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PRODUCTION OF TINPLATE IN ROURKELA STEEL PLANT OF HINDUSTAN STEEL LIMITED, INDIA [1]

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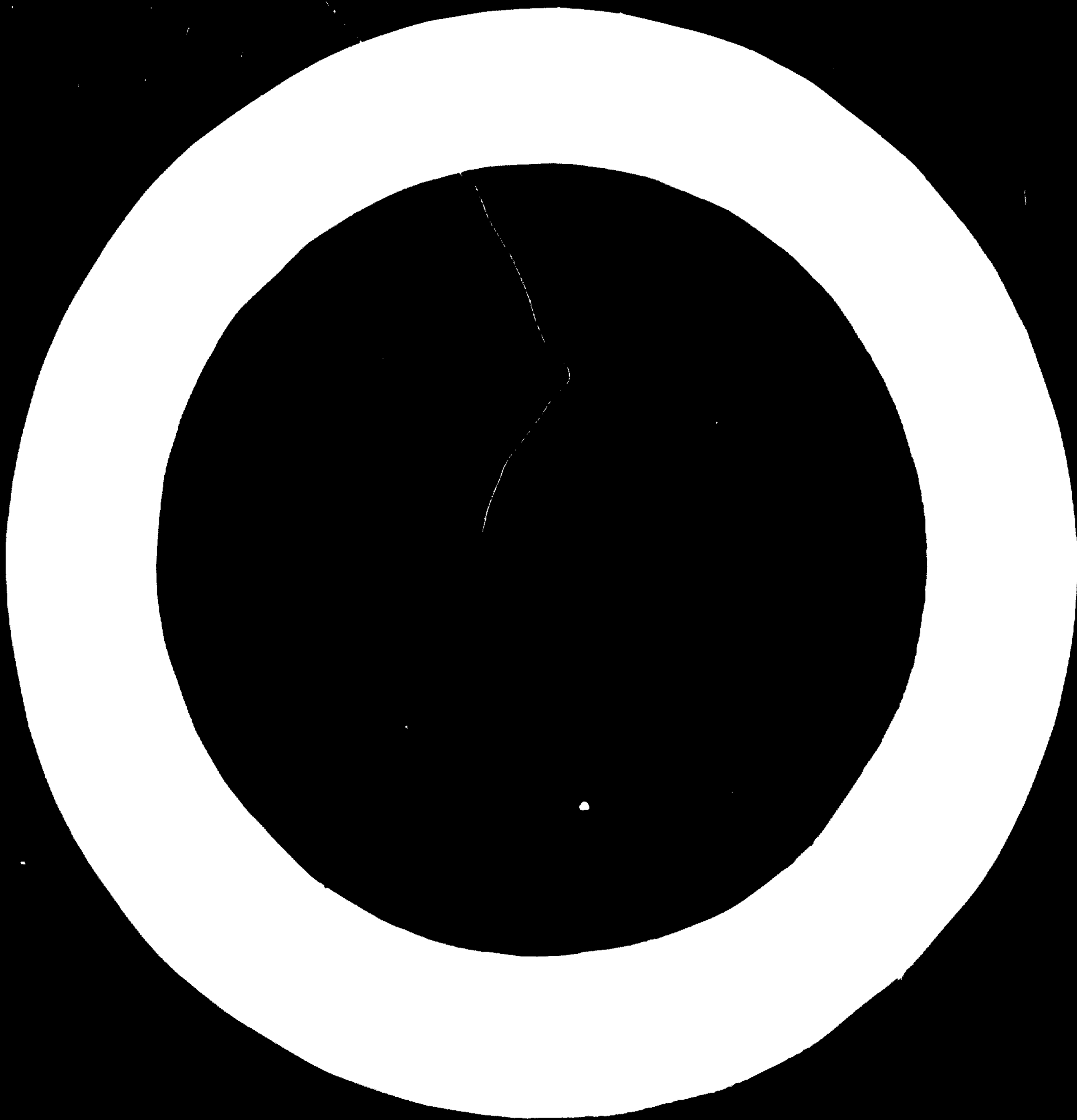


SYNOPSIS

This paper is an attempt to put together all the difficulties experienced in the manufacture of hot dip and electrolytic tinplate in the Rourkela Steel Plant of Hindustan Steel Limited. It highlights the difficulties which are peculiar to a developing economy like India's in the manufacture of a product which is probably the most sophisticated of all the products manufactured by the Steel Industry.

The author briefly describes the various difficulties faced in the starting up of the hot dip tinning lines at Rourkela, when the organisation itself was new, there was lack of trained and experienced personnel and there was need to take corrective measures to overcome planning and equipment defects. Added to this were a critical shortage of foreign exchange for imports of spares and consumables and a lack of quality consciousness right down the line. All these difficulties required quite a long time to overcome.

He then details steps taken to avoid or minimise recurrence of the same types of problems at the stage of manufacture of the electrolytic product. This foresight and planning have led to the development of electrolytic tinplate in Rourkela in a much shorter period and the quality is comparable to any available in the world market. The canning industry in India is expanding rapidly and the future for tinplate manufacture is very bright. There are also prospects for export of the product manufactured in Rourkela.

The author, who started his career in Hindustan Steel Ltd. in the Cold Rolling Mills of the Rourkela Steel Plant and later worked as Superintendent of the Hot Strip Mill, has recently taken over as the General Superintendent of the same Plant.

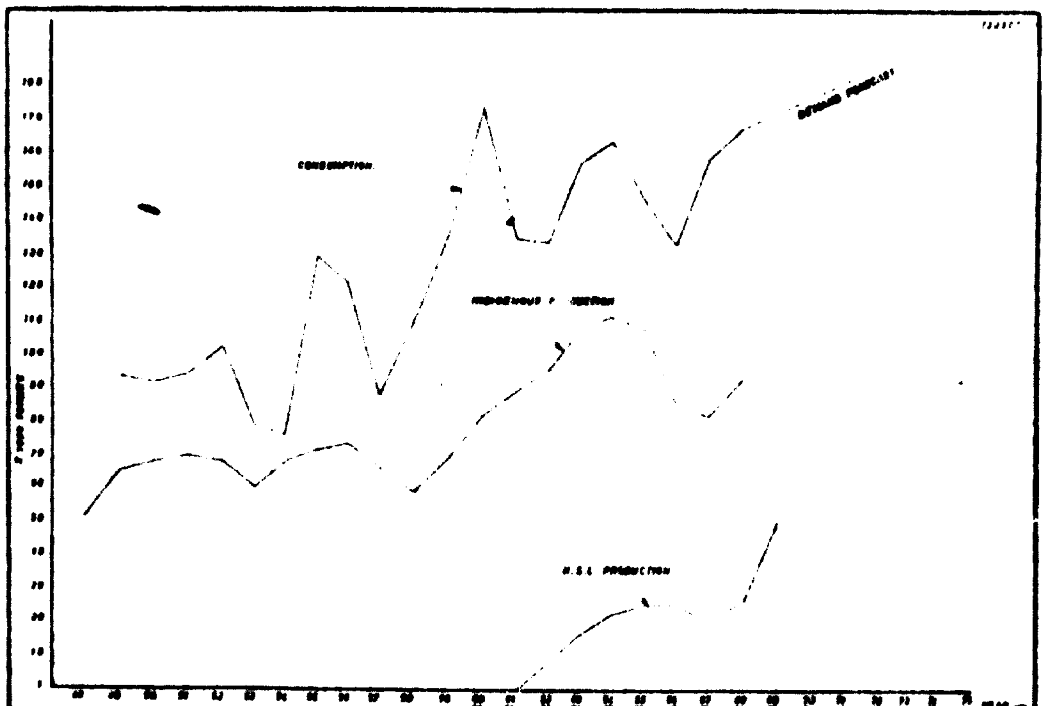


Fig.1. Production, Consumption and Estimated Demand Forecast of Tinplate in India.

1. <u>INTRODUCTION</u>.

The tinplate industry in India started in 1922 when the need for tins for petrol and kerosene was felt. The pioneer manufacturer[1] started manufacturing tinplate by using the hot pack rolling process and hot dip tinning. Subsequently, another private manufacturer[2] also started producing hot dip tinplate and, encouraged by the tremendous demand for this product, this Company purchased a second-hand Alkaline line from the States to produce from imported cold rolled strip the first electrolytic tinplate made in the country.

When the Cold Rolling Mills of Hindustan Steel Limited were planned in 1955-56, a decision was taken by the Consultants[3] to produce tinplate by the hot dip process rather than the electrolytic process mainly because the estimated demand for tinplate in the country at that time (Fig. 1) did not justify the installation of an electrolytic unit on economic considerations. Hindustan Steel Limited therefore entered the field of tinplate manufacture in 1961-62 with strip rolled in its own Cold Rolling Mills. Since demand kept on increasing and imports did not stop even after this, it was decided to go in for a modern electrolytic tinning unit[4], when the expansion of the Rourkela Steel Plant from 1 m/t to 1.8 m/t was planned. Initially, based on demand forecasts made by various agencies appointed by the Government, it was planned to instal one line to manufacture 100,000 tonnes per year but this was later changed to a faster unit to produce 150,000 tonnes per year, as a recheck showed that the anticipated demands of the canning industry in India would outstrip the production of tinplate in the country. This electrolytic tinning line has gone into production towards the end of 1968 and, after initial teething troubles, the line started normal production in the middle of 1969.

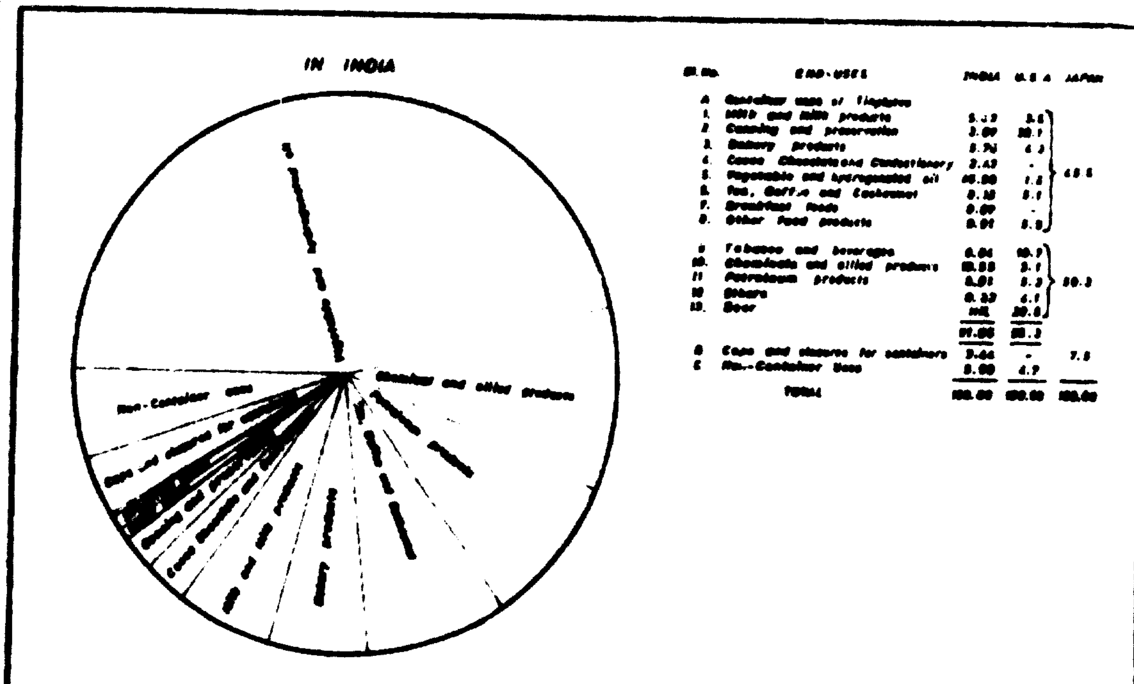


Fig.2 Pattern of Consumption of Tin Plate as per Manavasi Consultants

Fig. 2 indicates the pattern of consumption of tinplate in India compared to that in U.S.A. and Japan which has been prepared by a Consultant appointed by Hindustan Steel Limited. This clearly shows that there is tremendous scope for expansion of the canning industry in India and that there will be no dearth of demand for tinplate in the country. Our progress in the past year leads us to believe that we will live up to the challenge of supplying the requirements of this industry.

This paper will attempt to describe the problems which were faced by Rourkela Steel Plant in manufacturing these sophisticated products in a developing economy like India's and will highlight the measures taken to overcome these difficulties.

2. MANUFACTURE OF HOT DIP TINPLATE IN ROURKELA.

The various problems encountered in the manufacture of hot dip tinplate in Hindustan Steel Limited have been described by the author in a paper presented by him in an earlier seminar[5]. Briefly, these problems could be classified under five heads :-

(a) Planning and layout difficulties.

(b) Organisational and training problems.

(c) Modifications/adjustments in equipment and operational practices found to be necessary.

(d) Problems peculiar to local conditions; and

(e) quality problems.

Due to overwhelming difficulties of mastering the technical and organisational problems in starting up and operating an integrated iron and steel works installed in a backward area, hot dip tinplate manufactured in Rourkela did not come up to the standards of imported hot dip tinplate till about the year 1965, when quality consciousness slowly permeated down to the level of the workers on these lines.

For example, the planners of the steel plant had been told to centralise all facilities like metallurgical laboratories, workshops etc. to enable workers in these specialised sections to be better supervised and trained in centralised locations. A workshop specially meant for building up the tinning machines was therefore not thought of originally and it became necessary to plan and locate such a workshop in the nearest proximity to the hot dip tinning section in order to cater to the needs of that unit. Most of the workers, who were recruited in the initial stages, were either men with very little experience of the type required or Science students who had undergone short apprentice training courses. Some engineers had also been trained on similar units in Germany and the United States but these were also mostly fresh from colleges and, although a team of American specialists[6] was engaged to commission the units, it took a long time to train such workers and to develop the necessary technical and quality consciousness in them.

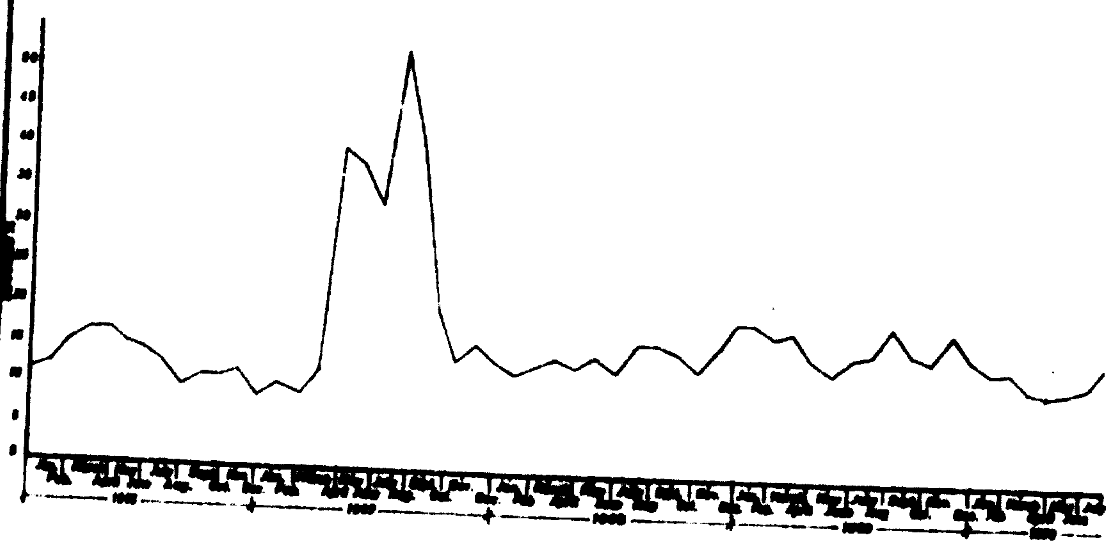


Fig. 3. Arisings of Seconds in Hot Dip Tin Plate.

No matter where a plant is installed, it is always necessary to modify and alter some of the equipment to suit local conditions and this was true of the hot dip tinning section also at Rourkela. Extensive modifications had to be made in the carburettor system supplied originally, in the alkali supply line to the wet washers and a simple but efficient cleaning system had to be installed to remove tarry matters from the fuel gas before it entered the fine burners of the tin pots.

A major difficulty faced during the initial stages was lack of sufficient foreign exchange to import sufficient spare parts to run the units and, even when we managed to import some of these, we ran into occasions like one where a dozen complete sets of imported tinning rolls failed suddenly and prematurely in service leaving our production in the lurch. Due to lack of foreign exchange also, we were forced to try out indigenous consumables and one such trial of an Orthosilicate for our cleaning line led to a period of tremendous increase in the 'seconds' produced on our hot dip tinning lines (Fig. 3). This defect, which caused considerable anxiety to us, was finally traced back to the cleaning line after extensive laboratory tests and preventive measures had to be taken to ensure that the chemical concerned was completely washed off and the strip thoroughly dried before it was sent to the annealing section. Thanks, however, to the close liaison maintained with two of our major customers, we were able to gradually improve our quality to a stage which satisfied the Indian fabricators.

3. PREPLANNING FOR COLD ROLLING MILL EXPANSION.

Some of the difficulties encountered in the manufacture of hot dip tinplate were eliminated by taking care to select and train a group of the most promising engineers and technicians from the old units on similar units in Germany for operation of the units in the expanded Cold Rolling Mills. This paid rich dividents, because many of the problems peculiar to Indian conditions which the designers in Germany were unable to foresee were avoided by suitable changes in the equipment before it was even erected. Unexpected troubles, which will be described later, did hamper the raising of the production on the electrolytic tinning unit in Rourkela but these would have proved to be almost insurmountable without the experience gained by this group of dedicated young men. It was also significant that the electrolytic tinning section was planned by the Central Engineering and Design Bureau of Hindustan Steel Limited consisting entirely of Indian engineers and it was therefore possible for our Consultants to take care of many of our local problems while negotiating with the suppliers of our equipments. The presence of a team of experienced German specialists[7] at site also shortened the duration of this starting up period.

Although the line is not yet producing to anywhere near its rated capacity, this has not been due to the difficulties of this section itself but rather due to the difficulties in adjusting ourselves in all sections of the plant to the quality demands of a much more sophisticated product. A consciousness of the need for extreme vigilance regarding quality is however permeating right down to the workers' level and the general feeling of most of our customers is that our product is comparable to any that has been imported by them in the past and is far superior to the hot dip tinplate either imported or indigenous. A decision has therefore been taken that preference would be given to manufacture of electrolytic tinplate and the hot dip lines will be gradually shut down. The problems that still exist and the solutions proposed to be taken to step up production to rated capacity and perfect the quality of electrolytic tinplate will now be enumerated in detail.

4. STEEL-MAKING FOR TINPLATE IN THE L.D. CONVERTORS.

Production of rimming steel with low sulphur and phosphorus contents, which are absolutely essential for manufacture of high quality electrolytic tinplate, is

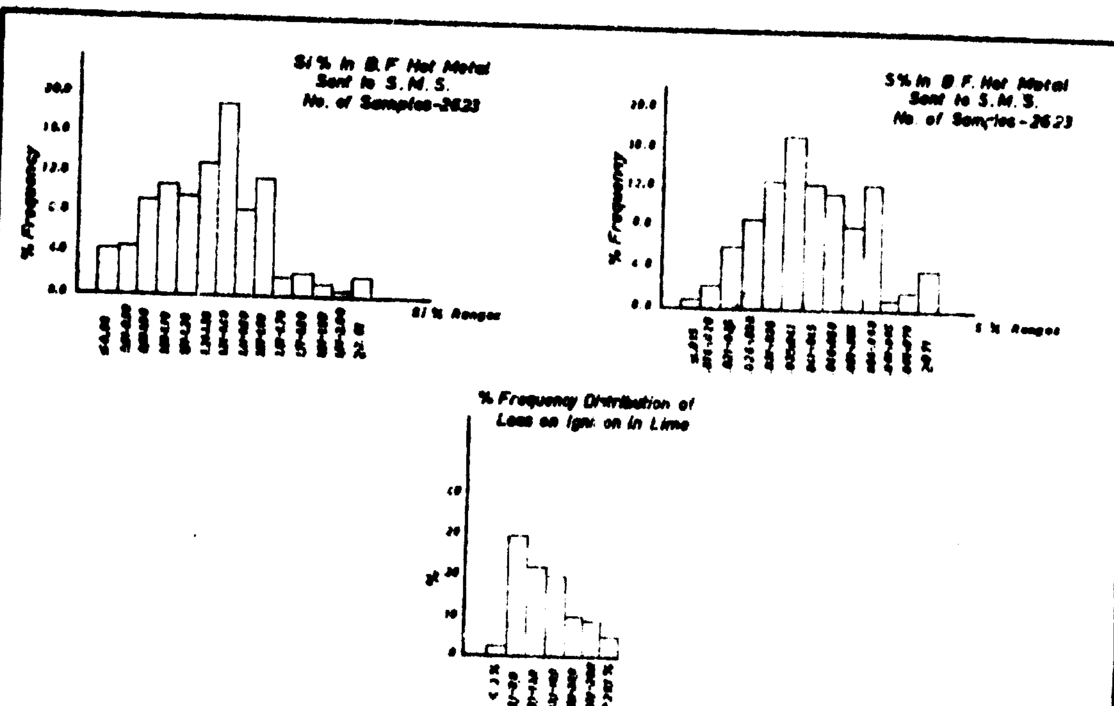


Fig.4. Variation of Sulphur and Silicon in Hot Metal and Lime Quality

very difficult under Indian conditions due to the high alumina content of Indian iron ores. Rourkela has to augment raisings of iron ore from its captive mines with purchased ores with the result that the inputs to the Blast Furnaces cannot be controlled to very close quality and size tolerances, particularly in view of the absence of bedding and blending facilities at the plant. Our hot metal analysis with respect to sulphur and silicon is therefore very inconsistent. Further, Rourkela has faced difficulties right from the inception in producing a good quality of dead soft burnt lime due to inherent defects in the vertical shaft kilns installed for that purpose. Fig. 4 indicates the variation in the sulphur and silicon contents of the hot metal produced by the Rourkela Blast Furnaces and the loss of ignition of the lime produced at present in Rourkela.

Rimming steel produced in Rourkela has a carbon content of 0.06% max. and a manganese content of 0.25% to 0.40% while attempts are made to keep the phosphorus and sulphur as low as possible. Generally, however, there is a wide variation of these two elements between a minimum of 0.02% and a maximum of 0.035%. The main difficulty experienced in the mass production of such steel at Rourkela by the Basic Oxygen Process is the control of the end-point temperature for good rimming action due to the two major short-comings mentioned above. The following steps are being taken to overcome these difficulties :-

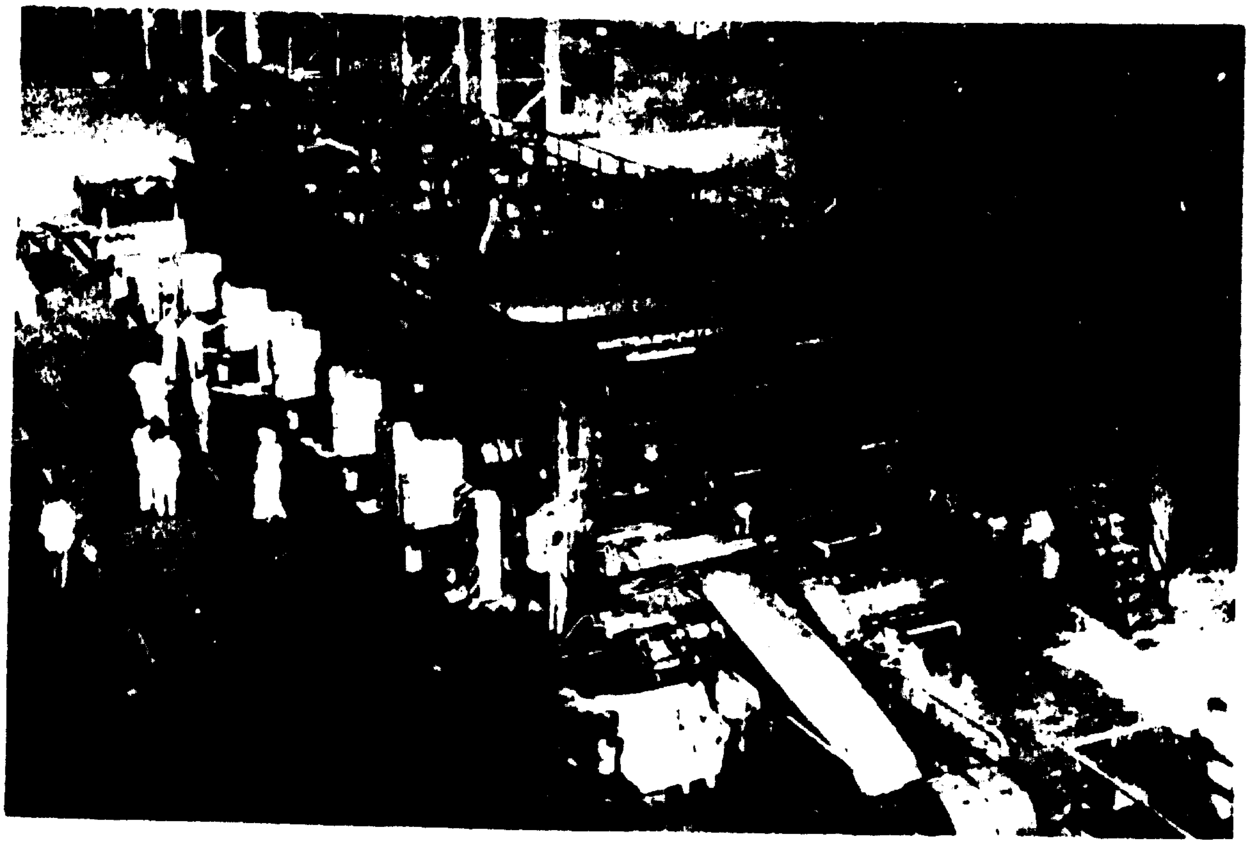


Fig. 5 - 5-stand Tandem Cold Mill.

(a) distributing the blast furnace metal to different mixers depending on the silicon range, so that the metal from each mixer is more consistent as regards silicon content;

(b) ensuring a supply of good dead soft-burnt lime by modification of one of our shaft kilns to a modern design and installing one more new shaft kiln with a parallel flow regenerative system; and

(c) making use of modern operational research methods to predict and control the end-point temperature.

Action has already been initiated on the first point and there is already an improvement in the quality of rimming steel produced. It is expected that the other two measures will be fully operative by the middle of next year after which our steelmaking should pose no problem.

5. ROLLING OF TINPLATE GAUGES ON THE TANDEM COLD MILL.

Attempts for gauge accuracy, strip flatness and surface quality were not so rigid when the strip was being rolled on the reversing mill for the hot dip tinning lines but the manufacture of the electrolytic product immediately highlighted the poor quality of the base material which we had been producing till then. Our 5-stand Tandem Cold Reduction Mill (Fig. 5), designed for a maximum speed of 1830 m/minute,

HSL RSP

Acceptance Data for Hot Rolled Coils

PERIOD MARCH/APRIL 1968

TABLE I

ACCEPTANCE ACTION	PERIOD DURING WHICH MATERIAL WAS PROCESSED									
	FIRST HALF MARCH		LAST WEEK MARCH		FIRST HALF APRIL / SECOND HALF APRIL — SLABS MARKED IN SCARFING YARD AS MEANT FOR TANDEM MILL BUT ROLLED ON REVERSING ROUGHING MILL IN HOT STRIP MILL				SECOND HALF APRIL — SLABS NOT MEANT FOR TANDEM MILL BUT MARKED FOR COLD ROLLING QUALITY AND ROLLED ON REVERSING ROUGHING MILL IN H.S.M. WITH EDGING	
					WITHOUT EDGING		WITH EDGING			
	No. OF COILS	PERCENT	No. OF COILS	PERCENT	No. OF COILS	PERCENT	No. OF COILS	PERCENT	No. OF COILS	PERCENT
INSPECTED AT PICKLING LINE	73	100.00	29	100.00	67	100.00	125	100.00	84	100.00
ACCEPTED AT PICKLE LINE	34	46.50	10	34.50	35	52.20	77	61.60	37	44.00
REJECTED AT PICKLE LINE	39	53.50	19	65.50	32	48.00	48	38.40	47	56.00
CAUSES FOR REJECTION										
1. PICKLE LINE DEFECT	20	27.40	3	10.30	2	4.30	10	8.00	10	11.90
2. CAMBER	1	1.40	2	6.90	0	10.00	3	2.40	1	1.19
3. BAD SHAPE	0	0	0	0	0	0	2	1.60	0	0
4. HOLES, PIPE & HEAVY LAMINATION	1	1.40	6	20.70	7	14.00	15	12.00	9	10.70
5. DEEP ROLLED IN IMPRESSIONS OF SEAMS, SHELLS, SLIVERS ETC OR SLIVERS, EDGE BREAKS, DOUBLINGS & FEATHER EDGES ON PICKLED STRIP	17	23.30	8	27.70	8	17.00	18	14.40	27	32.21

found it impossible to process many of the coils which were suitable for reduction on our slower reversing mill. The first step therefore was to educate the inspection staff at the exit end of the Pickling Line to recognise defects which made the coils unsuitable for further processing on the Tandem Mill and this was done with the assistance of the foreign rollers who commissioned the Tandem Mill. Coils so diverted were rolled on the reversing mills and an attempt was made to process these on the electrolytic tinning line. This experiment showed that the gauge of strip rolled on the reversing mill was so inconsistent that more than 30% of it was unsuitable for processing as electrolytic tinplate.

When the Tandem Cold Mill was commissioned, the foreign commissioning team rejected a large majority of the coils pickled on our new Pickling Line. Even though the defects were apparently minor, the reason they advanced was that our mill crew was inexperienced and the mill equipment was itself having teething troubles. Corrective measures were immediately taken on the Pickling Line but the acceptance was still extremely low. A study extending over a period of two months was made (Table I) and each defect was noted down and classified under various heads. The effect of corrective actions at various stages right from the scarfing of the slabs and the resultant improvement in the quality of the hot rolled coils can be clearly seen from a close study of the table.

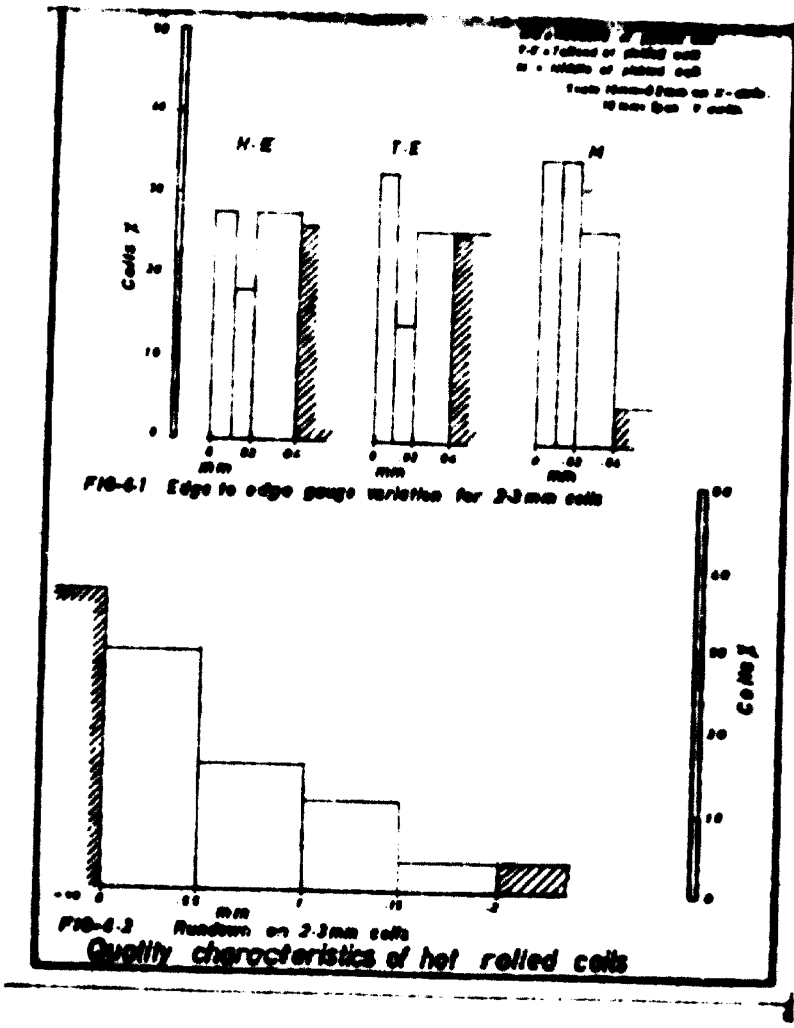


FIG-6.1 Edge to edge gauge variation for 2.3mm coils

FIG-6.2 Rundown on 2.3mm coils

Quality characteristics of hot rolled coils

There was also a breakdown on the edger of the Reversing Roughing Mill in the Hot Strip Mill section from the iddle of March 1966 to about the middle of April 1968, and there was a resultant increase in the rejection of coils for rolling on the Tandem Mill due to this factor. From the beginning of April 1968, strict procedures were enforced in the scarfing section. Slabs were specially marked for the Tandem Mill and inspected more carefully and the acceptance immediately increased from 31% to about 51.5% for these specially treated slabs, whereas it was still quite low for slabs where special attention was not paid. Various obviously wrong practices in the Strip Mill, which were responsible for high rate of rejection at the Tandem Mill, were listed out, such as inadequate scarfing particularly at the edges, late starting of the descaling sprays on the

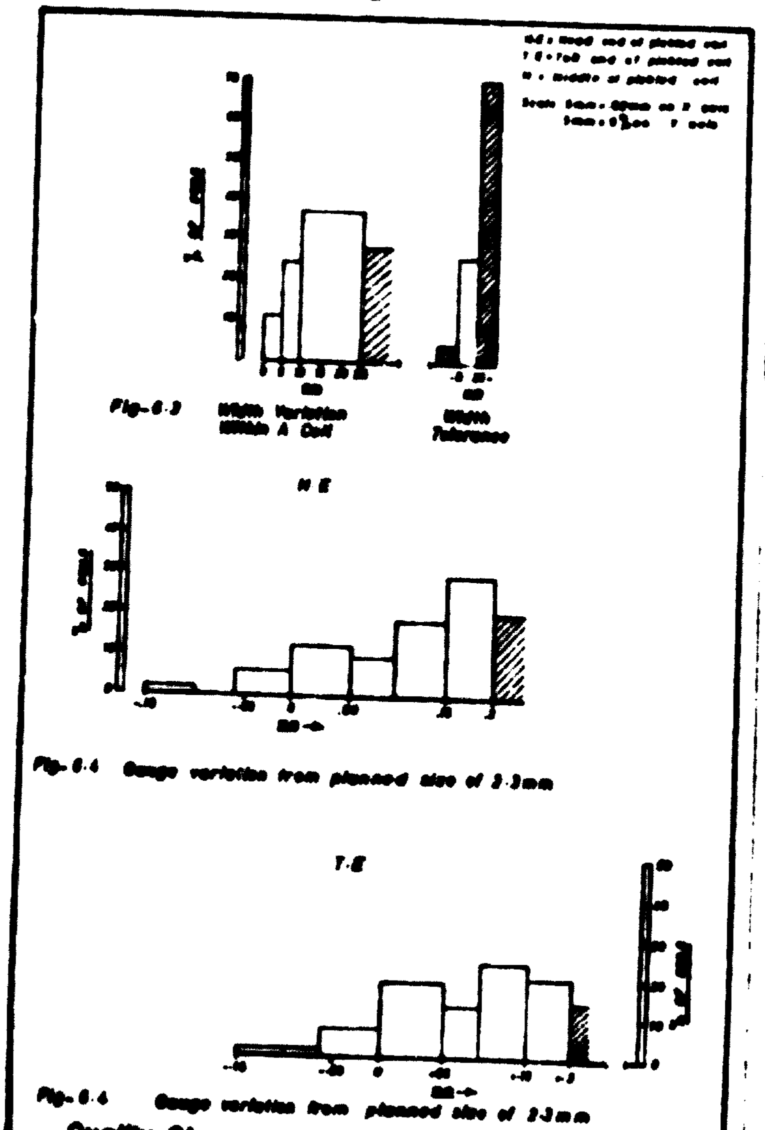


Fig-6.3 Width Variation Within A Coil   Width Tolerance

Fig-6.4 Gauge variation from planned size of 3.3mm

Fig-6.4 Gauge variation from planned size of 3.3mm

Quality Characteristics of Hot Rolled Coils

Reversing Mill, late changes of work rolls and back-up rolls on the different mills, non-replacement of defective guid s, bad condition of the coilers etc. and certain do's and dont's were formulated for implementation by the personnel of the Hot Strip Mill section.

Although the acceptance figure is now around 70% on an average, we are still not very satisfied with the quality of the hot rolled coils. Constant efforts are being made to improve the quality and it is now intended to build up a data bank of defects on hot rolled coils and frequency of roll changes, guide changes, blocker roll changes and other vital factors in the Hot Mills section, so that particular types of defects could be correlated to the corresponding cause and a system of Statistical Quality Control could be set up for this purpose. Some data has already been collected (Fig. 6.1, to

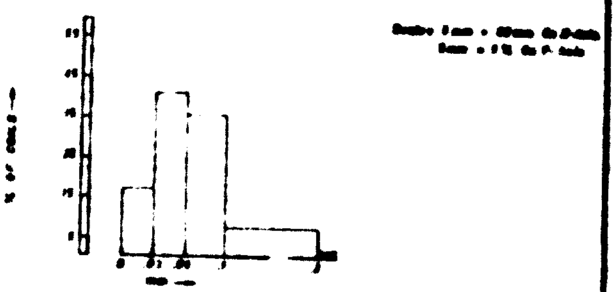


Fig. 6.5. Crown in 3.3 mm Coils-Head end of Pickled Coil.

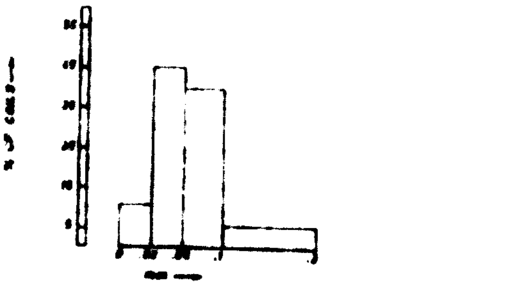


Fig. 6.5. Crown in 3.3 mm Coils-Tail end of Pickled Coil.

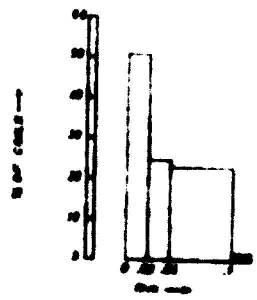


Fig. 6.6. Crown Variation with in A 3.3mm Coil

Quality Characteristics of Hot Rolled Coils.

6.6) on gauge difference between the edges of hot rolled coils, rundown, crown, accuracy of gauge throughout the coil etc. as a preliminary basis for the above purpose. Improved maintenance and operational practices in the Hot Strip Mill as a result of introduction of such a system of Statistical Quality Control would help us ultimately to ensure that all our hot rolled coils are fit for rolling on our Tandem Mill.

6. <u>POPULARISING USAGE OF CONTINUOUS ANNEALED QUALITY TIN PLATE:</u>

Although Hindustan Steel Limited had informed its major customers even before erection of the unit had started that one-third of its production of

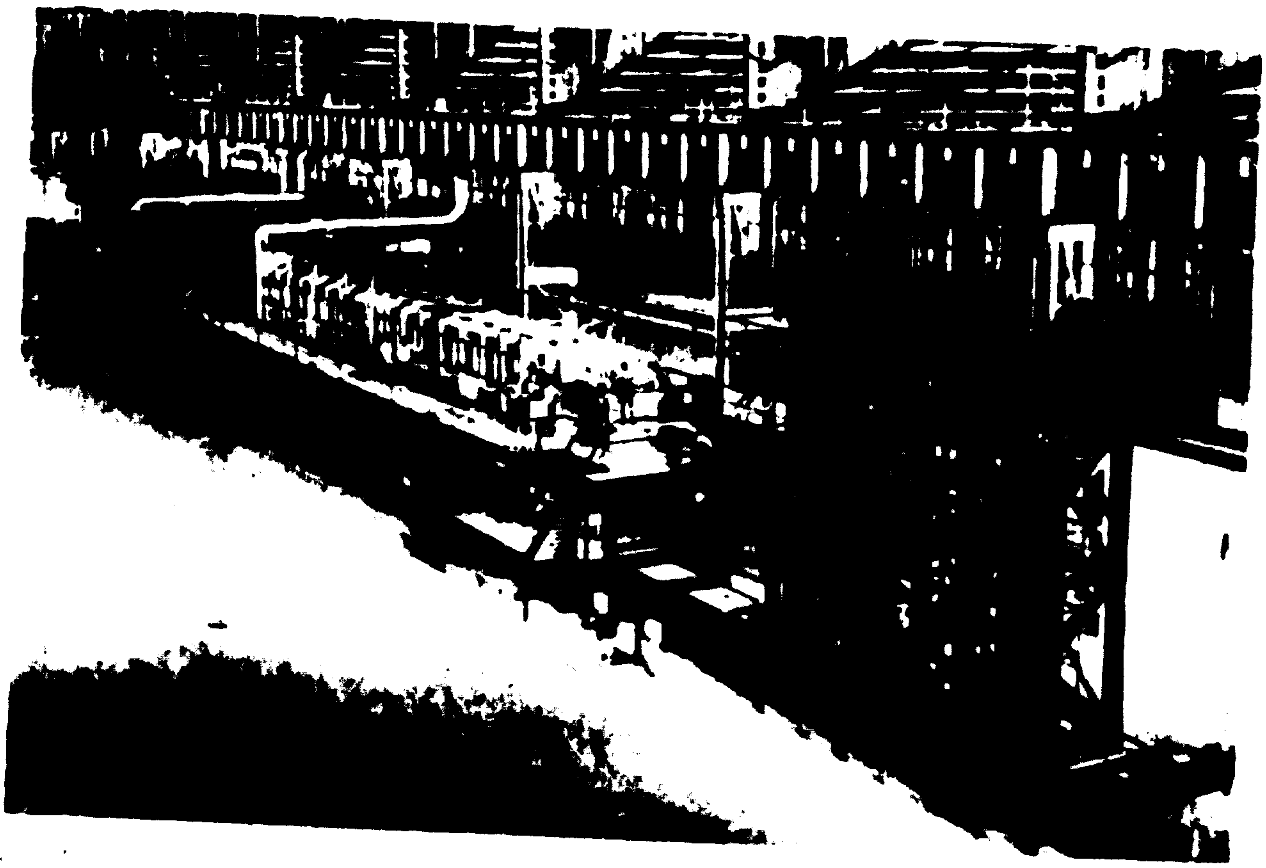


Fig. 7 -- Continuous Annealing Line.

electrolytic tinplate was planned to be made from continuous annealed quality cold rolled strip, the Indian fabricators were rather hesitant to accept this product in the initial stages. Persistent efforts had therefore to be made to woo these customers and prove to them that continuous annealed tinplate was in fact less damaging to their equipment than batch annealed plate due to better consistency of the mechanical properties, particularly temper. The continuous annealing line (Fig. 7) was commissioned practically with no firm orders for this type of tinplate. Initially, the line was run at very slow speeds to produce strip to Temper T5, which was what the customers had been demanding earlier. Supplies were made to the oil can industry and, when no complaints were forthcoming, this material was also supplied for other end uses in place of batch annealed material. Customers were apparently satisfied with the product and a promotional visit by our engineers accompanied by the foreign expert was arranged to the Works of the two major consumers. Samples of tinplate manufactured by the continuous annealed process at normal working speeds to a higher temper were actually fabricated on their lines and it proved to them that there was no need for them to invest in extra equipment to process the same. It was also brought home to them that continuous annealed plate manufactured to TO (Temper Ordinary specification HR30T:56-64) was more advantageous than the

HSL RSP — **Mechanical Characteristics of Continuous Annealed Tin Plates**
Manufactured at Rourkela — TABLE-2

Temper	[illegible] 30 T	Characteristics	Example of Usage
1	2	3	4
T-3	54-60	Suitable for shallow drawing Degree of stiffness just enough to minimize fluting	Can ends and bodies, large diameter closures, crown caps (Note: Orders for T-3 continuous annealed material not encouraged)
T-4	58-64	Suitable for moderate forming Fair degree of stiffness	Closures, can ends and bodies
T-5 (TU)	62-68	Increased stiffness to resist buckling. Rephosphorized steel not used.	Can ends and bodies

corresponding batch annealed material, because they could use a lighter substance than they had hitherto ordered. Customers had also doubts about the existence of directional properties in the continuous annealed plate but these were set at rest by actual usage of the material. At present, the continuous annealed product is used practically for all purposes by the fabricators. Some of the characteristics of continuous annealed tinplate are given in Table 11.

7. COMMISSIONING OF THE ELECTROLYTIC TINNING LINE:

The Tinning Line at Rourkela (Fig. 8) is a Ferrostan line rated to produce 150,000 tonnes per annum of electrolytic tinplate. Apart from the 5-stand Tandem Mill, this is the most sophisticated unit commissioned in the expanded section of the Cold Rolling Mills. The equipment in the tinning section consists of a coil preparation line fitted with gauge recorders, pinhole detectors etc. where coils after temper passing are first processed. The line itself is a standard Ferrostan line of U.S. Steel Patent and consists of the normal alkaline cleaning, electro pickling, coating, resistance melting and chemical treatment followed by a Trion Oiler. Two shearing lines are included in the section, each equipped with classifiers and pilers and a small re-assorting line has also been installed.

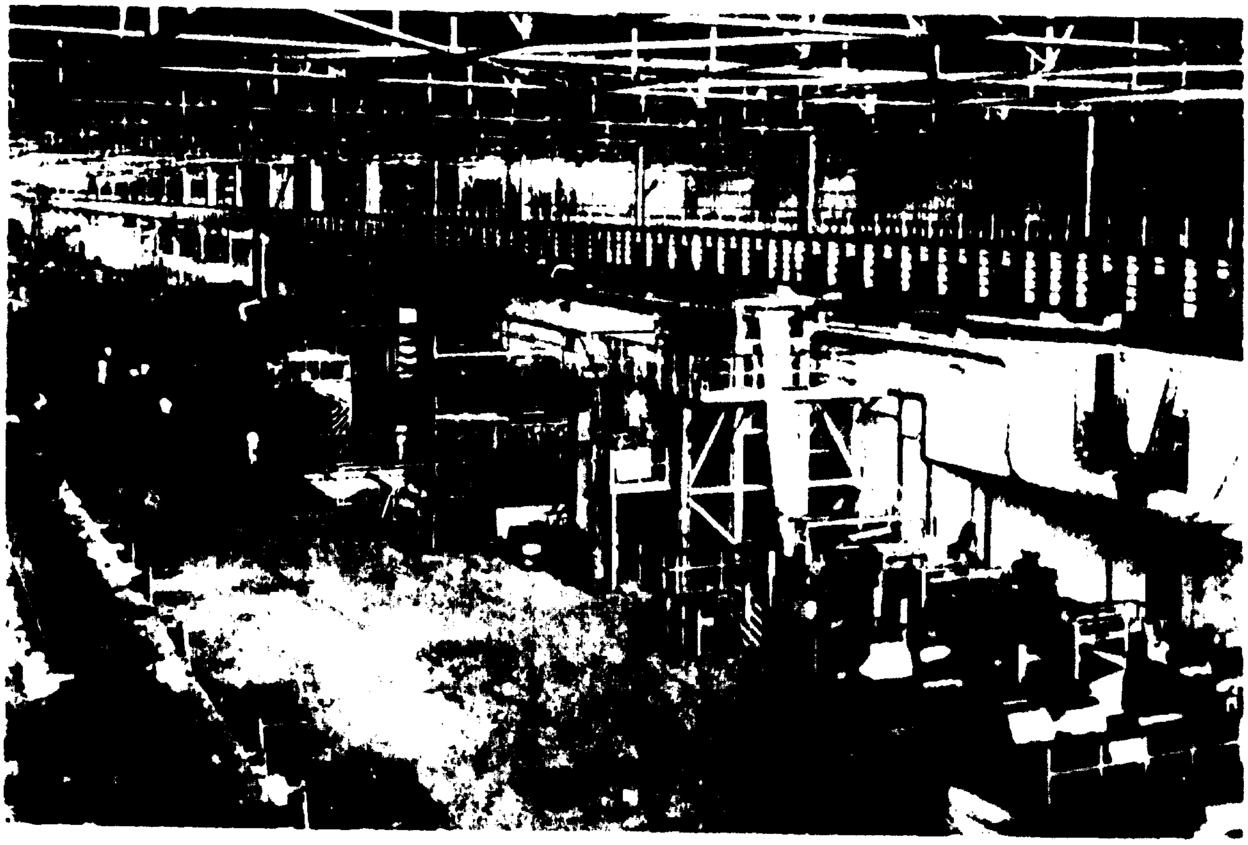


Fig. 8 - Electrolytic Tinning Line.

The first major problem that we faced on this line was due to a design defect in the numerous rolls which were supplied originally from abroad due to which these rolls started failing at the necks in rapid succession. When one remembers that there are approximately 160 rolls of different types in such a line, the enormity of the problem would be appreciated. The manufacturer was contacted and, meanwhile, temporary arrangements were made to modify and repair the broken rolls at site. However, due to the frequency of these breakages, the line could operate only very intermittently for a considerable period of time. A more rigid design was later worked out in Germany and many rolls of the modified design had to be air-freighted to save the situation. We also took some time to locate and develop suitable indigenous manufacturing capacity for special rubberising of some of these rolls and for repair of conductor rolls by electro-deposition of the very thin hard chromium layer required on the surface. Difficulties in obtaining the necessary foreign exchange for imports have even led to the development of indigenous manufacturing capacity for very special chemicals like Phenol-Sulphonic Acid and ENSA, although these industries are still not stabilised to the extent that they can supply us all our requirements to run the line at rated capacity.

A series of modifications and improvisations had also to be carried out on the main line itself as well as on the auxiliary units which will be briefly described below :-

(a) The shearing lines were supplied with only four pilers, the last one for 'primes', in which unfortunately only one pile could be piled up at a time. The line had therefore to be stopped every time a pile was to be taken out so that we were forced to modify piler No. 3 and convert it also into a 'prime' piler, leaving us with only two pilers for classifying all other arisings, viz. 'off-gauge', 'menders', 'pinholes' and 'seconds'. Piler No. 1 on both the lines is now used for piling up sheets with the first three types of defects which are then re-assorted on the reassorting line or sold directly to small-scale industries as 'Tinplate Defectives' for fabrication into various small articles.

(b) Initially, extensive quench stains and uncontrolled alloy layer were noticed on the product. This was finally traced to the lack of control of the temperature of the water sprayed on to the strip and this has now been rectified by installation of an extra pump for the spray system and a motor valve in the incoming waterline.

(c) Conductor rolls, in particular the Dry Melting and Quench Tank rolls, were badly damaged by arc spots caused during strip breakages, when the torn strip ends touched various portions of the charged roll. Attempts were made to stop the line immediately on strip breakage but these were unsuccessful. A solution has now been found by installing limit switches which cut off the current passing through the conductor roll as soon as the strip breaks anywhere in the line. Arc spots which may still occur are being removed by an automatic cleaning device fitted on the conductor roll.

(d) In order to achieve a better current density in the chemical treatment section, additional rectifier capacity has now been provided. Also, as designed originally, more than one chemical treatment could not be provided to the strip after tinning. This is now possible with the installation of a second chemical treatment tank which is mainly used for bi-carbonate treatment.

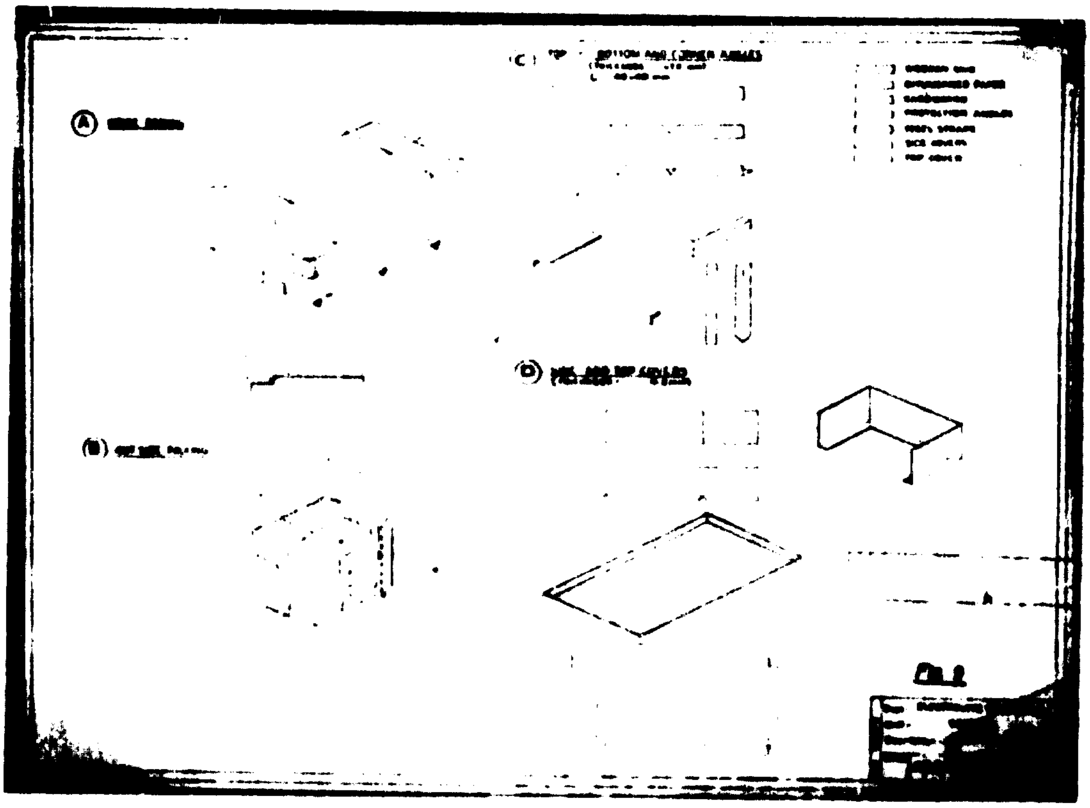
(e) The designers had supplied a condensate tank made of PVC material but this failed immediately after the first filling. It has now been replaced by a rubber-lined steel tank. Fortunately, we were able to continue production without interruption due to the very low chlorine content of our water (3-5 ppm.) compared to water in German plants which contains as much as 10-15 ppm.

(f) The suppliers had originally equipped the line with idle squeezer rolls. When the line was operated at very high speeds, it was noticed that this gave rise to scratches on the surface of the tinplate. These rolls are now being replaced by driven units.

8. PRODUCT STANDARDISATION AND PACKING OF TINPLATE.

The tinplate fabricators in India used equipment from different countries in their plants, with the result that they were insisting on supply of a large number of sizes which added up to about 200 in number. This has had an adverse effect on the production in our own Plant and has caused innumerable difficulties in the planning and progressing of the different orders through the Rolling Mill units. We are trying to persuade our major customers to agree to a reduction in the number of sizes to 32 only, which we think can cater to the entire demand of the canning industry in India. The latest Indian Standard for tinplate was formulated about eight years ago and is already obsolete in many ways for the needs of a sophisticated product like our electrolytic tinplate and the absence of a common language between customers and manufacturers is sometimes felt keenly. In the initial stages, a plethora of different standards was quoted by customers when specifying their requirements. We also found that different customers called the same defect by different names. However, with the passage of time and with close contact with the various customers this difficulty has been reduced to a certain extent.

One other major hurdle has been the fact that India still transports tinplate mainly by railway wagons which have been designed for multipurpose transportation. This has resulted in tinplate packets despatched from Rourkela being subjected to a buffetting en route which similar packets imported from abroad would probably not receive. A considerable amount of time and effort has had to be spent in improving the packaging to a stage where the customer is ensured that the tinplate will reach him in a good condition. Local conditions have made this an extremely difficult exercise. Our railway wagons in which the tinplate is transported, do not have the sliding roof which is usual for such wagons in other countries. In the absence of suitable indigenously manufactured pallet loaders, immense difficulties were faced in the initial stages to load the fairly heavy tinplate packets into such wagons. Loading was initially done by hand pallet loaders but this was extremely hard work. Then, an ingenious idea was implemented by modifying the mast of a fork lift truck and the packets were loaded by entering the wagon with the truck. This has now become



standard practice in Rourkela and the original diesel fork lifts have now been changed to the battery-operated variety to avoid the nuisance of fumes. Strapping material of the right quality (as has been developed by a very few specialist firms in advanced countries) and suitable strapping equipments are also scarce items in India and these have also had to be developed or obtained with the greatest of difficulty. After loading the packets, they are braced inside the wagon by wooden scantlings but, due to the rough shunting in transit, the wagons have often reached their destinations with the packets all askew. Due to the excessive vibration during the train journey, the tinplate over which so much care is exercised at the works, often exhibits transit rub marks. During the monsoons, very often, quite an amount of water collects on the floor of the wagons, enters the tinplate packets and damages the contents. To add to this, some of the customers do not themselves have suitable equipment to unload the tinplate packets with the result that crude and rough methods are often employed for this purpose with consequent damage to the product. We hope to avoid some of these difficulties by a modified method of packing which is now under discussion with the customers (Fig. 9). We feel that we can convince them that it is worth paying the extra cost of such a sophisticated pack rather than allow the tinplate to be damaged before it reaches their plants. Some success has also been achieved in persuading some of our major customers to move more and more tinplate by road but this is also difficult in a country which still does not possess a wide network of good roads.

HSL RSP	Quality Characteristics of Electrolytic Tinplates. Manufactured in Rourkela		TABLE-3
Specified by most finicky customer	Actual specifications of Rourkela Tinplates (Electrolytic)		
1. Size and Overgge: Length and width of each sheet shall be such as will permit a rectangle of the specified size, excluding the list. None of the selected sheets shall be below the nominal size.	Overage	Percentage of production	
		On length	On width
	6 mm & above	6	12
	5 " "	9	82
	4 " "	27	94
	3 " "	36	100
	2 " "	54	-
	1 " "	72	-
	0 " "	100	-
2. Shape: Sheet should be commercially flat when placed in the vertical and horizontal position. Requirement on Bow = 5 mm. Max Edge Waviness = 3 mm. Max.	Bow	Percentage	
	5 mm (Max.)	80	
	10 mm (Max.)	95	
	Edge Waviness		
	3 mm (Max.)	89	
	4 mm (Max.)	100	
3. Thickness: Average thickness of the individual sheets shall not deviate from the ordered thickness by more than ± 8½%	Deviation	Percentage	
	± 5%	67	
	± 6%	86	
	± 7%	96	
	± 8%	99	
	± 10%	100	
4. Tinplate: As per order to Indian Standard Specification No. ISS: 1993-1962	Ensured		
5. Tin Coating: As per order to Indian Standard Specification No. ISS: 1993-1962	Ensured		

TYPES OF ELECTROLYTIC TIN PLATES MANUFACTURED IN ROURKELA
[illegible]
[illegible]

9. FUTURE OF TINPLATE INDUSTRY IN INDIA.

The tinplate fabricating industry in India is planning rapid expansion and has been held in check till now only by the paucity of foreign exchange for extensive imports of the base material. The future for tinplate manufacturers is therefore exceedingly bright. Hindustan Steel Limited is making all-out efforts to meet the demands of the fabricators both for quantity and quality. Although the difficulties enumerated earlier are vast, efforts are being made to step up the production of tinplate on our modern units and to improve the quality to World Standards. Simultaneously, one of the national institutes[8] has been entrusted with the task of conducting extensive studies to see to what extent our tinplate, which uses a base plate containing higher phosphorus than commonly accepted for MR type, can be used for Open Top Sanitary food cans. These investigations have proved that our tinplate is eminently satisfactory for products like green peas, cabbage, potatoes, orange juice, tomato juice and mango nectar. Investigations are still under way to conclusively test the suitability of our tinplate for other more corrosive products like orange segments in syrup, pineapple slices in syrup, pineapple juice, mango slices in syrup, cherries in syrup etc. It is expected that the imports of this type of tinplate will also be completely eliminated in the foreseeable future if these tests are successful.

In the various demand forecasts made for any product in a developing country like ours, there is always a considerable measure of error due to the tendency of consumers to exaggerate their demands. Tinplate has been no exception. It is therefore very likely that, if Rourkela should step up its production of electrolytic tinplate to somewhere near its rated capacity, there would be a necessity to enter the export market. Since fabricated products made from Rourkela tinplate have already been exported in quite considerable quantities to the Middle and Far-East, there is every possibility that our tinplate itself should find a ready market in these regions. With the rapid improvement in quality (Table III) which we have been able to achieve within the two years that our line has been in operation, Hindustan Steel Limited is quite confident that its tinplate will be able to compete with other producers in the World market.

10. CONCLUSION.

a) The growth of the tinplate industry in India has been outlined with particular reference to the production of tinplate in the Rourkela Steel Plant under M/s. Hindustan Steel Limited.

b) Inadequate availability of trained manpower, spare parts, foreign exchange, design defects and slower development of ancillary industries for the supply of indigenous spare parts and consumables have given rise to problems which are not altogether unexpected for a developing country like India. The effects of the above problems were quite appreciable during the commissioning and operation of the hot dip tinning lines but, by proper preplanning, these have been minimised during the commissioning and operation of the much more sophisticated electrolytic tinning line, and the production has almost been stabilised within the period of just over a year.

c) It has been observed that higher sulphur and silicon contents in hot metal and poor quality of dead burnt lime used during steel-making adversely affect the quantity and quality of tinplate steel produced at Rourkela. Steps are being taken to overcome these difficulties by the middle of next year.

d) The high speed Tandem Cold Mill places stringent demands on the quality of hot rolled strip which necessitates strict control on the scarfing and hot rolling practice.

e) Electrolytic tinplate produced in Rourkela found a ready acceptance in the Indian market. After initial reluctance, Indian consumers have also recognised the superiority of electrolytic tinplate produced from continuous annealed cold rolled strip.

f) Attempts are being made to standardise tinplate sizes. Proper wagons with sliding roofs for transportation of tinplate are not yet available in India and road transport is still to gain universal popularity.

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