STEEL MAKING IN PORT TALBOT WORKS OF BRITISH STEEL CORPORATION

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Port Talbot is a small town in South Wales situated between Swansea and Cardiff on the Bristol channel. It has port facilities for handling the raw materials used in steel making. On land it is linked to other steel works and associated industries by rail and road.

Seventy five years have now passed since steel was first made in this works. Continual development has gone on making the average age of the plant about twenty years, however, as a comparison with other works on the continent and in Japan will show, this is a relatively long span. A description of the steel making process will be divided into the following sections; raw material handling, iron making, steel making, hot mills, cold mills and finishing.

Raw Material

Iron making requires three main raw materials. The most important is iron ore which is in this case imported. Port Talbot gets its supplies from Canada, Australia, Brazil, Sweden, Angola and Liberia. Imported ore is favoured because of its high iron content when compared with home ore. At the Port it is off loaded and conveyed on belts to a stockyard. For best results the ore has to be prepared before it is charged. It is crushed,screened and blended. The very fine particles from screening are mixed with flux and coke breeze and then processed through the sinter plant. This plant converts the fine particles into bigger grains,easier to handle in the furnace. Particles too fine for the sinter plant are pelletised by being mixed in large rolling drums, followed by firing on grates. A modern sinter plant just been commissioned. It has been rated as a very clean and highly automated plant - a result of strict environmental pollution control. Other materials which go into the sinter plant and directly into the blast furnance are coke and limestone. The coke is processed from coking coal in coke ovens prior to being used.

Iron Making

(i) The Plant

The blast furnace is the centre of iron making. The furnaces used in Port Talbot are of the conventional type shown diagramatically in fig. 1. Even the real model is very similar in structure to the type used in the 19th century. However, a lot of modification has been carried out so that while the former furnaces produced 30 tons/day the current ones in Port Talbot produce up to 3300 tons/day.

The largest furnace has a diameter of 9.45 m and a height of about 50 m. Impressive as it may sound it is still very small compared to its contemporary in Japan, the Oita No. 12, which has a heath diameter of 15 m and an output of 12,000 tons/day. Other developments, besides size, include a computerized weighing, batching and charging systems.

(ii) The Process

The chemical reactions in iron making are outlined in fig. 1. The inputs into the furnace are the burden (mixture of lime and coke and ore) and air blown from tuyeres. A mixture of oil and natural gas is also injected to provide fuel. Formerly the only fuel was coke. The outputs are iron and slug.

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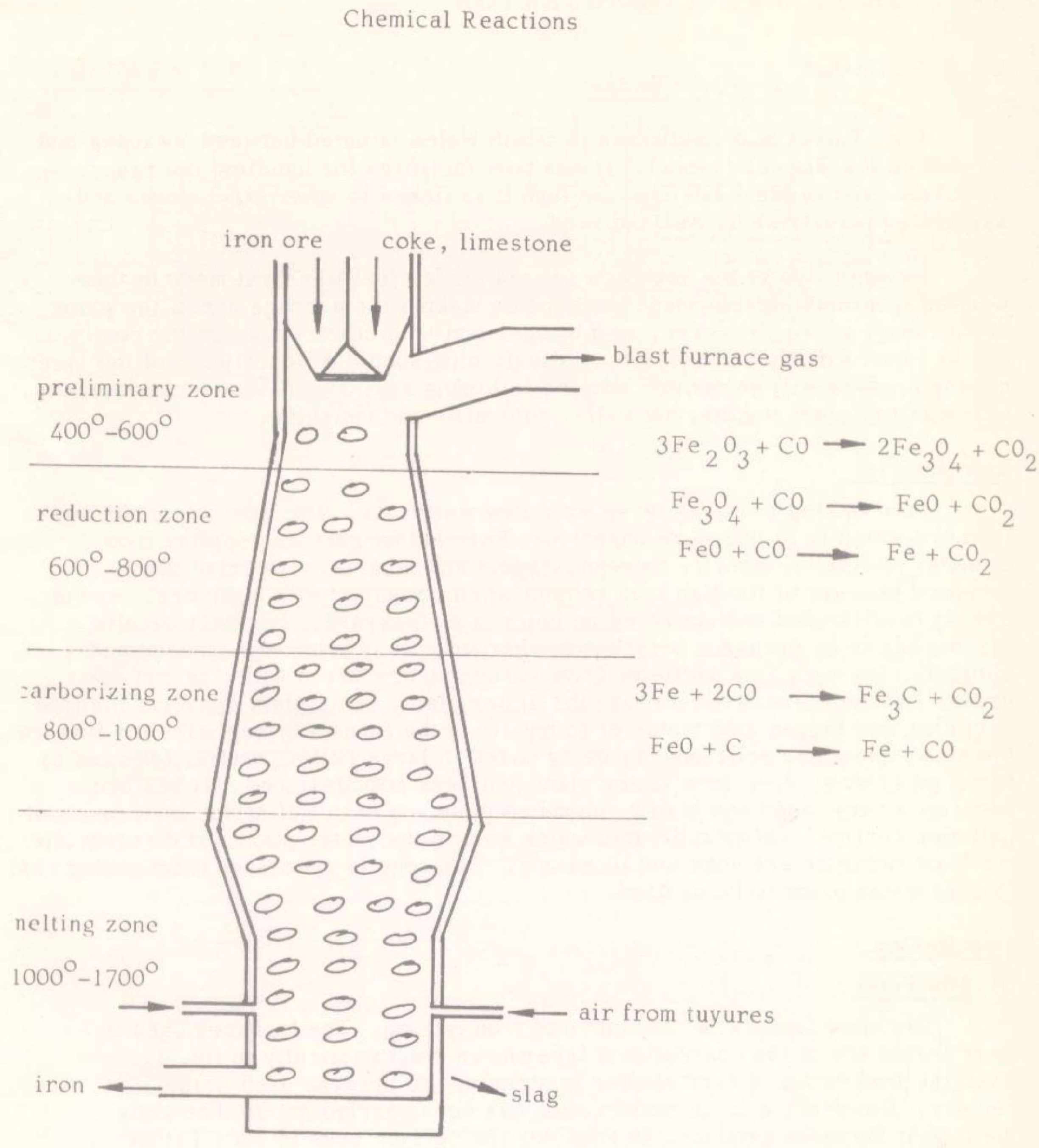
Chemical Reactions
iron ore
coke, limestone
blast furnace gas
preliminary zone
400°-600°
$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$
reduction zone
600°-800°
$Fe_3O_4 + CO \rightarrow FeO + CO_2$
$FeO + CO \rightarrow Fe + CO_2$
carborizing zone
800°-1000°
$3Fe + 2CO \rightarrow Fe_3C + CO_2$
$FeO + C \rightarrow Fe + CO$
melting zone
1000°-1700°
air from tuyures
iron
slag

Figure 1

Steel Making

In most works, iron is no longer a final product. It is a stage towards steel making. The liquid iron tapped from the blast furnaces is transported in torpedo ladles to the Basic Oxygen Steel Making (BOS) plant. The B.O.S. plant also receives scrap metal, iron and fluxes. These are charged into a converter which normally holds about 250 tons of molten iron and 100 tons of scrap metal. Oxygen is blown through the mixture for 20 minutes raising the temperature from 1300^{o} C to 1600^{o} C. During the blowing, most impurities are reduced to either slug or gases which leave the vessel. An elaborate electro-static system cleans the gases to remove fine dust and hence cut down pollution. The converter is tapped every 45 minutes. The steel is collected in ladles and taken on rails to the casting bay, where it is poured into moulds. After solidification the moulds are transferred to the stripping bay. In Port Talbot there are two converters working alternately and with a weekly output of 65,000 tonnes.

The B.O.S. plant incorporates a degassing unit for special purpose steel making. This unit rids a charge of steel of gases (mainly nitrogen) to make better alloys. Electric steel (silicon steels) which account for 5% of the production are made in this way.

Hot Rolling Mill

Ingot moulds received in the stripping bay are stripped by cranes. Often they are put in the stockyard from where they are either sent to the soaking pits or sent out as "exports". In the soaking pits the ingots, which will have spent sometime in the bay, are heated to a uniform temperature of 1288^{o} C before they are sent to the Universal Slabbing Mill. The fuel used in the soaking pits is blast furnace and coke oven gas mixture.

Ingots spend between three hours and a whole day in the pits depending on their entry temperatue. Immediately after the ingots arrive on the slabbing mill they are rolled. Slabbing starts with a set of vertical rolls and ends with horizontal rolls. The slabs go through a scarfing machine which removes surface defects by burning them off in oxygen/natural gas mixture and remove them with a jet of water. Normally the slabs are stocked, reheated and then hot rolled. In Port Talbot there are five reheat furnaces fired by either oil or gas. The sequence of hot rolling is vertical edging, surface breaking, roughing, finishing, water spraying and coiling. The reduction in thickness is from 220 mm for the slab to 5 mm for the sheet.

Cold Mills and Finishing

The coil received from the hot mill is reduced further in the cold mill. First it is passed through a pickle line consisting of a number of hydrochloric acid tanks. Then it is cold rolled on either the five-stand or the three-stand mill. The specification from customers determines what is to be done after this final rolling stage. Some customers want annealed and tempered strip, in which case it is taken through the two stages then either cut into sheets or coiled. Others like a galvanized sheet in which case it is diped into a hot zinc pot and then coiled again.

The latest developments in the cold mill have been the inclusion of a process line computer. Data is fed into a terminal predetermining various coil parameter such as thickness, width and length. The entire rolling process is controlled on the computer so that rolling speeds, pressures, etc., are automatically adjusted. The same terminal will output a printout on which the resulting coil parameters and deviations can be read.

Summary

In this essay, steel making in a conventional style works has been described. The works layout is illustrated in (ref. 4). A number of factors have influenced the layout among them environmental pollution legislation and shortage of space during the days when the works was expanding. It will be noted that in the traditional design a source of coking coal is necessary. Where this coal is available naturally, it first has to be processed in coke ovens which add to the complexity of the works and creates environmental problems. For these reasons the direct reduction plant is advantegeous especially in countries with a cheap source of natural gas and electricity. The direct reduction works (ref. 5) incorporating continous casting plants have been strongly recommended to developing countries; they are comparatively economical and have low demand for scrap metal.

Reference

1. Bates, M.P. & Harrison, W.R. - Blast furnace practice Britain v Japan: Metals & Materials, October, 1977.

2. Watkins, R. & Corbett, B.H. - Computer Control of Charging of Port Talbot No.4 Blast Furnace. B.S.C. Subject Bulletin, 1978.

3. Bouman, R.W. - Historical Development of the Blast Furnace - Part I - Paper presented at McMaster University, Hamilton, Ontario, Canada, June, 1977

4. _____ Basic Oxygen Steel Making Plant: Port Talbot

5. Hamilton, J.G. & Amaya, L. - HYLSA's Puebla 11 direct reduction plant.

6. _____ Introduction to the Universal Slabbing Mill process area. B.S.C. Port Talbot, Technical Publications - March, 1976.