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THE ACTUAL SITUATION AND CURRENT PROBLEMS OF THE IRON AND STEEL INDUSTRY IN SOUTHERN RHODESIA

by

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HISTORY.

The formation of the Iron and Steel Industry in Rhodesia was based initially on the requirements of the Mining and the Agricultural Industry, expanding to its present position from very small beginnings.

The first Steel Company was formed in Bulawayo in 1937, the idea being to make rolled steel sections, by piling iron scrap into bars, and then rolling the bar to the required section. It was realised that this method was unpractical, subsequently a 5 ton Electric Furnace was installed, and produced the first cast in August, 1938.

The equipment in the plant at that time consisted of the following:-

(a) One 5 ton basic Electric Furnace. Casting Ingots 4' 6" long, $6\frac{1}{2}$" square at top, and $5\frac{1}{2}$" at the bottom.

(b) Two batch reheating furnaces.

(c) Two mills, a four stand 12" mill, and a four stand 10" mill, each driven by a steam engine, with a rope drive to the flywheels weighing 20 ton and 30 ton each.

(d) A ball stamp for making grinding media for ball mills.

The products produced from the mills were mainly reinforcing rounds, light angles, flats and balls.

With the event of the Second World War, demand for locally produced iron and steel grew. This demand resulted in serious consideration being given to installing an Open

Hearth Furnace in the Bulawayo Plant, together with a Blast Furnace to produce Pig Iron from low grade Iron Ore, which was to be found in the Bulawayo area.

In 1942, The Southern Rhodesian Government formed The Rhodesian Iron and Steel Commission, which took over the assets of The Rhodesian Iron and Steel Company.

The Rhodesian Iron and Steel Commission moved its main operation to the Iron Ore and Limestone deposits at Redcliff; where the following plant was installed:-

(a) One Blast Furnace producing 120 short tons per day of Pig Iron, followed in 1954 by a second Blast Furnace producing 150 short tons per day.

(b) One 25 ton Gas Producer fired basic, Open Hearth, and a 5 ton basic Electric Furnace. This was followed by a 75 ton basic Open Hearth in 1955.

(c) Three mills, 21", 12" and a 10" for rolling sections.

Operations were continued until 1957, when the Rhodesian Iron and Steel Company took over from the Government Commission, and instituted a development programme, which gave rise to the present plant.

<u>The Actual Plant at present.</u>

At Redcliff the Rhodesian Iron and Steel Company's Works comprises of the following plant:-

(a) Crushing, screening and stock piling equipment for handling Iron Ore and Limestone.
(b) Sinter Plant.
(c) A Coke Oven Plant.
(d) Three Blast Furnaces.
(e) Two Open Hearths and an Electric Furnace.
(f) <u>Mills</u> : 38" Blooming Mill. 21", 12" and 10" Section Mills.
(g) Sheet and Plate Mill.

<u>Raw Materials.</u>

<u>Iron Ore.</u>

The Iron Ore for the plant at Redcliff is obtained from three deposits, adjacent to the Works. These deposits give the following typical analysis:-

	% Fe.	% Sio2.	% P.	% S.
North Hill	61.6	6.3	.050	.005
Central Hill	57.9	9.7	.060	.005
Orpheus	65.2	3.0	.040	.005

Limestone.

The Limestone is obtained from the quarry adjacent to the Works, and has the following typical analysis:-

% CaO.	% MgO.	% Al2O3Fe2O3.	% P.	%S.	% Insol.
48.5	4.0	2.2	.006	.082	1.6

Material Handling Plant.

Iron Ore.

The ore is delivered by lorry to a primary jaw crusher, dimension 36" x 24". From the primary crusher it passes over primary screens, the oversize material being returned to a Newhouse 10" gyratory crusher. All material passes over a secondary screen giving two final sizes of - 2.7/8" + 1/4" and - 1/4". The large material is fed to stockpiles, by traversing tripper. The stockpile capacity is 50,000 short tons. The - 1/4" material is delivered to the Sinter Plant by conveyor.

Limestone.

The Limestone is delivered to a separate plant from the Iron Ore. The Plant consists of a primary jaw crusher, followed by a secondary gyratory crusher, which produces the Blast Furnace size required. A tertiary crusher is incorporated in the circuit for producing Limestone for the Sinter Plant. The sizing is as follows:- -2.1/2" x 3/8" for Blast Furnace, and -3/8" for the Sinter Plant.

The Limestone stockpile capacity is 18,000 tons.

Sinter Plant.

The Sinter Plant is a Huntington Heberlein design, built by Simon Carves, United Kingdom.

The Plant consists of:-

Strand Width	4 ft.
Bed Depth	10 inches.
Wind Boxes	12
Fan Motor	750 H.P.
Wind Volume	6,000,000 cu. ft. hour.
Strand Cooler box blower	

Instruments.

Automatic weighing on coke fines and flue dust.

All materials tray weighed.

A George Kent Mixing Station to enrich Blast Furnace gas with Coke Oven gas to raise the C.V. of gas delivered at the ignitor to 105 B.T.U. cu. ft.

Operation.

The daily output from this plant is 500 tons per day, but this depends largely on the Blast Furnace requirements.

Typical Burden.

Coke	3.6 tons
Flue dust	2.0 tons
Heamitite Ore	25.0 tons
Limonite Ore	9.0 tons
Orpheus Ore	9.0 tons
Return Fines	14.0 tons
Limestone	11.0 tons

These ores are mixed in varying proportions to control the Manganese and Silicon percentages in the finished sinter.

The Limestone addition is made to obtain a Sio2, Cao, ratio of 1 to 1.3, thereby maintaining a self fluxing sinter.

The strand speed is maintained at approximately 7.6 feet per minute and cooler speed 5.2 feet per minute.

The return fines are prescreened + 3/8" being used as a hearth layer and the -3/8" is returned to the Sinter Plant.

Discharge.

The discharge passes through a sinter breaker onto a Schenck screen, the + 1/2" is sent to the Blast Furnace bins on a conveyor.

Coke Ovens.

Coal.

The coal as nut pea duff is purchased from the Wankie Colliery Co., Southern Rhodesia.

Typical Analysis.

Moisture	Vol.	Ash.	S.
4.0%	27.2%	12.5%	1.9%

The coal is delivered in 40 ton wagons, which are off-loaded into a bunker by a wagon tippler. The coal is then fed to a washery where the ash is reduced by means of gravity separation to 9.5%. The separating medium is fine magnetite in suspension, operated at an S.G. of 1.55, and the approximate discard at this S.G. is about 8%, consisting mainly of shale. After washing, the coal is pulverised to 20% + 1/8 80% - 1/8, the moisture is controlled at 8 to 8.5%. The coal is oiled with a furnace oil, at the rate of 0.4 gallons per ton of coal.

The coal is delivered by conveyor to a service bunker, of 2,000 short tons capacity.

The oven is a Coppee compound regenerative under jet in two batteries of 25 ovens each.

The coal is drawn from the service bunker to charging car, where it is weighed. The quantity charged per oven is 16.5 tons dry. The carbonising time is approximately 20 hours. The daily production of Blast Furnace coke is 680 short tons, and - 3/4 coke breeze 50 short tons per day.

The quality of coke produced is as follows:-

Chemical Analysis.

% Ash.	% Vol.	% S.	% H_2O
12.5	1.0	1.15	1.0

Shatter	91.0% + 1.1/2".
Abrasion	76% + 1/8".
Bulk Density	32 lbs. cu. ft.
By-Products	
Gas	9,400,000 cu. ft. day
Gas Calorific Value	525 B.T.U. cu. ft.
Tar	7,300 gallons per day.
Crude Benzole	57,000 gallons per month.
Motor Spirit	45,000 gallons per month.

Ammonia is run to waste.

Blast Furnaces.

The plant consists of three furnaces, the details of which are as follows:-

	No. 1	No. 2.	No. 3.
Hearth diameter ft.	9'	10'	17'
Average production short tons per day.	140	190	670
Coke ratio lbs. per ton iron	1500	1500	1400
Blast volume cu. ft. minute.	13000	15000	40000
Blast Heats.	550/660°C		700/850°C1
Large bell diameter ft.	6' 6"	6' 6"	11' 0"
No. tuyeres	6	8	12
Diameter of tuyeres inches.	3.1/2 + 4"	3.1/2 + 4"	6"
Refractories.			
Hearth	Firebrick	Carbon	Carbon
Bosh	Firebrick	Carbon	Carbon
Stack	Firebrick	Firebrick	Firebrick
Cooling.	Banded bosh Flat Cooler Spray Cooled Hearth Jacket	Flat Cooler at Tuyer Spray cooled bosh and Hearth Jacket.	Flat Cooler in Stack
Stoves No.	5 Stoves for No. 1 and 2 furnaces.		3
Dimensions Height ft.	80'	80'	98'
dia. ft.	16'	16'	20'
Refractories.	Firebrick	Firebrick	Firebrick
Instruments.			
Stock line recorder and visualizer.	Yes	Yes	Yes
Hot Blast temperature Control and recorder	Yes	Yes	Yes
Blast Volume recorder and visual indicator	Yes	Yes	Yes
Inwall temperature recorder	No	No	Yes
Steam Addition Controller	No	No	Yes
Dome and trunk, stove temperature recorder and controller	Yes	Yes	Yes
Clay Guns	Air	Air	Electric

Instruments (cont'd)	3 Stoves for No. 1 and 2 furnaces		3
Hand pneumatic tapping jack	Yes	Yes	-
Remote tapping jack	-	-	Yes
Tap Hole	Clay	Clay	Carbonatious mix.
Coke Bins	5	5	2
Limestone Bins	4	4	2
Iron Ore Bins	7	7	3
Sinter Bins	4	4	3
Manganese Ore Bins	-	-	1

No. 3 Furnace.

This furnace has twin skips equipped with weight scales for charging the furnace.

No. 1 and 2 Furnaces.

Raw materials transferred from the bins to two transfer cars, which are weighed on a weighbridge, then the charge is dumped in single skips.

Operation.

The output from all three furnaces is mainly basic iron, but high silicon iron is made to order.

Basic Analysis.

Si.	S.	Mn.	P.	C.
1.2 max.	.05 max.	as required	0.1	3.5/4.5

The vast bulk of the iron produced from these furnaces is for export. Local orders are supplied as required, and some iron is sent to the Steel Plant when a surplus arises. The iron from No. 1 and 2 furnaces is tapped into 30 ton ladles and cast into 60 lb. pigs, which can be broken in two pieces. The metal is taken to No. 1 Pig Casting machine which is a single strand moving wheel type, spray cooled. The iron from No. 3 furnace is tapped into 75 ton ladles and cast into 60 lb. pigs, which can be broken into two pieces. The metal is taken to No. 2 Pig Casting machine which is a single strand moving wheel type, spray cooled.

Slag Disposal.

The slag from No. 1 and 2 furnaces is run into 9 ton slag ladles and taken to the slag dump by locomotive where it is tipped to waste.

The slag from No. 3 furnace is granulated and is sold to a Company who intend manufacturing Blast Furnace slag cement in the future.

<u>Gas Cleaning Plant.</u>

Dirty gas from the Blast Furnace primary cleaning cyclones is conveyed by means of a six foot brick lined gas main to the gas cleaning plant. At this stage the gas is at 180 - 220°C, 20 - 30" W.G., and contains approximately ± 15 grains per cu. ft.

Two washers or scrubbers capable of handling 1.5 m.c.f. per hour each, receive this gas. Gas flowing into the washers impinges on a water seal and then flows upwards through a series of tiles and water sprays, eventually discharging into a common precipitator main. 600 gallons of water per minute, at 22°C is used in each washer, and these running in parellel remove approximately 68% of dirt carried by the gas.

From the common precipitator main, gas flows into three Head Wrightson Research electro static precipitators, these consist of single compartment tanks containing 196, 15' x 8" tubes, a bottom water seal and overflow, a top water weir with cleaning sprays, gas inlet (at the bottom) and outlet (top) pipes, and suitable insulated frame to carry a high D.C. voltage (up to 70,000 v at 250 - 300 milli amps) through the 196 anodes.

Water overflows from the weir at a comparatively slow rate, down the inside walls of each tube and hence discharges into the water seal.

Through each tube, and suspended by an insulated frame are 1/4" square twisted steel centre electrodes, these acting as the anodes and the tubes as the cathodes, dust particles in the gas flowing through the tubes are ionised and thrown to and collected by the water.

Each precipitator is designed to handle 1.0 m.c.f. of gas per hour at maximum normal loading giving a clean gas containing 0.005 or less, grains of dust per cu. ft. Under certain conditions though, the flow may be increased to 1.5 m.c.f. per hour, this generally applies when one precipitator is taken off for cleaning, or maintenance, and means a general falling off of cleaning efficiency.

Water used on the plant is recirculated continuously at a rate of 116,000 gallons per hour. This is pumped through the washers and precipitators, and from these, flows by gravity to the 80' clarriflocculater, Aluminium Sulphate is added at the rate of 2 lbs. per hour to this flow to aid in the settling of solids. Sludge is removed continuously from the thickener by two diaphragm pumps, pumping into sludge dam.

Clear water overflowing from the clarrifloocculator gravitates to a sump, and from this, is pumped through a slatted timber cooling tower which reduces the water temperature by some 5 to 6°C and thence to the main sump, which feeds the washers and precipitators. Approximately 35,000 gallons of water per day are required for replacement of evaporation losses, etc.

It has been found in practice, that Ph control of this water is very difficult, but it has been shown that a Ph of 6.8 or 7.0 gives the best results in settling out the solids.

Gas flowing from the precipitators either goes to a consumer, or to a 2.0 m.c.f. gas holder, depending on the demand. If it happens that the gas holder is full and the demand is slight, dirty gas is bled to the atmosphere through the Blast Furnace bleeders, this practice is adopted to get a longer cleaning life from the plant.

The 2.0 m.c.f. gas holder is of the free moving tar sealed piston type, and this piston is weighted to control the clean gas pressure at 10.5" W.G.

Attached to the gas cleaning plant is a gas control room where all gas flows, both Blast Furnace and Coke Oven gas, are recorded, and controlled to different consumers.

Steel Plant.

The Steel Plant consists of two 75 ton Basic Open Hearth furnaces, and a four ton Electric furnace.

The Open Hearths are in one building which is divided into three sections.

(1) Scrap and Raw Material bay, served by a 15 ton overhead crane, fitted with a 5 ton magnet. In this bay are 22 lifting trays, each containing 5 charging boxes, 7 ft. by 1' 9" by 1' 9". Also in this bay is an Avery Weighbridge, for weighing charge make up material.

(2) This, the centre bay, contains two furnaces, served by a 4 ton Arrol charger, and a 50 ton overhead crane.

(3) This bay is the teeming bay, served by a 100 ton crane. There are five 75 ton firebrick lined tapping ladles. The moulds are placed in sets of six, for uphill pouring of the ingots.

Open Hearth Furnaces.

The two furnaces called "B" and "C" were originally producer gas fired, but have since been converted to Coke Oven gas and tar firing. The gas and tar are by-products of the Works Coke Ovens. The furnaces are charged with scrap and hot metal, the percentage of hot metal depending on availability from the Blast Furnaces.

One Open Hearth "B" is at present being converted to the Maez design, with a sprung magnesite brick roof, sloping magnesite brick end walls, and magnesite brick uptakes.

The following table gives the data of the furnaces:-

	"B"	"C"
Overall length	64'	64'
Overall width	19' 3"	19' 3"
Area of Hearth	441 sq. ft.	441 sq. ft.
Depth of bath	28"	28"
Number of doors	5	5
Sloping back walls	Yes	Yes
Uptakes	2	2
Uptakes - Cross Section	41.5 ft. pair	41.5 sq. ft.
Height of sill	2' 9"	2' 9"
Roof ribbed	Yes	Yes
Size of brick in rib	15"	15"
Valley between ribs	12"	12"
Slag pocket	17'4" x 15'	17'4" x 15'
Number of regenerators	4	4
Arched roof	Yes	Yes
Size of opening in Checkers	6.3/8" sq.	6.3/8" sq.
Size of Checker brick	9 x 4.1/2 x 3"	9 x 4.1/2 x 3"
Capacity of forced draft fan	700,000 cu. ft. hr.	700,000 cu. ft. hr.
Reversing valves	Blaw knox Sliding	Blaw knox Sliding
Fuel Used		
Coke Oven Tar galls. per hr.	200	200
Coke Oven gas cu. ft. hr.	50,000	50,000
Burners	Artillery type	Artillery type
Atomising Steam pressure at valves	150 p.s. i	150 p.s. i
Tar pressure at valves	150 p.s. i	150 p.s. i
Steam and Tar ratio	5.6 lbs./steam/gal.tar	5.6 lbs/steam/gal tar.
Tar temperature at burner	200°F	200°F
Steam temperature at burner	330°F	330°F
Tar nozzle diameter inches	5/8"	5/8"
Gas nozzle diameter inches	2"	2"

These furnaces in full production can tap three heats each per day. The production depends, to a large extent on the percentage of hot metal available for the furnaces.

The types of steel made vary from rimmed steel, with ·08% C, to a killed steel with 1.2% C. This wide variation in qualities is required to cover the market requirements. Some low alloy steels containing copper and chrome are made.

During the normal operation, the flushing and tapping slag is run into a 9 ton slag ladle, and removed by locomotives, to the slag dumps. The furnace lining is repaired by means of a Blaw knox dolomite fettling machine.

Instruments.

(1) Carbometer for determination of carbon.

(2) Bath immersion pyrometer.

(3) Furnace pressure control.

(4) Pressure gauges in uptakes and flues.

(5) Radiation pyrometers on roof linked to tar and gas flow to control roof temperature.

(6) Flue temperature recorders and controllers for reversals of the furnace on temperature differences. There is a check on checker temperatures by a radiation pyrometer sighted in the checker chamber.

(7) Tar and gas flow recorder.

The size of ingot produced is 74" high, top 17" x 23.3/4", bottom 19" x 25.3/4", weight 8,200 lbs.

The ingot moulds are sprayed with tar before each tap, and stripped from the ingots by a Wellman, 6 ton capacity screw type stripping crane, developing a pressure of 60 ton, which is housed in the building, containing the soaking pits.

The Rolling Mills.

38" Blooming Mill.

The ingots on being stripped from the moulds are charged hot into the soaking pits by a 6 ton Wellman crane. There are 4 pits, each pit has two cells capable of holding 12 ingots each.

The soaking pits have the following dimensions:-

Cell Height	9'
Cell internal length	6'
Cell internal width	7' 3"

The pits are heated by Coke Oven gas, fired through low pressure burners.

Instruments.

Pit temperature control and recorder.
Gas and air indicator recorder and controller.
Pit pressure recorder and controller.

The ingots are lifted from the pits by a crane and placed in a tilting pot, which lowers the ingots onto the 38" Mill feed table.

The 38" Mill consists of a single stand two high reversing mill, complete with roller table, and manipulators on both sides. The entry side has tilting fingers which turn the bar through 90°. On the outlet side there is a 350 ton Mesta Shear capable of cutting a cross sectional area of 64 sq. inches. The mill rolls are 38.3/4 inch in diameter, with a barrel length of 96 inches into which is cut passes which will take an ingot 17" x 2[illegible].3/4" to 19" x 25.3/4" and by 74" long.

The rolls are driven through 38" helical pinions by a 5000 H.P. D.C. motor energised by a motor generating set. The peak load of the motor is 14,000 H.P.

The roll bearings manipulators and shear are lubricated with Farbal System, but the bottom roll in addition is lubricated with block grease. Feed and discharge table rollers are lubricated with a Denco pressure oil system. The top roll is suspended by ropes lifted by hydraulic rams.

The Screw down is electrically operated by two 75 H.P. motors.

Products.

Blooms are produced in this mill from 5" x 5" to 6.1/2" x 6". The length varies from 7 ft. to 20 ft.

Slabs for the Plate Mill are produced in sizes 12" x 1.3/4" to 15" x 3.1/2".

This mill is capable of producing 400 tons of blooms per shift, but at present, due to the Steel Plant capacity and market requirements, it only operates one shift per day, six days per week.

21" Mill.

The blooms from the 38" Mill are charged into the 21" mill bloom furnace. This furnace can take 6.1/2 x 6" blooms, 20 ft. in length, and deliver them heated to the required temperature at the rate of 40 tons per hour. The furnace is fired by Coke Oven gas and pulverized coal. The coal being used during periods when there is a shortage of gas. The blooms are charged broadside by an Electric pusher, and are carried on water cooled pipe skids set in the bottom of the furnace.

The hearth size of this furnace is 82 ft by 22 ft.

Instruments.

Gas flow recorder.
Furnace pressure recorder, recording eight points.
Kent temperature recorder.

The mill consists of 3 three High Mill stands in line across country.

The roughing stand is equipped with feed rollers on the ingoing side and a lifting table on the delivery side, to lift the bars from the bottom roll to the top. The bars are skidded from the roughing stand to the intermediate stand by wire ropes, connected to pawl skids. The intermediate stand is also equipped with a roller feed on the ingoing side and a lifting table on the delivery side.

The roughing and intermediate stands are coupled together and driven by a 1000 H.P. A.C. motor through a reduction gear and enclosed 3 High Helical pinions. The roll speed is 80 r.p.m.

The finishing stand is equipped with driven rollers on the feed and delivery side. This stand has two speeds, 80 and 120 r.p.m. changeable by switch. It is driven by a 1500 H.P. A.C. motor through a reduction gear and 3 High pinion.

From the finishing stand the bars are carried by driven roller conveyors to a 48" hot saw and a 300 ton Loewy shear, before being allowed to cool on one of 5 cooling banks.

The three stands use texalex bearings, water lubricated, all floor rollers are hand greased.

Products from the mill are as follows:-

Rounds	2" to 4" diameter.
Billets	1.7/8" to 4"
Flats	4" to 12" in width, thickness from 1/4" up to 1.3/8", with size increases of 1/8".
Equal Angles	2.1/2" x 2.1/2" x 1/4" to 1/2". 3" x 3" x 1/4" to 1/2" 3.1/2" x 3.1/2" x 5/16" to 1/2". 4" x 4" x 3/8" x 1/2"
Unequal Angles	3" x 2" x 1/4" to 1/2" 3.1/2" x 2.1/2" x 1/4" to 1/2" 4" x 3" x 1/4" to 1/2"
Channels	3" x 1.1/2" x 4.60 lbs. ft. 4" x 2" x 7.09 lbs. ft. 5" x 2.1/2" x 10.22 lbs. ft. 6" x 3" x 12.41 lbs. ft.

Rails	20 lb. per yard. 30 lb. per yard.
Plough Share	4 lbs. ft.
Grinding Mill Liner	4" x 1.1/4" x 3/4"
Sole Plate	for railway tracks.
Grader Blade	
Sheet Bar	10" and 12" widths up to 1.3/8" thick.

The output from this mill has been up to 12,000 tons in a month including the rolling of billets.

12" and 10" Mill.

Billets produced in the 21" Mill cut to weight according to requirements are transferred to this mill by rail and charged to the furnace.

The furnace is fired by Coke Oven gas, the billets are charged broadside and pushed through the furnace by an electric motor driven pusher.

The inside dimensions of the furnace are 27 ft. by 8 ft. 6 inches.

Instruments.

Gas and air flow recorder and controller.
An electroflo temperature recorder, recording two points.

The 12" Mill has two stands 2 High across country, these stands are coupled and driven through reduction gear and pinions by a 650 H.P. A.C. motor. The roll speed is 125 r.p.m.

The 10" mill is fed by the 12" Mill, it consists of 7, 3 High Mill stands across country. All the stands are coupled together and driven by a 600 H.P. D.C. variable speed motor at 400 to 800 r.p.m., this gives a roll speed of 175 to 350 r.p.m. On the delivery side the bars travel to a 36" hot saw by driven pinch rollers. The bearings on all stands are toxalex water lubricated.

The products produced in these mills are as follows:-

Rounds	3/8" to 1.1/2" rising to 1/8"
Squares	3/8" to 1.1/2" rising to 1/8"
Angles	1.1/4" to 1.1/4" x 3/16" and 1/4" 1.1/2" x 1.1/2" x 3/16" and 1/4" 2" x 2" x 3/16" and 3/8"

Flats	5/8" x 1/8" up to 3" x 1/2" thickness, rising in 1/16" and widths in 1/8"
Window Section	FX7 F7
Plough Beam	
W. Fencing Standard	1.5 lbs. ft.
W. Fencing dropper	6 oz. ft.
Rail Clip	for 91 lb. rail.

Finishing Department.

All finished products from the 38", 21", 12" and 10" mills are delivered to this section for inspection; straightening, bundling and despatching of the products is carried out.

Within this section finished tarred, bundled fencing standards and droppers are made. Rails are punched and ended.

Billets for a tube making plant in Que Que are cut to size and dressed.

Sheet Production

Sheet bars are heated prior to rolling in a continuous reheating furnace to a temperature of approximately 900°C. The furnace is fired with a mixture of coke oven gas and blast furnace gas. Material is conveyed through the furnace by a system of water-cooled walking beams and on reaching the discharge end, the feeder operates a switch which controls the electrically operated discharger. The sheet bars travel along a short conveyor onto the feeder's table which takes the bars to the mill. (3 High)

3 High Mill.

This mill is the primary unit in the production of sheets. It is driven by a 1200 H.P. A.C. induction motor through double helical reduction gears to the universal spindle driving the middle roll. A friction drive in gear with the main reduction train rotates the top and bottom rolls and prevents roll skidding on release of the sheets from the mill. All rolls are special quality cast alloy steel top and bottom rolls being 32" dia. and 60" long and middle roll 20" dia. and 60" long. The top and bottom rolls rotate in water lubricated synthetic resin bounded fabric bearings and the middle roll in grease lubricated totally enclosed white metal bearings.

Two operators control the operation of the mill, one being known as the "feeder" the other the "catcher". The automatic control of the screw down which controls the draft or roll opening is pre-set prior to rolling, depending on the gauge required.

Once set, the mill continues to repeat the sequence of passes at the pre-set drafts simply by the operation of a foot pedal switch. The feeder and catcher tables, the movement up and down of the middle roll and the raising of the catcher's table are all synchronised and interlocked with the roll setting.

2 High Hot Finishing Mill.

This mill consists of a two stand, two high mill, coupled together.

Moulds from the three high mill are pre-heated in a similar furnace to that at the 3 High Mill.

The moulds in threes are delivered to the finishing mill, from the furnace on a chain conveyor. The Mill is non-reversing and after each pass the moulds are returned over the top of the top roll by the discharge conveyor. The mill screw setting is done manually at each pass. The moulds after the run over passes are hot opened, doubled and returned to the furnace for reheating and the finishing passes in the same mill. These mills are driven by a 1300 H.P. A.C. motor.

The rolls are heated by a gas flame and maintained about 390°C during rolling.

The rolls in the mill are ground with a camber gap between the rolls of 42 thousands of an inch. The rolls are of cast iron, chilled to a depth of 3/4".

Shearing Line.

The packs are allowed to cool and then passed through a roller leveller which flattens the sheets prior to shearing to length and width. After shearing the packs of six are then separated by operators known as cold openers.

Products produced.

Flat Black Sheets. Gauges 14 to 26.

Galvanised flat and corrugated sheets. Gauges 20 to 26.

Plate Production.

Slabs for plate production are supplied by the 38" Blooming Mill.

The plate is rolled in two mills, the 3 High Mill, and the 2 High Hand Mill.

The 3 High mill as described in Sheet production is used to roll all the plate up to 1/4" thick, The maximum width of plate is 4', the length varies from 10" with 1/4" thick plate to 16' in 1/8" plate.

These plates are cut on the Shearline, close annealed if required and roller levelled before despatch.

The 2 High Mill is used for rolling plate from 5/16" to 1/2". Maximum size of plate is 8' x 4'.

The slabs for the mill are heated in a gas fired walking beam furnace.

This mill consists of two, two high mills, one with counterbalanced water cooler rolls used for roughing and the other stand with heated rolls is used for finishing.

Screw Down settings are hand operated.

Metallurgy and Chemistry.

The Rhodesian Iron and Steel Company has a well equipped laboratory in the Works, in which all raw material, iron and steel, slags etc., are analysed and other chemical determinations performed. There is also a well equipped Test House, to ensure that the products may fully meet the requirements that may be specified on the orders received. These tests include tensile, impact brinnel, elongation, bend etc. Equipment is also on hand to perform photomicrographic, and photomacrographic tests.

Besides the staff for carrying out the Chemical and Metallurgical work, there are observers on the plant on quality control work.

Conclusions.

An Iron and Steel Industry being developed or in operation in an underdeveloped country has a number of problems. These problems would tend to be similar in any developing country. In Southern Rhodesia they can be summarized as follows:-

(1) Through the unavailability of skilled labour in a country without an Industrial background, trained personnel are often difficult to obtain. Men trained in the skills required have to be obtained from the more developed countries, and demand high wages. This gives rise to the unfortunate position whereby skilled personnel are paid wages out of proportion to the unskilled local population.

To overcome this position training and apprenticeship schemes are in operation in conjunction with institutes of higher learning. This is a long-term process and it will be many years before the country is able to produce enough trained people to run industries.

(2) Difficulty in obtaining spares and stores items at short notice gives rise to the necessity to carry large stocks. This ties up Capital and gives larger quantities of stores items becoming obsolete than would normally be expected.

(3) In Southern Rhodesia the market for the Iron and Steel Industries products is small in any one item. The position arises whereby to obtain a high rate of output the plant requires to make a large number of products to many specifications.

This means in practice the following:-

(a) In the mills roll changes are being made for uneconomic quantities.

(b) Products are being produced from plant for which it was not designed. This often gives rise to an inferior article.

(c) Any by-products which are produced or could be produced cannot be sold or are sold in such small quantities as to be uneconomic.

(d) The market position is further complicated by competition from imports which can be obtained often at a cheaper price than can be produced locally.

(4) Material for export has to be carried long distances by rail to foreign ports.

(5) Certain processed materials required by the Iron and Steel Industry have to be imported; some of these are as follows:-

(a) Ferro manganese

(b) Ferro phosphurous

(c) Ferro Silicon.

FIGURES

Illustrations for this document will be circulated at a later date under symbol STEEL SYMPOSIUM/1963/Technical Paper/B.27/Add.1.

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