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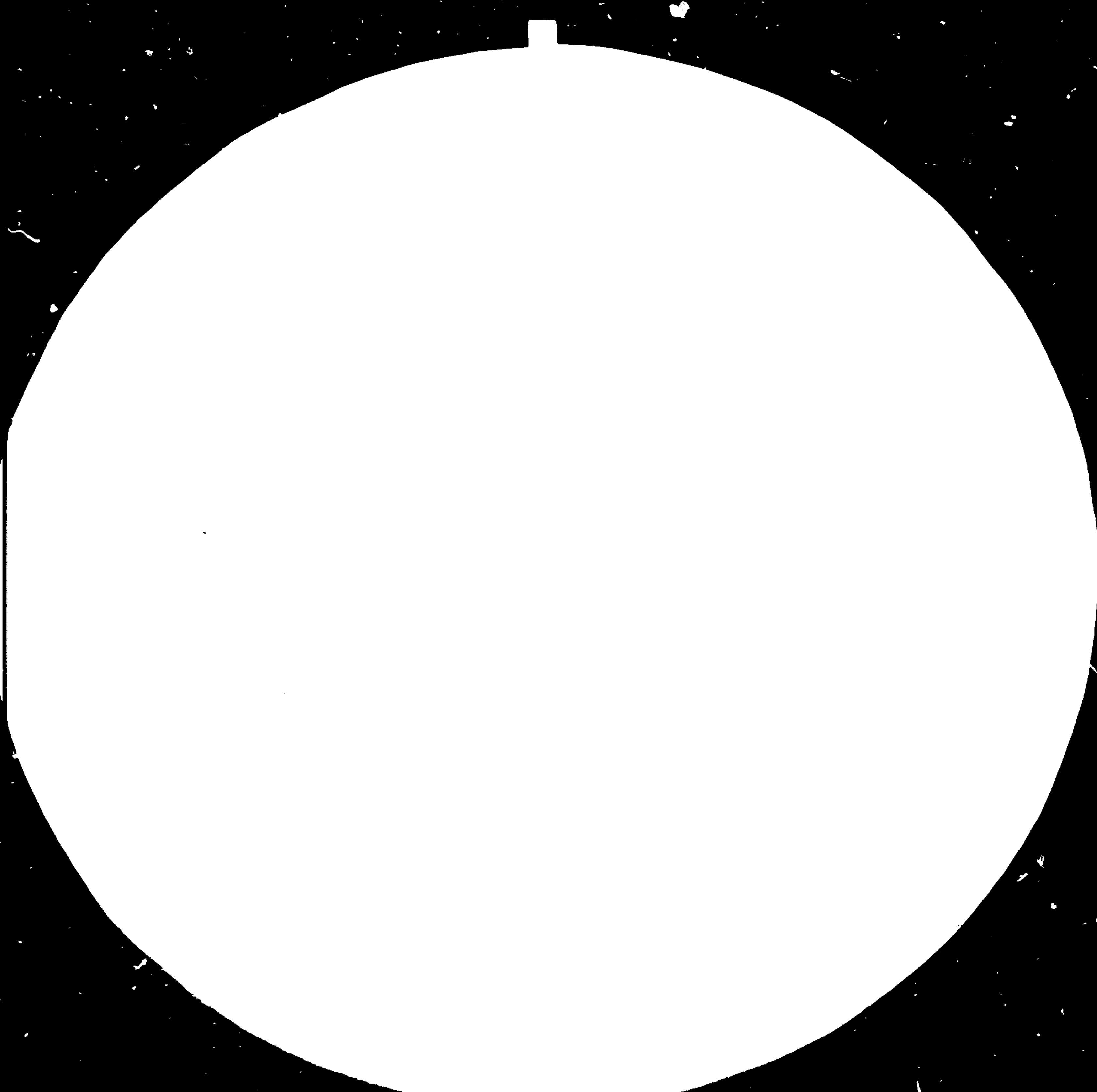

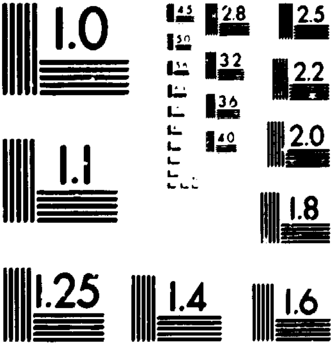

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THE STATUS OF THE TINPLATE/TIN FREE STEEL (TFS) INDUSTRY IN INDIA AND POSSIBILITIES FOR CO-OPERATION AMONG THE ESCAP REGION COUNTRIES*

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2834

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INTRODUCTION

The supermarkets and food sections of every store are always piled high with canned goods packed in tinplate/tin free steel cans. It is a common experience to use canned goods like vegetable oils, hydrogenated oils, processed food, baby foods, beverages, tea, candies, paints and varnishes, pesticides, talcum powder, insecticides, industrial oils and lubricants, cosmetics, pharmaceuticals, transistor batteries or shoe polish - that we do not stop to think of the importance of cans.

The manufacture of tinplate in India began in 1922 when the first hot dip tinning mill in the country was commissioned by the Tinplate Company of India Ltd. It was a significant event because till then all tinplate was imported from South Wales to be fabricated into kerosene containers. In a fitting tribute to the Father of the Indian Steel Industry, Jamshetjee Nusserwanjee Tata, the Tata Iron and Steel Company pioneered the idea of promoting along with the Burmah Oil Company, the Tinplate Company of India Ltd. (TCIL) at Jamshedpur. TCIL rolled the first tinplate sheets on 1 December 1922.

For almost half a century thereafter, tinplate was produced by the hot dip process. But meanwhile, technology had begun to take a long stride and TCIL, always aware and quick to welcome innovation and change, commissioned an electrolytic tinning line in January 1979.

In the face of ever growing treat to tinplate from more cost effective packaging materials and steadily growing applications of tinfree steel in India, the management of the Tinplate Company decided to install facilities for production of TFS, the only one and first of its kind in the country. Hoping that it would be of interest to other developing countries in the region, TCIL is prepared to share its experience in manufacturing this product, however little it may be.

Today there are three tinplate manufacturers in India - The Tinplate Company of India Ltd. at Jamshedpur, the Rourkela Steel Plant (RSP) at Rourkela, and the Khemchand Rajkumar Steel Union (KRSU) at Bombay.

The primary objective of the Workshop on Tinplate Production in the Asia and the Far East Region, held at TCIL in Jamshedpur from 2 to 6 April 1984 was to usher an era of exchange of technical knowledge and to lay the foundation for co-operation within ESCAP countries for the manufacture of the right quality of tinplate using indigenous resources to meet their own requirements as well as to compete in international markets.

To pursue this objective a first step will be to familiarize ourselves with each others facilities and capabilities and to share our experiences in the areas of tinplate production and application. To help to understand the current state of technology relating to tinplate production in TCIL, an attempt is being made in this paper to provide information on the plant, process, quality control awareness and efforts, as well as some of the quality and production problems that have been solved and others that still prevail.

PART I - The Status of Tinplate/Tin Free Steel (TFS) Industry in India with special reference to products of TCIL

1. TINPLATE MARKET IN INDIA

1.1 DEMAND AND SUPPLY OF TINPLATE

Table No. I shows the demand and supply of tinplate in India including prime tinplate, open top sanitary can(OTSC) Waste Waste.

The production of OTSC and TFS in India during the period was negligible.

TABLE I

PRODUCTION AND DEMAND FOR TINPLATE IN INDIA

Year	TCIL Prod. t	RSP SAIL Prod t	KRSU Prod t	Total indigenous Prod t	Imported t	Total t
1962	77,346	7,836	9,142	94,324	40,752	135,076
1963	84,107	12,191	4,580	100,878	47,859	148,737
1964	80,371	14,800	11,300	106,471	53,226	159,697
1965	59,667	22,823	7,543	96,033	35,821	131,854
1966	53,897	26,624	4,509	85,030	34,040	119,070
1967	64,657	18,091	654	83,402	66,181	149,583
1968	62,780	27,978	6,061	96,819	58,838	155,657
1969	44,877	43,363	8,194	86,434	42,359	138,793
1971	69,339	39,067	7,539	115,945	38,719	154,664
1972	62,137	48,187	13,666	123,990	63,122	187,112
1972-73	60,037	45,196	11,076	116,309	46,483	162,792
1973-74	46,847	34,456	5,206	86,509	62,020	148,529
1974-75	46,988	30,444	3,806	81,238	48,080	129,318
1975-76	53,552	48,179	3,425	105,156	55,504	160,660
1976-77	41,915	54,355	1,978	98,248	36,303	134,551
1977-78	31,920	59,234	nil	91,154	64,738	155,892
1978-79	32,370	57,396	nil	89,766	82,133	171,899
1979-80	35,449	54,432	9,241	99,122	80,589	179,711
1980-81	36,392	31,695	13,422	81,509	80,000	161,509
1981-82	46,372	38,878	11,022	96,272	90,000	186,272
1982-83	33,947	31,284	16,184	81,415*	73,480*	154,895
1983-84	50,000**	50,000**	20,000**	120,000**	NA	-

Foot note

The Tinplate Company of India Limited - TCIL
Steel Authority of India Limited - SAIL
Khemchand Rajkumar Steel Union - KRSU

* April/December 1983 figure

** Approximate figures.

NA - Not available.

1.2 **INSTALLED CAPACITY**

Against the demand, the installed capacity of tinplate/ TFS in India is as follows :

TABLE II

INSTALLED CAPACITY IN INDIA

Producer	ETP	ETP/TFS	Total
TCIL		90,000 t	90,000 t
RSP	150,000 t		150,000 t
KRSU	60,000 t		60,000 t
			300,000 t

Looking at the installed capacity it would be seen that India has an installed capacity far beyond the demand. This could pave the way for the bilateral cooperation between ESCAP countries.

1.3 **TINPLATE MARKET TREND**

The tinplate industry is faced with a peculiar situation. The packaging industry is growing in leaps and bounds, yet the growth rate of tinplate industry has been stagnant for the past decade. The main reasons for this situation are as follows :

a) Tinplate has lost ground to substitute materials such as poly-ethylene, tin free steel, aluminium foil, cardboard containers, blackplates and composite containers.

b) Heavy cost increase of major inputs such as TMBP coils, tin, furnace oil, fuel, power, spares, Government levies, unfavourable foreign exchange rates and spiralling transportation costs. Added to this list is the ever increasing wage demand.

c) Recessionary conditions in the West have led to "dumping" of tinplate products in India. Coupled with this, is the concessional rates of duty applicable to imports from GATT countries - such as Spain, Republic of Korea, and Brazil. Statistics indicate that a major portion of the imports into India are from GATT countries.

d) Despite some restriction in imports imposed by the Government, from the statistics available it is known that an amount of 73,480 t (excluding imports into Calcutta port) have taken place between April and December 1983. As per production figures recorded on 30-1-1984 by the Tinplate Producers Consultative Committee, a quantity of 86,000 t has been produced by the three indigenous producers in the same period. As per available details of imported consignments from GATT countries the following emerges :

Thickness	Per M/T CIF/Price	Landed cost at Bombay inclusive of 9 % prem.	Comparative TCIL price Landed Bombay
0.30 mm (Mill Excesses)	Rs 5267.50 (Equiv. to about $ 490	Rs 9676.00	Rs 9,978.00

It may be noted from past experience that dependence on imported tinplate at depressed prices is a dangerous practice.

a) With the recovery of respective economies of exporting countries, price hikes become inevitable.

b) Any curbs imposed or detrimental cuts in indigenous production would authmatically place these exporting suppliers in a position to demand enhanced prices.

c) Tinplate being a vital packing medium for packaging of various essential commodities, the repercussions of a force majure situation resulting in disruption in supplies from importing countries could be devastating.

2. **THE THREAT TO TINPLATE INDUSTRY AND MEASURES TO COUNTER THE THREAT.**

In the above we have broadly discussed the market trends for tinplate and briefly explained the threats to the tinplate industry. This threat arises in any country out of one of the following reasons and the corporate goal of any tinplate manufacturer is to counteract such extraneous factors through policy decisions most appropriate to the corporate management and the country in which the industry is situated.

2.1 USE OF RECYCLED CANS FOR PACKING HYDROGENATED OIL/ EDIBLE OILS

The price of reconditioned can being much lower than cans made out of prime tinplate, tempts one to use the reconditioned can, though it may not be fit for reuse. Such use of reconditioned cans could mean health hazard as edibles packed in reconditioned cans cannot be guaranteed from being unfit for consumption.

2.2 USE OF TINPLATE WASTE WASTE FOR MAKING CONTAINERS

Use of tinplate waste waste for making containers instead of tinplate prime is more dangerous in some ways than the use of reconditioned cans. Some manufacturers tend to import and use cheap tinplate waste waste instead of tinplate prime because of its cost benefits without realising the adverse effect the waste waste would have on the edible contents packed in such containers. In view of this the matter needs great attention from the Government, the users of tinplate waste waste and consumers.

2.3 BLACKPLATES

The individual manufacturer-wise domestic consumption of Blackplates in India and imports of 1981-82 are given in Table No. III. This shows that the large as well as small consumers are importing substantial quantities of tinplate and blackplates. Blackplates have made an inroad in the container industry. The areas in which blackplates have featured in container industry are given in Table No.IV.

Out of Six categories of the items shown in Table No. IV, item nos. 1, 3, 5 are exclusively produced by Blackplate whereas 30% of containers made out of Blackplate cater to Paints and varnishes.

The replacement of black plate by some variety of tinplate or TFS would be an area for important study.

TABLE III

USE OF BLACKPLATES FOR CANS

Container Manufacturers	Tinplate		Black Plates		
	Domestic t	Imports t	Domestic t	Imports t	Total t
Metal Box	23,000	12,428	-	10,000	45,428
Poysha	1,500	9,105	-	2,870	13,475
Kaira	3,770	4,410	-	-	8,180
Zenith	2,500	1,500	-	6,000	10,000
Containers & Closures	-	-	-	2,000	2,000
Oriental Containers	500	500	-	3,000	4,000
Others	7,000	13,000	6,000	130	30,130
Grand Total :	38,270	40,943	6,000	24,000	109,213
Crown Cork	7,000	-	-	-	7,000
					116,213

TABLE IV

BLACKPLATES USED FOR CANS

Sl. No.	Item	(.19/.20) t	(.21/.22) t	(.24/.25) t	(.26/.27) t	(.30) t	Total t
1.	Lubricant Oil	4000	-	10000	-	-	14000
2.	Biscuit Tins	-	-	-	-	10000	10000
3.	Talcum Powder	-	2000	-	-	-	2000
4.	Paints	-	-	-	2000	-	2000
5.	Shoe Polish	-	-	-	1000	-	1000
6.	Others	-	100	-	-	900	1000
		4000	2100	10000	3000	10900	30000

2.4 IMPORTED TINPLATE/TFS - OTSC AND OTHER QUALITY

Presently a quantity of 90,000 t of OTSC quality is being imported whereas TCIL and RSP are in a position to produce and market this item. There is no reason why any other type of tinplate/TFS would need to be imported.

In our opinion if the indigenous installed capacity is fully utilized not only would the country meet its full demand but also could export Tinplate. Capacity utilization would also make tinplate/TFS available at substantially cheaper prices.

2.5 NON METALLIC MATERIAL

Table No. V illustrates the invasion of Non-Metallic Containers into the container industry :

TABLE V

NON METALLIC CONTAINERS USES

Trade	Type of Containers Metallic %	Non Metallic %	Type of Non Metallic Material
1. Hydrogenated Oil	70	30	Plastic
2. Instant coffee	10	90	Refill packs/ bottles.
3. Talcum powder	80	20	Composite packs
4. Malted foods	10	90	Glass jars

2.6 GOVERNMENT POLICY

Government policies on duty on TMBP coils and other raw materials essential for tinplate/TFS manufacture as well as on imports of tinplate prime/secondary, waste waste to a large extent has affected the tinplate industry in India. It may be noted that the rationale for granting concessions to the tinplate industry by the Government is largely to enable the end users to hold the priceline of tinplate required for packaging of essential commodities such as hydrogenated oil, edible oils, cashew, baby foods and pesticides. The Government should be concerned to continue to grant concessions such as duty waiver on imported TMBP coils and to ban imports of tinplate of any quality so as to utilise the installed capacity in the country.

2.7 SOME MEASURES TO COUNTERACT THREATS

(i) The threat to tinplate from Non Metallic and aluminium containers, apparently, is due to the cost benefit accrued from the latter. In countries where energy is scarce tinplate production has an edge over others as the energy consumption for tinplate cans is the lowest. The following table illustrates this point.

TABLE VI

ENERGY CONSUMPTION FOR CANS

	Energy consumed in producing raw material for one ton. GJ	No. of containers per ton	Energy consumed per container KJ
1.Tinplate can	49	16,500	3,010
2.Aluminium can	395	44,500	8,660
3.Bimetallic can	77	18,400	4,210
4.Glass bottles, returnable.	54.8	2,000	27,540
5.Glass bottles: nonreturnable.	54.8	4,000	13,700

(Source: Second International Tinplate Conference - 1980)

Thus the use of tinplate cans also paves the way for saving of energy. This point needs to be highlighted to Government and other policy making bodies in any country and may form part of a slogan to popularise the use of tinplate.

(ii) Use of cheaper tinplate viz. flash coated tinplate, low tin coated steel (LTS) tinplate or double reduced (DR) tinplate along with cheaper methods of can making such as drawn and iron method for non-consumable use.

Foot Note

GJ - Giga Joule
KJ - Kilo joule

iii) Use of tinplate for canning industry can also be beneficial as tinplate cans can be magnetically recovered and recycled again for uses as scrap for steelmaking units.

(iv) Tinplate/TFS cans can store edibles longer than any other type of can.

(v) Tinplate cans are stronger than containers made out of other materials.

(vi) Semi-cooked food packed in tinplate/TFS cans relieve pressure of cooking problems.

(vii) Tinplate cans store food and beverages longer.

(viii) Tinplates/TFS take excellent printing.

3. SCOPE FOR BILATERAL COOPERATION AMONG ESCAP COUNTRIES

3.1 TINPLATE/TFS CAPACITY AND PRODUCTION

Table Nos. VII and VIII give a picture on the tinplate installed capacity, production and consumption in many of the Asia and Pacific region countries. As it would be observed, capacity is built up only in a few countries whereas tinplate is consumed extensively. This may form a basis for bilateral cooperation in terms of tinplate/TFS imports/exports.

3.2 EXCHANGE OF KNOW HOW

TCIL has worked on a technology and a plant new to them and have now operated the plant at almost 200% of its rated capacity in a day (against 100 t/shift TCIL has produced 200 t/a shift, against 300 t/day TCIL has produced 502 t/day). The ratod capacity of 7500 t/month could be attained. TCIL quality is accepted to be as good as that produced in other countries. This has given adequate confidence in TCIL to operate as Quality Control Consultants in any Ferrostan Line when called upon to do so. The plant also successfully import-

TABLE VII

TINPLATE PRODUCTION CAPACITY

Country/Expected Demand (year)	Present Capacity/ Production (year)	Future Plan	Imports(year)
1. Afghanisthan	NA	NA	NA
2. China	NA	NA	NA
3. Democratic Peoples Republic of Korea.	NA	NA	NA
4. Hong Kong.	NA	NA	NA
5. India	KRSU 60,000 t. SAIL 150,000 t. TCIL 90,000 t.	Nil	90,000 t(1981-82)
6. Indonesia 208,100(1990) ** 237,700(2000) **	Pt Krakatau ** Steel 130,000 t		119,000 t(1982) 111,000 t(1981)
7. Iran	Nil **	Nil	70,000 - ** 80,000
8. Malaysia	Prestima. 90,000 t.	NA	NA
9. New Zealand	NA	NA	NA
10. Pakistan.	Nil **	2 Plants each of 80,000 t.	68,000(1981-82)
11. Peoples Republic of Bangladesh.	NA	NA	NA
12. Phillipines.	National 100,000 t Steel Corpn30,800 t Prod. (1982)	NA	NA
13. Republic of Korea.	Dong Jin Steel. 120,000 t Dong Yang TP. 200,000 t Shin Hua 30,000 t Dong Jin Steel. 11,166 t(82) Dong Yang TP. 80,000 t(82) Shin Hua 25,000 t(82)	NA	Nil
14. Singapore.	NA	NA	NA
15. Sri Lanka.	NA	NA	NA
16. Thailand	Thai TP Mfg.Co. 60,000 t.		
17. Turkey	Erdemir** 100,000 t 90,000 t(83)	150,000**	

(Ref: Metals Bulletin Monthly July 1983)

Foot Note NA - Not Available.
** Details collected from Delegates to UNIDO Workshop on Tinplate Production at TCIL Jamshedpur, India in April 1984.

TABLE VIII

TINPLATE PRODUCTION AND CONSUMPTION IN ASIA AND PACIFIC REGION COUNTRIES (in Thousand tonnes)

		Production 1978	Production 1979	Consumption 1978	Consumption 1979	Apparent Tin plate consumption kg per Capita.*
1.	Afghanistan	NA	NA	NA	NA	-
2.	China	NA	NA	NA	NA	-
3.	Democratic Peoples Republic of Korea.	NA	NA	NA	NA	-
4.	Hong Kong.	NA	NA	2405.1	1827.3	-
5.	India	120	120	256.2	162.7	0.40
6.	Indonesia.	-	-	47.7	37.3	0.40
7.	Iran	Nil**	Nil**	88.9	22.0	-
8.	Malaysia/ Singapore.	-	-	84.2	87.6	8.1
9.	Newzealand.	-	-	27.7	32.0	-
10.	Pakistan	Nil**	Nil**	50.0	52.4	0.7
11.	Peoples Republic of Bangladesh.	NA	NA	NA	NA	-
12.	Phillippines	110.0	100.0	184.4	145.4	-
13.	Republic of South Korea.	93.0	134.0	102.6	100.3	-
14.	Singapore	NA	NA	NA	NA	-
15.	Sri Lanka	NA	NA	6.3	2.7	-
16.	Thailand	43.9	61.7	87.7	79.5	2.1
17.	Turkey	82.2	72.3	87.0	51.6	-
18.	Japan	1810.0	1880.0	993.1	789.3	8.9
19.	Taiwan	67.0	67.0	171.1	108.9	-

(1 - January September Source A-La-Spada ITC, Metal Bulletin Monthly December 1980)

* Source - Second International Tinplate Conference 1980.

** Information collected during the Workshop from the representatives of the countries.

substituted raw material required for manufacture of tinplate as well as spares for plant and machinery.

3.3 MARKET SURVEY

The TCIL Marketing Division assisted by Marketing Services Group of The Tata Iron and Steel Company Limited, had carried out a countrywide Market Survey on Tinplate in September 1982. Such services could also be provided by TCIL if requested.

4. HIGHLIGHTS ON EXPERTISE OF TINPLATE COMPANY OF INDIA LIMITED IN THE AREAS OF ELECTROLYTIC TINPLATE/TIN FREE STEEL PRODUCTION

4.1 THE SOPHISTICATED ETP/TFS LINE

The process adopted for the production of ETP is the world famous FERROSTAN process developed by the U. S. Steel Corporation, which accounts for 70% of the world ETP production. This plant was commissioned on 4th January 1979 and was set up with an investment of about Rs 24 crores* The equipment suppliers were Wean United, Canada, the world's leading manufacturers of equipment for steel finishing lines. The Electrics were obtained from ASEA, Sweden.

The line essentially consists of an entry section that includes two uncoilers, a double cut shear, welder, side trimmer and a loop tower, a preplating section that comprises alkaline electrolytic cleaning tank, electrolytic pickling tanks and rinsing tanks, tinplating tank section with dragout recovery unit and flux tank; a reflow melting unit with quench tank; a chemical treatment section/TFS plating section, an electrostatic oiling unit and a delivery section that consists of off gauge and pinhole detector, a Halden shear, classifiers and pilers.

Foot Note

* 1 Crore = 10 million

A provision exists for installation of recoilers in the delivery section to provide for supply of finished tinplate in the form of coils.

The plant is also provided with a well equipped laboratory, perhaps the best of its type in India. Tinplate, to the best of international standard is being produced.

TFS - The TCIL dual ETP/TFS line is quipped to produce Tin Free Steel which is a substitute for tinplate for many uses. The process adopted for the production of TFS is the world famous one-step TFS III process developed by the U.S. Steel Corporation. The chromium plating on TFS is achieved by electrolytic deposition from a predominantly chromic acid bath.

Both the facilities for production of ETP or TFS were installed under direct supervision and control of TCIL engineers, assisted by the Tata Consulting Engineers. The team had paved the way for import substitution of plant and machinery thereby saving substantial foreign exchange. TCIL engineers were associated from the planning to the successful commercial commissioning of the ETP/TFS Plant.

4.2 PRODUCT RANGE OF ETP MANUFACTURED AND MARKETED BY TCIL

	Designation.	Nominal coating weight g/m^2	Minimum average coating weight Test value g/m^2
Equally coated Weights.	E 25	5.6(2.8/2.8)	4.9
	E 50	11.2(5.6/5.6)	10.5
	E 75	16.8(8.4/8.4)	15.7
	E 100	22.4(11.2/11.2)	20.2

4.2 PRODUCT RANGE OF ETP MANUFACTURED AND MARKETED BY TCIL (Cont'd)

	Designation	Nominal coating weight g/m^2	Minimum average coating weight Test value g/m^2
Differentially coated weights.	D/50/25	5.6/2.8	5.05/2.25
	D 75/25	8.4/2.8	7.85/2.25
	D 75/50	8.4/5.6	7.85/5.05
	D 100/25	11.2/2.8	10.1/2.25
	D 100/50	11.2/5.6	10.1/5.05
	D 100/75	11.2/8.4	10.1/7.85

Coating weights

There are two types of coating weights, the Equally Coated Weights (in which both sides have the same weight of tin coating) and the Differentially Coated Weights (in which one side is more heavily coated than the other).

Quality

Available in Prime/Seconds/Waste Waste. TCIL has produced OTSC quality tinplate.

Temper : Six categories of tempers are available at TCIL, ranging from T-1 to T-6 as per ASTM (T-4, T-5 and T-6 are continuously annealed and the rest are batch annealed).

Available Sizes

Thickness	-	0.17 mm to 0.60 mm
Width	-	600 mm to 965 mm
Length	-	450 mm to 1100 mm
Bulk Weight	-	Upto 1.4 t

ETP is produced in the line which is equipped with sophisticated control systems enabling push button operation at speeds of 247 m/min (308 m/min, with over voltage.)

ETP produced on this line is obtainable either in Matt or Bright finish. Tin coating weights upto 1 lb/bb (basis box) or 22.4 g/m^2 are possible. Facilities also exist for producing differentially coated ETP using the international standards of marking.

4 .3 PRODUCT RANGE OF TFS

TCIL produces High Oxide TFS with chrome coating 0.5 mg/dm^2 (0.3 to 1.30 mg/dm^2) and Oxide coating - 0.07 to 0.22 mg/dm^2 per side of the TFS Sheet. TFS is available in the same range of width, thickness, cut lengths and temper as in the case of ETP.

4 .4 ADDITIONAL FEATURES OF TFS

a) Filiform rust resistance

Filiform rust refers to rust progressing in the form of filament on the outside of a can beneath the enamel caused by scratch or similar imperfection. As compared to ETP, TFS has a much better resistance to this type of underfilm corrosion as a very small amount of Cr or Cr_2O_3 layer is sufficient to stop the undercutting from spreading on either side of an imperfection, on the lacquered surface.

b) Sulphur blackening resistance

The metallic chromium coating provides excellent sulphide resistance in TFS and enables canning of protein rich foods such as meat and fish, which is not possible in ETP without application of an expensive special purpose sulphur resistance lacquer.

c) Heat resistance

The superior heat resistance of TFS in comparison to ETP enables it to be welded freely with no danger of discolouration.

d) Coating

Unlike ETP, the coating in TFS is not amphoteric. Tin forms stannates with alkalis and salts with acids depending on the environment with which it is in contact thus damaging the internal laquer coating. Alkaline products such as detergents and dispersion colours can be packed in TFS with advantage.

4.5 APPLICATION

TFS with its excellent finish, workability, corrosion resistence, lacquerability and amenability to simple and quick joining processes is ideal for a wide range of applications and has proved to be a straight replacement for tinplate in many cases. Some of the important uses of TFS are as follows :

A) Food Containers

All food products except the very corrosive ones can be successfully canned in TFS containers.

B) Decorative Cans and Containers

Owing to its excellent lacquer adherence, workability and underfilm corrosion resistance, TFS is eminently suitable for general line cans designed to hold candies coffee, tea, paints, detergents, chemicals, film rolls and pharmaceutical products.

C) Oil Cans and Paints

The excellent special features of TFS make it highly suitable for use in cans for motor oils, paints and lacquers, certain chemicals, mineral oils, waxes and polishes.

D) Household Articles and Electrical Appliances

TFS is widely used for fluorescent lighting fixtures bodies for electric water pots, stove parts, trays, toasters, film spools, dry battery jackets and toys.

It will perhaps not be over optimistic to predict the increasingly important role TFS will be called upon to play as a substitute for ETP. Although ETP now enjoy unchallenged popularity as a packaging material, it will have to contend with the twin problems of dwindling resources of tin and prohibitive costs in the not too distant future.

5. CONCLUSION

We in TCIL believe that the Tinplate industry in our country as a whole is faced with serious threats from within and without. For continued survival and prosperity of this industry, not only should the industry influence its own environment within the country to create a favourable atmosphere for growth of the industry, but should also share its experience with neighbouring countries to benefit from each other's experience. We firmly believe that the external threat posed by industrially developed countries can be counteracted by a united effort on the part of developing countries by sacrificing short term benefits like importing cheap waste waste from developed countries and aim for long term survival of our industry. This can be done by influencing our own Government to support the industry as well as bring about bilateral co-operation between various countries for faster growth of the industry.

We welcome the efforts of UNIDO and FAO to forge a united approach amongst the ASIA and PACIFIC region countries by ensuring bilateral co-operation between these countries in the area of Tinplate Production. We are hopeful that our experience of the Tinplate Industry in India as a whole, the opportunities and threats to the industry as elaborated in this paper as well as TCIL's ability to meet these challenges would form a basis for further discussion and co-operation.

References

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3. Statistics from the Marketing Division of the Tinplate Company of India Limited.

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6. Aide Memoire presented by Tinplate Company to Government of India.

Part II - Experience of TCIL in tinplate production

Plant and process

The acid process developed by U.S.Steel is used by TCIL. While the line was designed by Wear United, Canada, main line equipment were supplied partly by Wean and partly by Davy Ashmore. Ours is a dual line, i.e., tinplate as well as electrolytically chromium coated steel can be produced. While the maximum line speed is 247 m/min. all steel tempers and both conventional single reduced and double reduced strip may be plated. Strip with thicknesses ranging from 0.17 mm to 0.60 mm. can be processed. Any desired tin coating may be deposited, normal range being 2.24 to 22.4 g / m^2. The amount of tin on each surface may be varied as desired and suitable means are there for identifying the differentially coated surface. The U.S.Steel developed process using acid sulphate bath is popularly known as the Ferrostan process, although strictly speaking this trade name refers to the product produced by this process rather than to the process itself. Of all the processes used in the manufacture of electrolytic tinplate, the U.S.Steel process is most extensively used and accounts for about 75% of all tinplate production in the world.

In the TCIL tinning line, a blackplate coil is placed on an uncoiler, fed into the welder where it is attached to the trailing end of the preceding coil and passed through the looping tower which can store as much as 201 metres of strip allowing almost a minute of holding time without any interruption while the new coil is being welded. After passing through the drag bridle, which provides the desired strip tension to control tracking, the strip enters the preplating section which comprises electrolytic cleaning, rinse, electrolytic pickling and rinse.

Cleaning takes care of grease, oil and dirt and the cleaning compound used is alkaline in nature consisting of sodium hydroxide, alkaline phosphate and wetting agents. Cathodic cleaning is preferred as scrubbing action by hydrogen is more intensive than scrubbing by oxygen in anodic cleaning with the same quantity of electricity, because of higher volume of hydrogen evolution. Pickling is required to remove oxides and rust and to etch the surface lightly so that a meticulously clean surface is available for plating which is an essential prerequisite for any coating/plating job. Sulphuric acid is used and depending on the type of finish and end use, polarity is selected. The quality of the incoming strip decides upon the current, concentration and temperature to be applied.

High pressure water jets are employed for effective rinsing after cleaning as well as pickling to prevent contamination of pickle bath and plating bath by traces of detergents and smut respectively.

The plating section consists of six vertical tanks through which the strip passes in a serpentine fashion. By adjusting the number of plating passes, speed and/or the current density, the desired tin coating is obtained.

The strip then goes through a drag out recovery tank where most of the excess electrolyte is removed and returned to the plating tanks through the drag out recovery system. The strip is then dried. The next stage is flow melting, in which the tin coating is momentarily fused by resistance heating followed by quenching in a tank of demineralised water.

This gives the bright surface and also produces a very thin slice of iron-tin alloy at the tin/steel interface which is important for corrosion resistance and solderability.

Following flow melting, tinplate is chemically or electro-chemically treated to improve storage stability and lacquerability. To reduce abrasion damage and impart further corrosion resistance, a very light uniform oil film on each surface is applied by electrostatic method.

The plate is then inspected in line both visually and automatically. The TCIL line is equipped with automatic gauge control and pinhole detector.

As the line does not have recoiling facilities, strip is cut into sheets in the automatic rotary shear and a belt conveyor carries the cut sheets to one of the four pilers according to quality grading.

Tinplate manufactured on that line is classified into three categories namely prime, seconds, and waste/waste which have the following characteristics:

Prime - Tinplates which at the time of despatch are free from defects readily visible to the unaided eye. Under normal conditions of storage and use, the whole surface of the sheet should be suitable for lacquering and printing.

Seconds - Tinplates which have a minimum of 75% of usable area. Surface blemishes e.g., spots, stain, scratches etc. are included here.

Waste/Waste - Tinplate with visible imperfections of moderate magnitude or frequency. This material is supplied in mixed sizes, thicknesses, coating weights and can have pinholes and can be a mixture of bright and matt finish.

PRODUCT MIX:

It will be not incongrous here to project the spectrum of TCIL's product mix concerning end use, gauge and coating weight and while dealing with these aspects it will be worthwhile having a look at the analysis of yield, process defects and coil defects. Product mix and the analysis for 1983 are projected in Fig. I to III.

QUALITY:

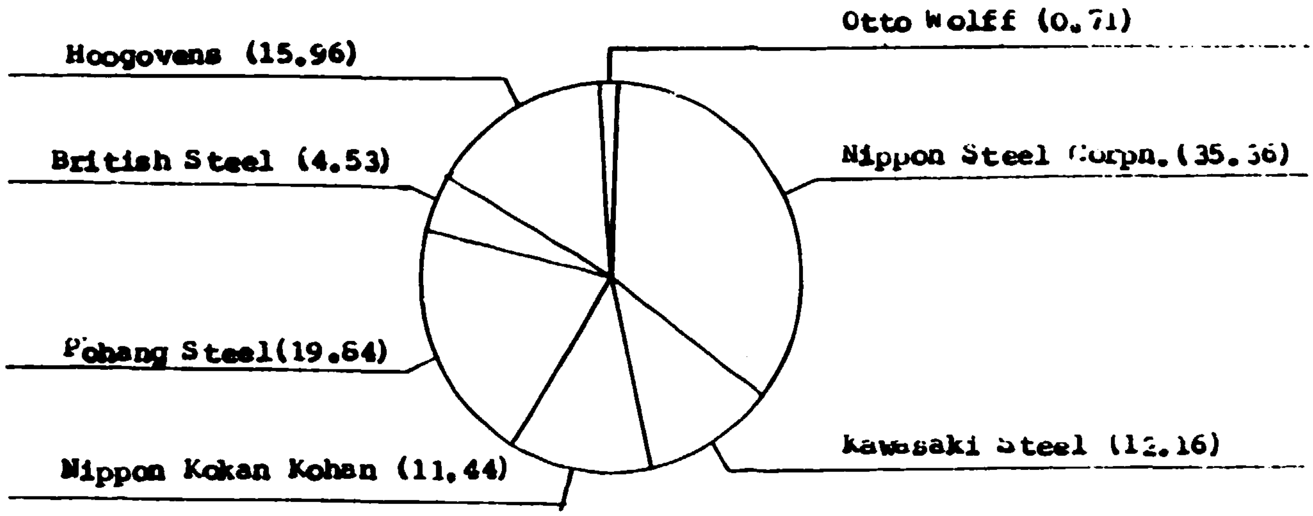
Tinplate has been recognised as a premier packaging material because of its strength, formability, solderability, weldability, amenability to lacquering and lithography and corrosion resistance under a wide range of conditions and unless adequate attention is paid at every stage of manufacture, a product fulfilling its functional requirements cannot be produced. With the rapid change and development in can making technology, accent on quality is getting stronger and stronger and the Tinplate Company is making every effort to keep pace with the growing quality requirements and to sharpen the competitive edge of tinplate.

TCIL tends to believe in the philosopy that the concept of quality is essentially dynamic in nature and not static. What today is perfectly acceptable as good quality, can nevertheless be regarded tomorrow as unacceptable. This is mainly because the customer is no longer satisfied with what did satisfy him yesterday. Everyday he requires more, because more is offered and more is offered because more is required.

To lend credence to the claim that quality is a way of life in Tinplate Company, some of the positive steps takeb by the top management of TCIL reflecting its total commitment to quality may be cited here:

TOTAL COIL INPUT IN 1983

45,513 TONNES



(N.B. - Figures in bracket indicate percentage.)

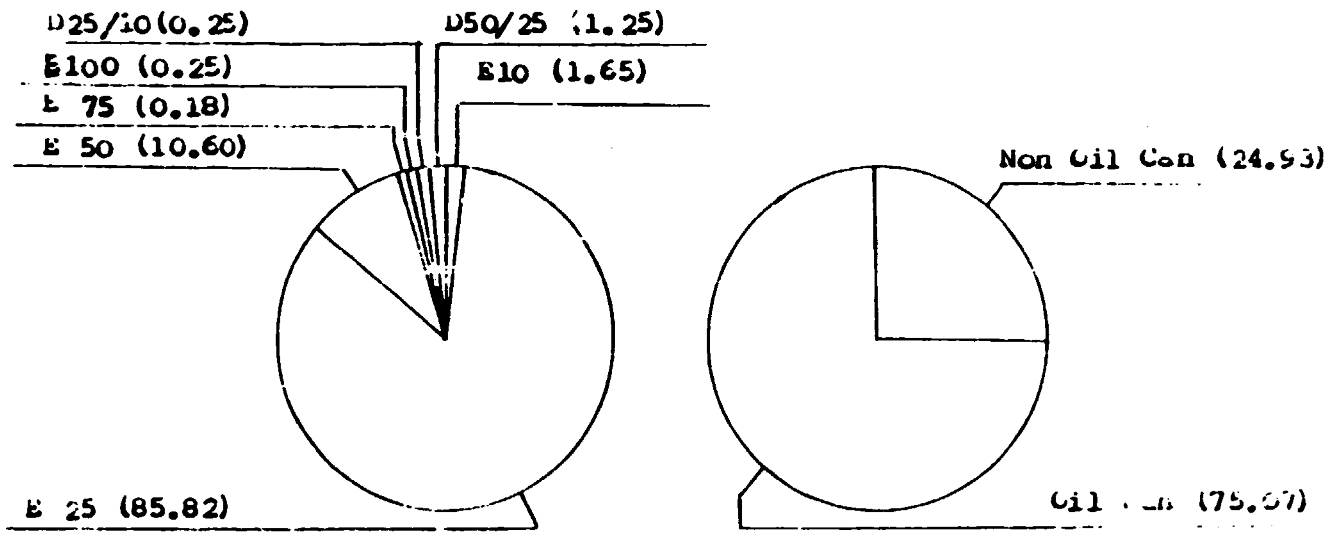
FIGURE I

PRODUCT MIX (45,513 TONNES)

1983

Coating Grades

End uses

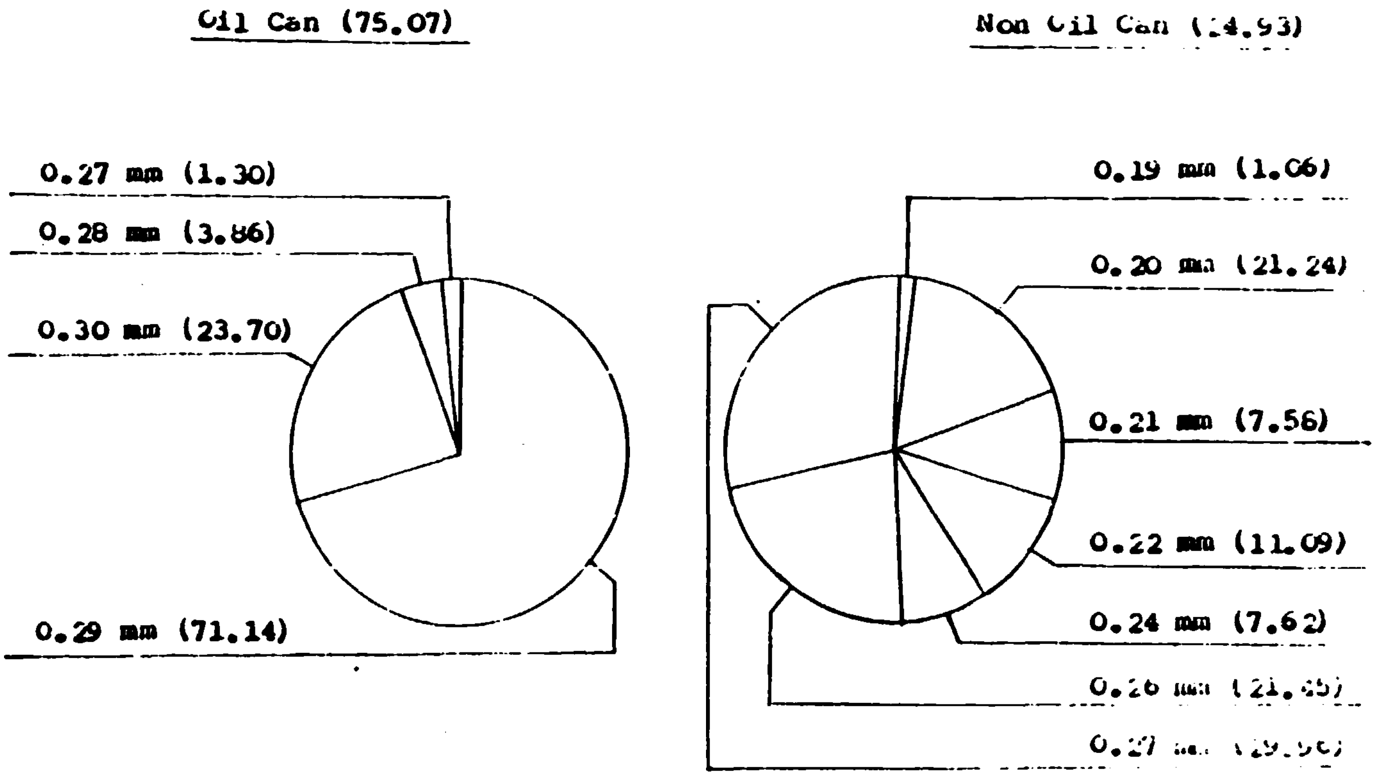


(NB - Figures in brackets indicate percentage)

FIGURE IIA

PRODUCT MIX (45,513 TONNES)- 1983

THICKNESS GRADES



(N.B. Figures in brackets indicate percentage.)

FIGURE IIB

PERFORMANCE ANALYSIS

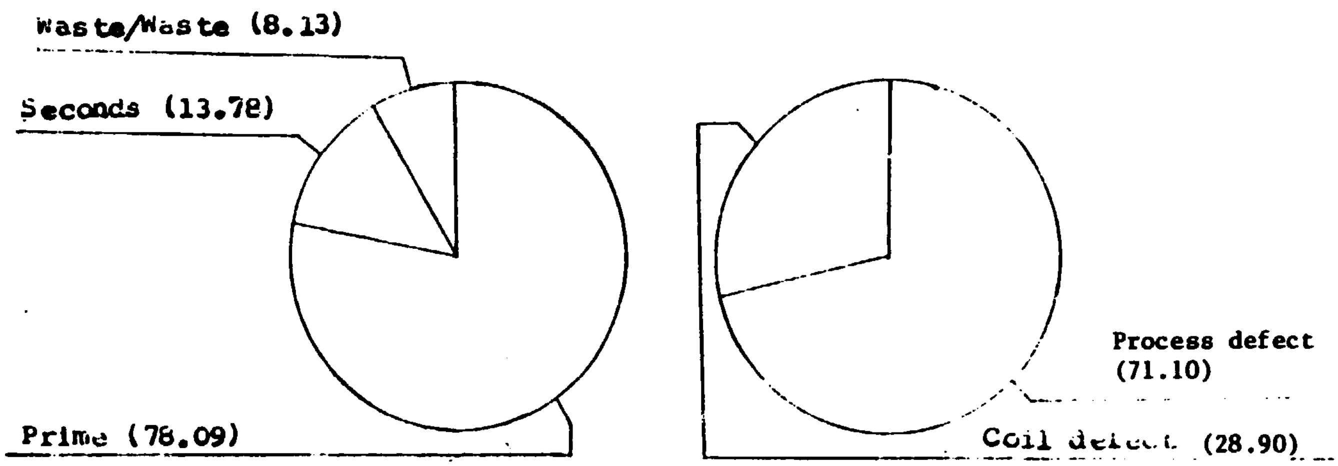
1983

Yield

Total Production = 45,513

Source of defects

Total Rejection = (21.91)



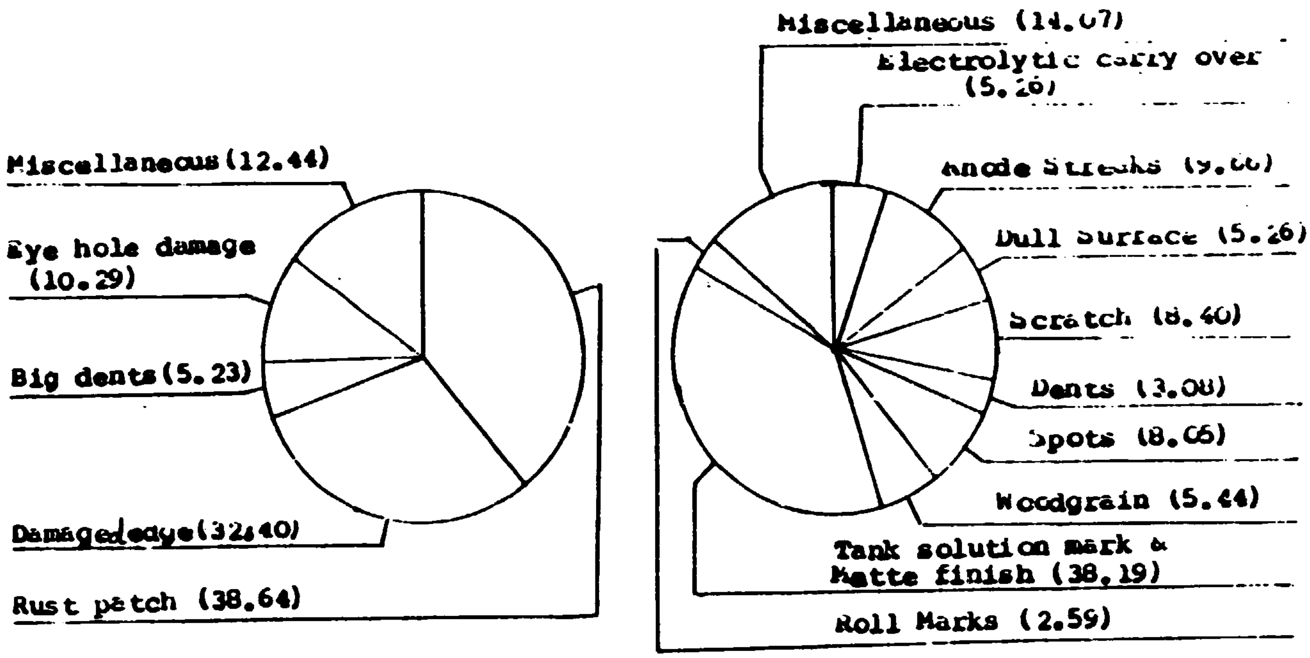
(NB - Figures in brackets indicate percentage)

FIGURE IIIA

PERFORMANCE ANALYSIS

1983

Analysis of Coil defects | **Analysis of process defects**



(NB - Figures in bracke indicate percentage)

Total production 45,513 t

Total rejection 21,91 %

FIGURE IIIB

1. The Quality Control Department reports directly to the Chief Executive.
2. Not a single tinplate packet is despatched without the Quality Control Department's certification.
3. If any of the line parameters is not maintained correctly, the Quality Control Department is empowered to stop the line till corrective actions have been taken.
4. During a period of financial constraint when most divisions receive lower sanction of funds, allocations of funds are seldom reduced for the Quality Control division.

The quality control functions start from laying down specifications of raw materials, e.g., chemicals, blackplate coil, and tin, to process control and inspection of finished products. After-sales-service constitutes another important responsibility.

Quality cannot be achieved by accident and that is why presently the emphasis is on control of the process so that quality is built into the product at every step in manufacture.

As has been described earlier, the electrolytic tinning line represents a series of precision unit operations like degreasing, pickling, plating, flow melting etc. and close control of each is vitally important for attaining the desired quality material.

Quality control tests carried out by TCIL may conveniently be grouped in two categories - process control and inspection.

While process control tests serve to ensure adherence to optimum operating conditions with regard to bath temperature, bath concentration, current density, anode geometry and so on, inspection involves assessment of finished product and quality grading.

The types of tests, frequency of testing and sampling alongwith a list of equipment which the laboratory is equipped with, are shown in table I to IV.

OPERATIONAL/QUALITY PROBLEMS:

During the first five years of tinplate production the company faced a number of quality problems. While a few of those problems could be surmounted, TCIL is still battling for finding a solution to leveller roll pick up, quench stain, and iron contamination of electrolyte.

The problems which have been by and large overcome relate to scratches, smudge, and woodgrain formation.

Scratches: Till 1982, because of scratches causing the base metal exposure, a lot of materials, otherwise acceptable in quality, were downgraded to seconds. In addition to this, the line had to be stopped frequently to locate the source of trouble and each stoppage entailed wastage of expensive coils and chemicals. In the initial stage it was thought that only slippage of rolls could give rise to scratches.

But as more experience was gained, it became clear that any dirt or tin pick up on the rolls could cause scratches. Cleanliness and good maintenance of the rolls were the answer. Ever since extensive cleaning of the plating tanks has been implemented, occurence of scratches has come down considerably.

Smudge: This is a form of black powdery deposit all over the surface. The amount of smudge may vary, but satisfactory tinplate should be free of smudge.

TABLE I

FREQUENCY OF PROCESS CONTROL CHECKS

No.	Process	Product	Parameters	Frequency
A	Primary cleaning	ETP/TFS	a. Bath concentration (as NaOH)	Twice per turn
			b. Bath temperature	Twice per turn
B	Electrolytic cleaning	ETP/TFS	a. Bath concentration (as NaOH)	Twice per turn
			b. Bath temperature	Twice per turn
			c. Current density	Twice per turn
C	Plating	ETP	a. Bath concentration	
			1. Stannous ion	Twice per turn
			2. Free acid	Twice per turn
			3. Stannic ion	Once per day
			4. Iron	Once per week
			5. Sulphate	Once per week
		TFS	b. Bath temperature	Twice per turn
		TFS	a. Bath concentration	
			1. Cr^{+6}	Twice per turn
			2. Cr^{+3}	Twice per turn
			3. Sulphate	Once per day
			4. $H_2Si\ F6$	Once per day
			b. Bath temperature	Twice per turn
D	Reflow Melting	ETP	Quench temperature	Twice per turn
E	Chemical Treatment	ETP	a. Bath concentration	
			1. Na_2Cr_207	Twice per turn
			2. pH	Twice per turn
			b. Bath temperature	Twice per turn
			c. Current density	Twice per turn

TABLE II

PRODUCT TESTING FREQUENCY

No.	Test parameter	Product	Frequency
1.	Sheet dimensions		
	a. Thickness	ETP/TFS	2 samples per hour
	b. Length	ETP/TFS	2 samples per hour
	c. Width	ETP/TFS	2 samples per hour
2.	Sheet shape		
	a. Bowness	ETP/TFS	2 samples per hour
	b. Edgewaviness	ETP/TFS	2 samples per hour
	c. Camber	ETP/TFS	2 samples per hour
	d. Askewness	ETP/TFS	2 samples per hour
3.	Physical properties		
	a. Hardness	ETP/TFS	2 samples per hour
	b. Bend value	ETP/TFS	2 samples per hour
	c. Cupping value	ETP/TFS	As and when required
4.	Coating		
	a. Free tin coating	ETP	1 sample per hour
	b. Alloy tin coating	ETP	1 sample per hour
	c. Chromium in chromium oxide	TFS	1 sample every 2 hrs.
	d. Metallic chromium	TFS	1 sample every 2 hrs.
	e. Passivation film	ETP	1 sample per turn
	f. Oil film	ETP/TFS	1 sample per turn
5.	Special properties		
	a. Corrosion resistance (sulphur dioxide test)	ETP/TFS	1 sample per hour
	b. Tin grain size	ETP for OTS can	4 samples per hour
	c. Iron solution value	ETP for OTS can	4 samples per hour

TABLE III

TYPICAL TIN COATING WEIGHT TEST RESULTS

OF E 25 COATING

Specimen Position	Side	Free Tin (g/m^2)	Alloy Tin (g/m^2)	Total Tin (g/m^2)
Edge 1	Top	4.31	1.38	5.69
	Bottom	4.47	1.37	5.84
Centre	Top	4.64	1.26	5.90
	Bottom	4.42	1.32	5.34
Edge 2	Top	4.02	1.32	5.34
	Bottom	4.19	1.42	5.61

Average Coating Weight 5.66 g/m^2

TABLE IV A

EQUIPMENT FOR PRODUCT TESTING

No.	Test Parameter	Equipment
1.	Sheet Dimensions and Shape	a. Micrometer b. Measuring tapes and scales c. Bowness table d. Askewness table
2.	Physical properties	a. Rockwell Superficial Hardness Tester b. Jenkins Bend Testing Machine c. Erichsen Cupping Test Machine
3.	Tin Coating Weight	a. Stannomatic Tin Coating Analyser b. Bendix Apparatus
4.	TFS Coating Weight	U-V Spectrophotometer
5.	Oil Film Weight	Hydrophill balance
6.	Passivation film weight	U-V Spectrophotometer
7.	Corrosion Resistance	Sulphur dioxide chamber

TABLE IV B

EQUIPMENT FOR RAW MATERIAL EVALUATION AND PROCESS CONTROL

No.	Test parameter	Equipment
1.	Metallographic analysis	a. Mounting Press b. Disc Polisher c. Zeiss Incident Light Microscope
2.	Oil film weight on TMBP coils	Soxhlet Apparatus
3.	Pickle Lag Value	Albert Autographic Pickling Rate Tester
4.	Chemical analysis of raw materials and line solution analysis	a. Channomatic and single pan balances b. Centrifuge c. U-V Spectrophotometer d. Expanded Scale pH Meter e. Muffle furnace f. Distillation Apparatus
5.	Plating cell performance	Hull Cell Apparatus
6.	Defect Analysis	Carl Zeiss Stereo-Microscope

TABLE IV C

NEW EQUIPMENT UNDER PROCUREMENT

No.	Equipment	Use
1.	Chromatic Analyser	TFS coating weight measurement (metallic chromium)
2.	Turbidity meter	Sulphate estimation in TFS plating bath
3.	Ion analyser with chloride and fluoride selective electrode	a. Fluoride estimation in TFS plating bath b. Chloride estimation in ETP plating bath
4.	Ellipsometer	Oil film weight evaluation (TMBP coils ETP/TFS)
5.	IR Spectrophotometer	ENSA estimation in ETP electrolyte.

This is normally noticed after melting and when strip comes from the oiler. This leads to pick up and formation of black coating over the surface drive bridles and subsequent pinch rolls.

This powdery deposit on being analysed is found to consist primarily of chromium salts. When a tinplate sample with smudge is subjected to sulphur dioxide testing this deposit becomes brownish resembling rust. This is actually not rust as this can be brushed off easily and the surface of the plate looks absolutely clean without any traces of base metal being attacked.

The incidence of smudge formation has been brought down to an insignificant proportion by introducing hot rinsing and changing the dunk tank solution as soon as chromium content exceeded 2 g / l. as a result of undue carryover of dichromate solution from passivation tanks.

Woodgrain: Tinplate occasionally exhibits a pattern of alternate bands of diffuse and specular reflectivity resembling the identical appearance as the grain of wood. This usually occurs haphazardly.

Although tinplate with woodgrain does not have any detrimental effect on corrosion resistance and solderability of the coating, this is undersirable, the more so when tinplate is to be decorated. For a long time we were absolutely clueless about the cause of development of woodgrain. Inspite of preplating conditions, plating parameters and flow melting variables being monitored very rigidly, woodgrain formation was unavoidable with T-25 product. This led to think that the oil level on TMBP coils could be an offending factor.

To isolate the effect of oil content, TCIL ordered a few coils without any oil and when these coils were tried with a line speed greater than 210 m/min. incidence of woodgrain was virtually negligible. It was experienced that if the oil content of TMBP coils is less than 75 mg / m^2. (both sides put together) and the line runs at a speed higher than 210 m/min. under specified bath conditions, woodgrain can be eliminated almost completely.

Iron Contamination of Electrolyte: Of the various problems which TCIL is currently saddled with, the excessive iron content of the electrolytic bath is by far the most formidable one. The iron content should preferably be below 15 g / l. and by no means this should exceed 20 g /l. Excessive iron content tends to oxidise stannous ions to stannic ions and thus promotes excessive quantity of sludge, which is undesirable both from the economic as well as from the operational points of view.

An analysis of the electrolyte indicated that the iron content fluctuates between 18 g/l to 25 g / l. The steps which were already taken to control the iron content of the electrolytic bath are as follows:

1. Change of hold down rolls of pickle tanks and subsequent dunk tanks to minimise carry over of pickle acid drag solutions containing iron.
2. Periodical inspection of plating tanks to ensure that rubber lining has not been damaged.
3. Whenever the line is idle because of certain interruptions, the electrolyte is immediately drained out to basement tanks.

However, inspite of these measures, not much improvement has been observed, so far, as regards iron content of electrolyte.

A further effort to combat this problem will be to avoid keeping any anodes idle in the first pass which is normally not used while producing 5.6 g / m^2 coating weight. Either these anodes will be taken out at that time or a very minimal amount of power will be supplied to effect a trace of coating, known as flash coating.

Quench Stain: Stains, which originate from the quenching operation following melting, are termed as quench stains and these mar the brightness of flow melted tinplate.

Although demineralised water is used by TCIL and temperature is varied according to coating weight, quench stain keeps appearing with varying severity. Judging from the appearance of the stains, it appears that these are due more likely to hot water than cold water. Spray pressure, spray adjustment and distance of sprays from the strip and quench temperature are the various parameters which are being looked into to overcome this problem.

Leveller Roll Pick Up: Whenever tinplate with heavier coating than #25 coating is produced, numerous small dents, fairly well distributed on both sides of the sheet are observed soon after the sheets come out from leveller rolls. It is apparently due to tin pick up by the leveller rolls, and when these rolls are cleaned of very tiny tin particles/dust, there is respite for some time but again these dents start showing up after about half an hour or so, as soon as tin particles gather around the rolls.

The root cause seems to be poor tin adhesion but it is not understood why tin adhesion should be different from that in heavier coating under similar operating conditions. Furthermore, we are yet to come across a suitable method for evaluating tin adhesion quantitatively.

TIN FREE STEEL: (TFS)

As mentioned at the outset TCIL operates a combination line i.e., Tinplate and TFS both can be produced in this line alternately. Strip handling, cleaning, pickling, oiling operations and classification system are the same. When TFS is to be produced, all processing units between the pickle rinse and the passivation tanks, which are used as chromium plating tanks during TFS manufacture, are bypassed but the strip is kept damp by passing it through tunnel like water trays until it reaches the plating tanks. This is an important step considering the susceptibility of pickled virgin surface to oxide formation as soon as it comes in contact with atmosphere. While electrolyte consists of chromic acid, sulphuric acid and fluosilicic acid, anodes used are an alloy of lead and silver.

Changeover from ETP to TFS or viceversa takes about eight hours, and warrants hosing down the splash areas and rinsing out the tanks and piping common to both systems.

Tin free steel produced on TCIL's line is known as TFS III and was developed by U.S.Steel. This coating has a duplex structure(metallic chromium and chromium oxide) and is produced by a one-step process whereby chromium and chromium oxide are deposited simultaneously.

While metallic chromium acts as principal corrosion barrier, the chromium oxide content regulates the appearance or color, and lacquerability.

At this point, a few observations may be made, which make TFS production somewhat more arduous and critical:

1. Since the coating thickness of TFS is almost 1/50th that of E25 coating, TFS will not cover any visible surface defects of unplated strip. Even mottle from cold rolled or double cold rolled plate will remain visible in the coated product. Moreover, metals like Ni and Cr can be deposited on slightly oxidised surface, but Cr never plates out on iron oxide. In other words, quality of TMBP coils in terms of surface blemishes should be more stringent, and cleaning and pickling perfect. One West European supplier mentioned that special care is taken when TMBP coils meant for TFS are rolled.

2. Plating parameters relating to bath concentration and temperature are far more rigid compared to those of tinplating calling for extreme vigilance on the part of line crew.

3. Line speed is more critical in TFS production than in tinplate processing. This is because chromium oxide of the duplex coating is dissolved by chromic acid solutions and thus final oxide content will be the difference of the amount originally produced and the amount dissolved by the plating solution.

The length of time that the strip is in contact with the electrolyte after plating is completed, which is a direct function of line speed will decide the oxide level, all other parameters remaining unchanged.

Because of gelatinous nature of chromium oxide and tendency of electrolyte to dry quickly, rinsing, squeezing and drying in the plating section are vitally important to obtain stain-free products. For effective squeezing, the quality of rubber rolls in regard to composition, and roughness plays a key role and the availability of the right type of rolls in India remains a problem to be solved.

4. Plant maintenance is more hazardous and by any account more expensive. Because of the corrosive nature of chromic acid containing electrolyte, tanks, pumps, piping and all other components in the system should be lined with expensive PVC or a suitable chromic acid resistant material.

5. The analysis of bath solution and determination of coating weight call for very sophisticated instruments. Alternative wet methods are too slow to cope up with operational need of requiring the analysis frequently for solutions and coating weight values within fifteen minutes.

COIL: It will perhaps not be irrelevant to make a special mention about two particular aspects of TCIL's blackplate coil requirements relating to quality which are not covered in any international specifications, e.g., ASTM, JIS or Euronorm.

TCIL is one of the very few tinplate producers in the world who are not an integral part of a steel plant with cold rolling mill complex and have to depend on imported coils which are rolled at least three months ahead of actual tinning operation and have to travel thousands of miles exposed to a wide range of climatic conditions starting from cold and dry climate to hot and humid tropical weather and involving multi-point handling. These two factors, it is felt, will adequately underline the importance of protective coating and packaging from the view point of corrosion and physical damage of coils.

Degreasing facilities available on the tinning line are meant to remove traces of lubricating oil or greases which incidentally contaminate coil surface either in temper rolling or in coil preparation line during side trimming. TMBP coils which received at TCIL, however, contain much more oil which is added intentionally to resist rusting during transit and long storage.

Coil suppliers in their overenthusiasm to prevent rust formation tend to supply more oil than what is specified and this adds to the already problem ridden task of removing this, and the significance of a scrupulously clean surface prior to plating cannot be over-emphasized. The oil content of TMBP coils is very critical to the company. It must satisfy dual functions. On the one hand it should be enough to resist rusting and on the other it should be easily removable. Based on the experience gained assidiously over the last four years, TCIL is of the opinion that if the oil content is between 25 to 75 mg./m^2, it should serve the purpose. Oil used for this purpose is mostly Dioctyl Sebacate (DOS).

One of the West-European suppliers is using Acetyl Tributyl Citrate.

The packaging of TMBP coils has an important bearing on the quality of strip available for subsequent plating. A coil pack must primarily be moisture proof. Though TMBP coils are given a rust preventive oil coat, the quantity of such a coat must necessarily be restricted in view of the limitations in TCIL processing line to remove the oil. A water proof packing is therefore necessary to provide an additional safe-guard against rust formation on coils. TMBP coils mounted on wooden stillage are preferred since this further protects the package from coming in contact with water which may be lying in the hatch of a ship or areas in ports where the coils are unloaded.

The packaging for TMBP coils must also provide adequate protection against mechanical damage during handling at various points which gives rise to such defects as damaged edges, dents and collapsed eyeholes. Considering the multistage handling involved in transit from the suppliers end to the Jamshedpur works and the comparitively poor handling facilities at the existing ports, the coil packing must include adequate protection angles on the outer and inner edges, thick, and strong eye protection drums and tight strapping.

The importance of packaging will be accentuated by the fact that of all the defedts associated with coil, rust patches because of water ingress and mechanical damage of coils as stated above account for eighty percent, Another problem characteristic to imported coils is longitudinal bowness in gauge less than 0.25 mm. Bowness is at times so high that it can not be rectified on leveller rolls. Some of the suppliers are of the opinion that when coils are under tension for a period of 3 to 6 months, some degree of bowness is inevitably introduced.

Explanatory Note:

g = gram

mg = milli gram

l = litre

mm = millimeter

m = metre

min = minute

TABLE V

TCIL'S ETP/TFS/PLANT RECORDS

1.	Longest uninterrupted line run	26.10.83	9 hrs. 6 min.
2.	Line Production		
	Maximum per shift	10.1.84	200 T
	Maximum per day	30.10.83	502 T
	Maximum per month	Dec 83	7146 T
3.	Packed Production		
	Maximum per shift	30.11.83	186 T
	Maximum per day	30.11.83	467 T
	Maximum per month	Dec 83	7640 T
4.	Despatch		
	Maximum per day	17.1.84	564 T
	Maximum per month	Dec 83	8517 T
5.	Best yield	Nov 83	86.4%