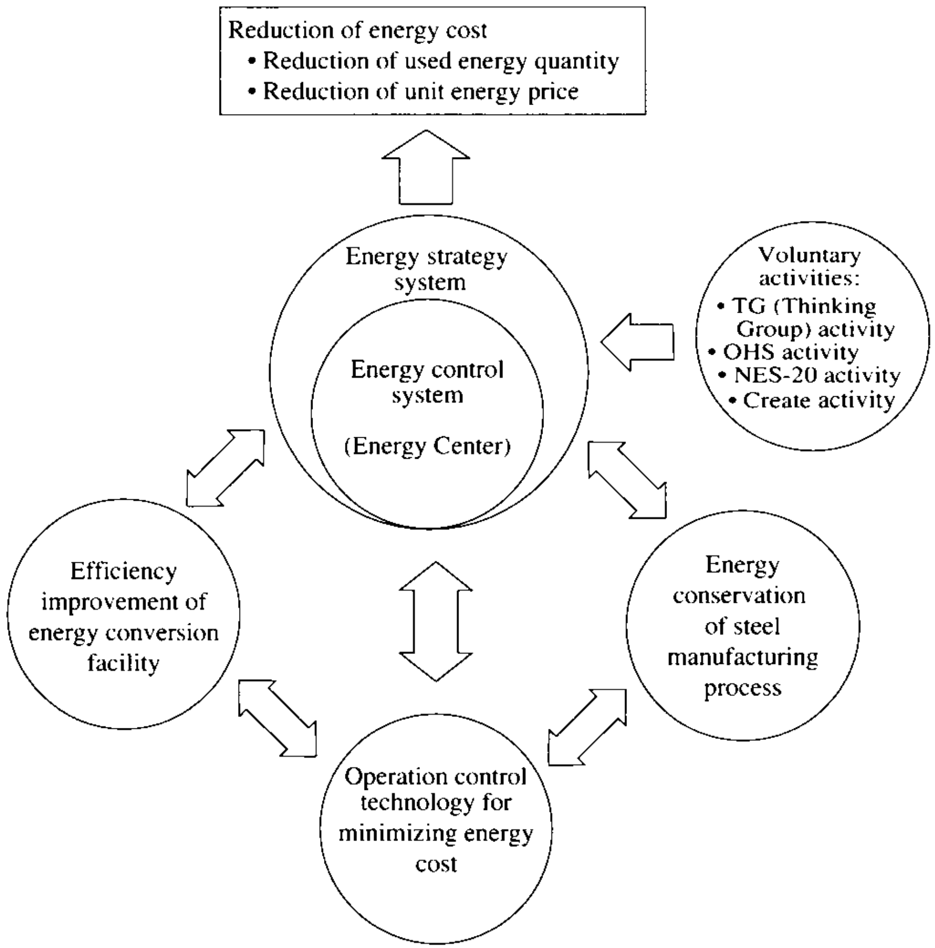
At present, the global warming issue has highlighted the necessity for energy conservation measures, and we, the iron and steel industry, recognize that the present situation necessitates further promotion of energy conservation measures also in future even though the conventional dramatic improvement cannot be expected, considering that major energy conservation measures such as continuous casting and waste heat recovery have been adopted up to high percentages.

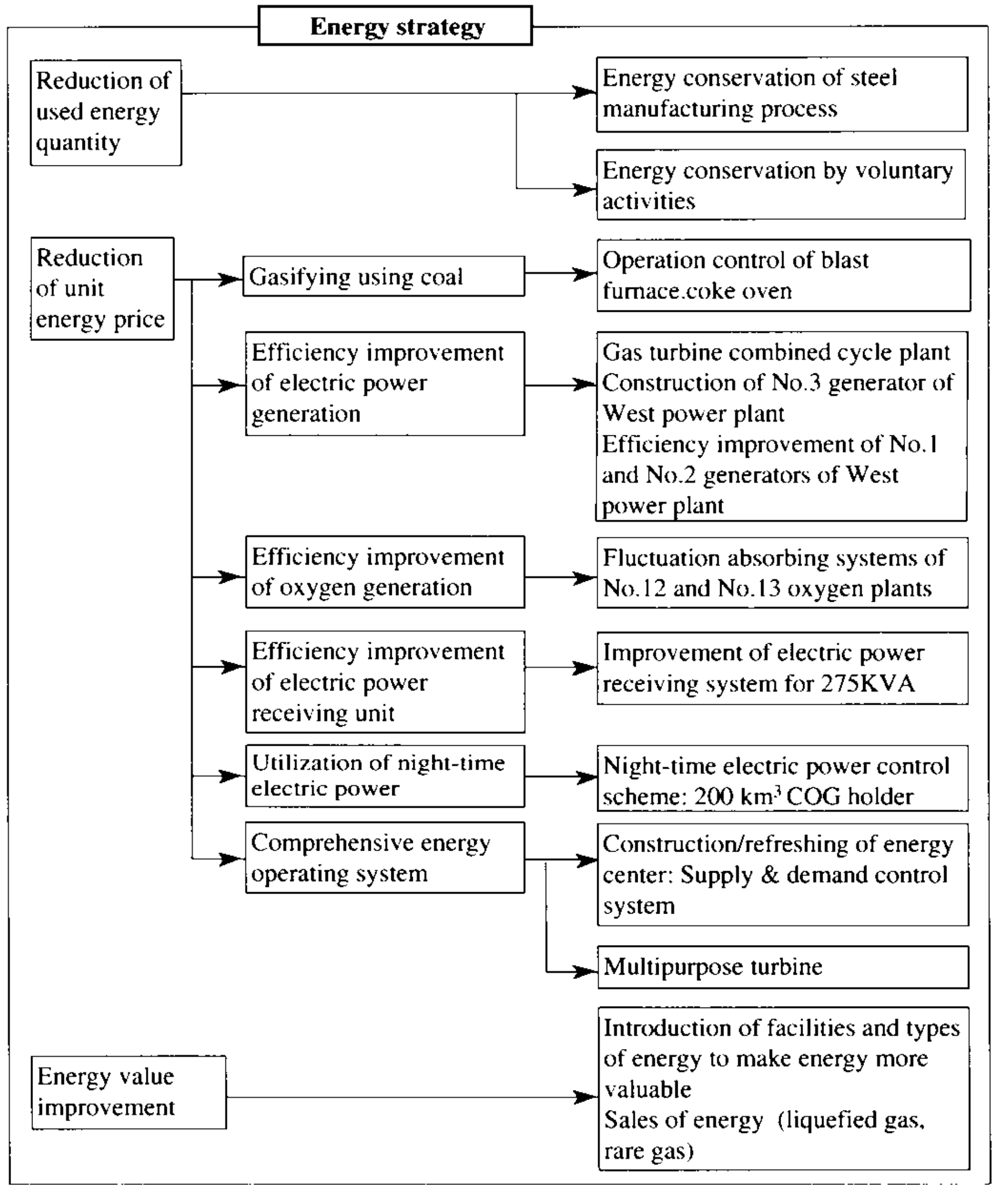
Appendix

Energy Conservation Activities of East Japan Works, Chiba in JFE Steel Corporation

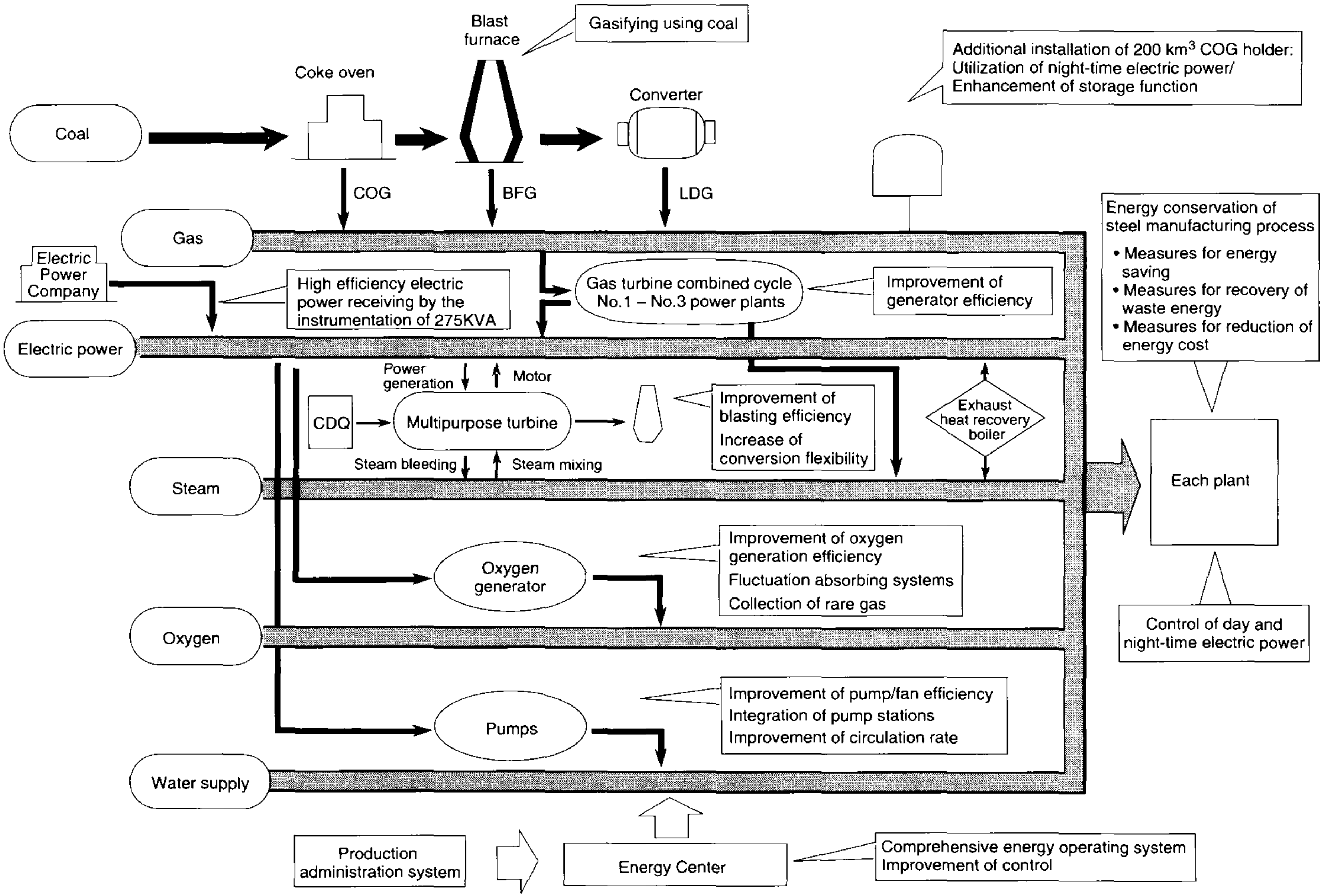
CONTENTS

1. Basic Strategy for Promoting Energy Conservation

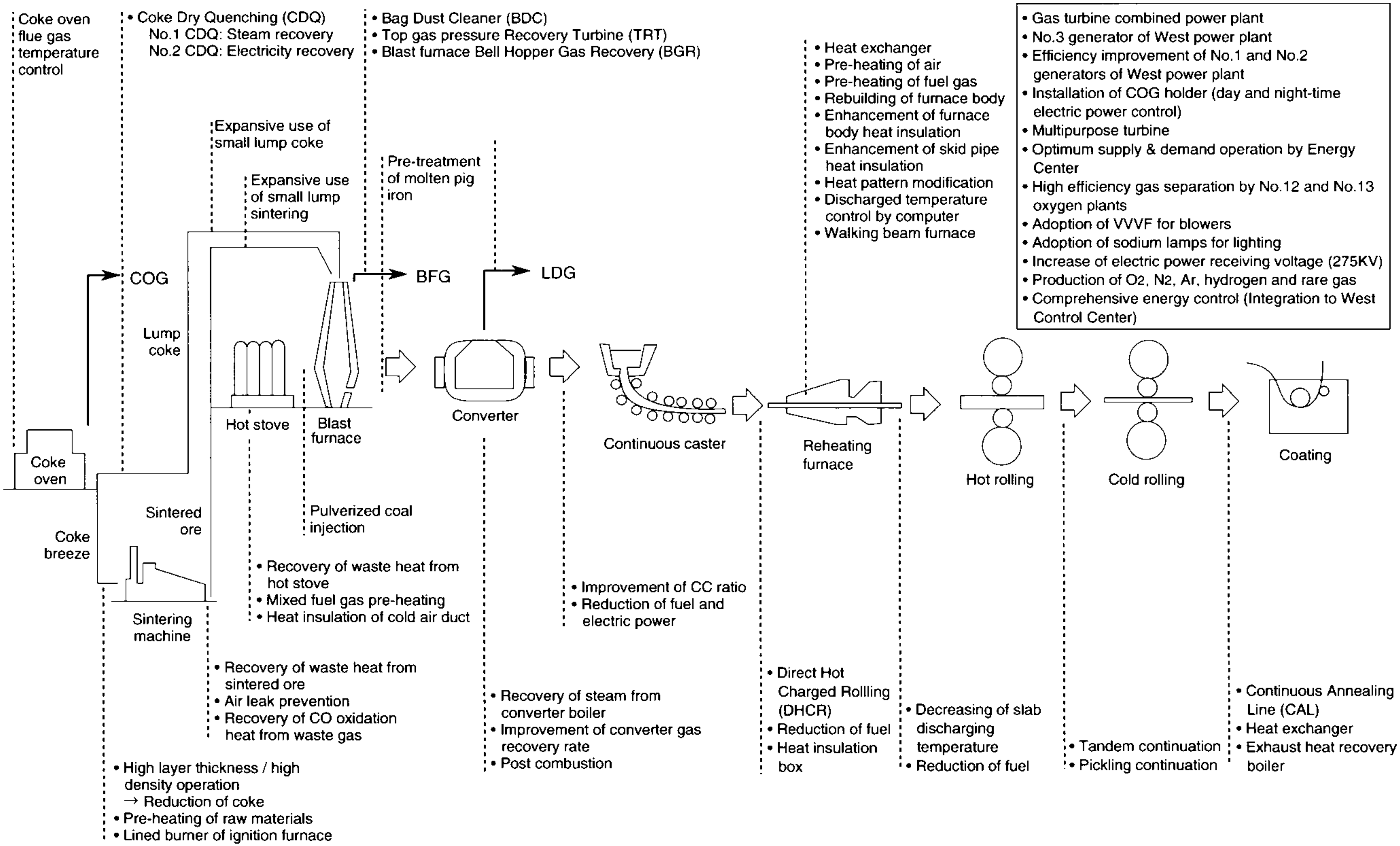




2. Energy Strategy of East Japan Works, Chiba

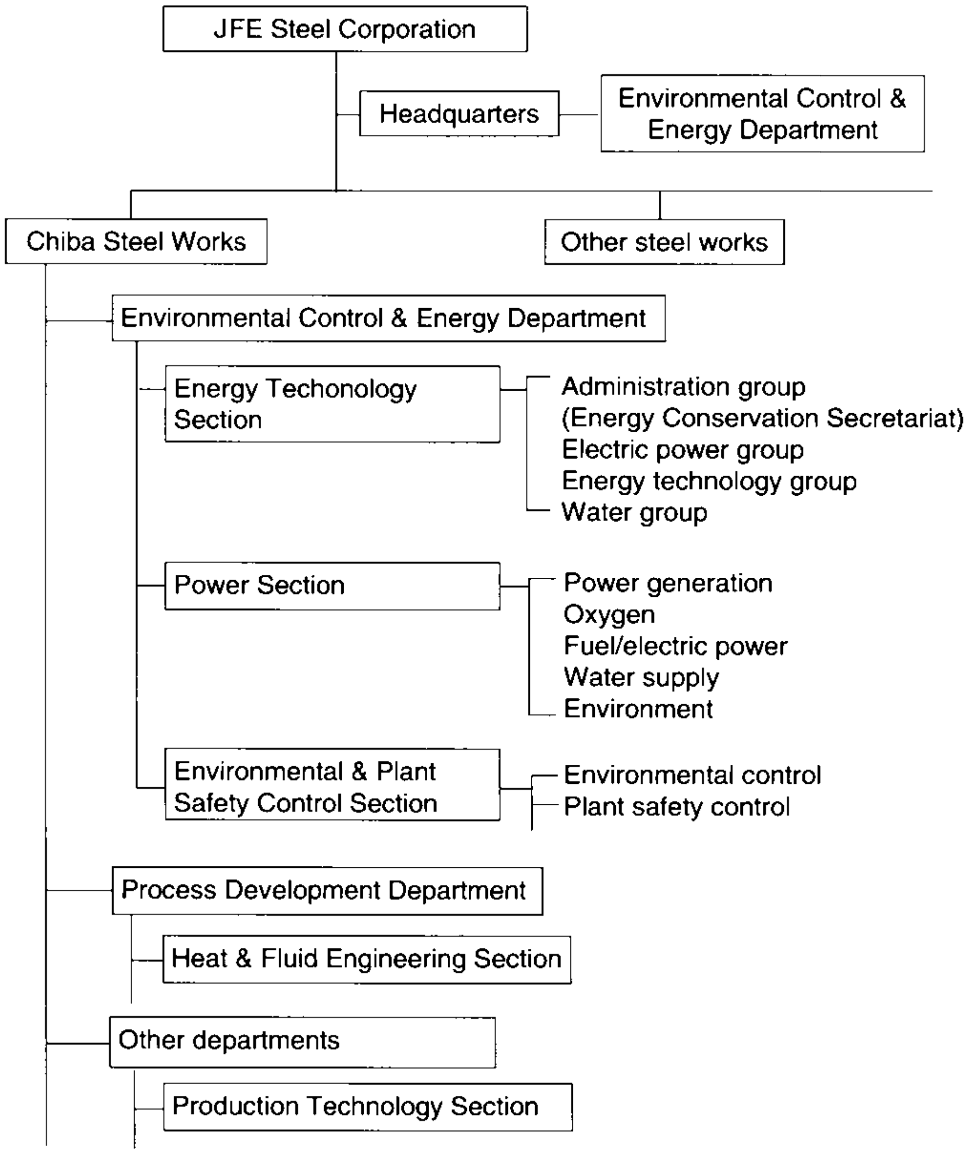


3. Major Energy Conservation Measures



4. Energy Administration Organization

Organization



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