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Technical Features of Electrolytic Tinning Lines Installed Overseas by Kawasaki Steel

Toshio Ohki, Takaiku Ohmori, Setsuo Nonaka

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The Steel Plant Group of Kawasaki Steel's Engineering and Construction Division erected seven electrolytic tinning lines in South East Asia over the last 20 years, and has provided guidance for line operation and maintenance. Kawasaki Steel's ETL has a halogen process with horizontal cells and a halogen bath, offering excellent operability and maintainability. Further Kawasaki Steel has made numerous improvements in the equipment and operation technology, including (1) rearrangement of the tinning cells, (2) increased productivity by the application of high current density, (3) fluxing system improvement, and (4) relocation of the tin-free-steel section. All seven lines have rated up smoothly and are operating by completely fulfilling client expectations.

The body can be viewed from the next page.

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Toshio Ohki
Staff Assistant General Manager, Cold Rolling Technology Sec., Rolling Technology Dept., Engineering & Construction Div.


Takaiku Ohmori
Staff Assistant General Manager, Cold Rolling Technology Sec., Rolling Technology Dept., Engineering & Construction Div.


Setsuo Nonaka
Staff Manager, Cold Rolling Technology Sec., Rolling Technology Dept., Engineering & Construction Div.

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1 Introduction

The Steel Plant Group of Kawasaki Steel's Engineering and Construction Division has constructed seven electrolytic tinning lines (ETLs) in Thailand, Malaysia and People's Republic of China (Taiwan) with the cooperation of Chiba Works of Kawasaki Steel during the last twenty years, and has provided assistance for line operation and maintenance. The ETLs in these countries differed according to clients' needs. The facilities were designed to match the operating environment of the site, to incorporate only the necessary features, and to reflect various improvements that would solve problems with facilities already in operation. As a result, all these lines achieved stable operation in a short time with appropriate assistance from Kawasaki Steel in their operation and maintenance. This report describes several improvements made to respective lines.

2 Outline of Typical ETL Facilities

A layout of up-to-date ETL facilities destined for overseas, and a general view of the line are shown in **Fig. 1** and **Photo 1**, respectively.

2.1 Entry Section

The entry section sequentially welds refined cold-rolled steel coils and sends them to the center section. It is composed of a coil holder, welder, and looper.

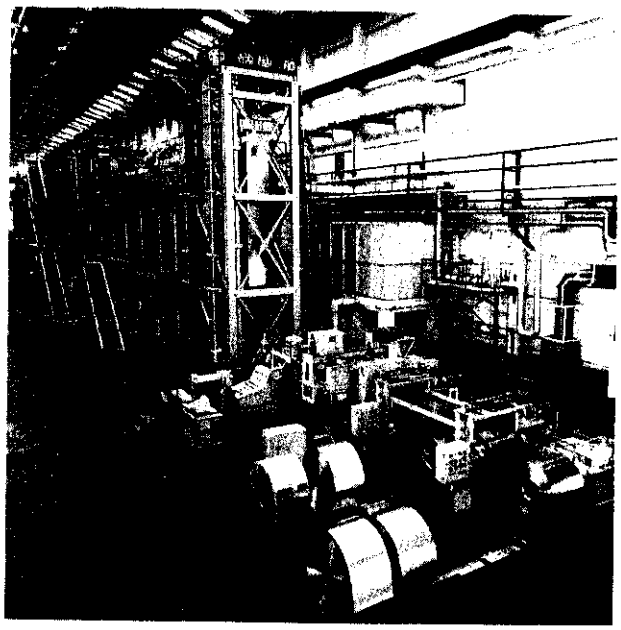

Photo 1 General view of electrolytic tinning line

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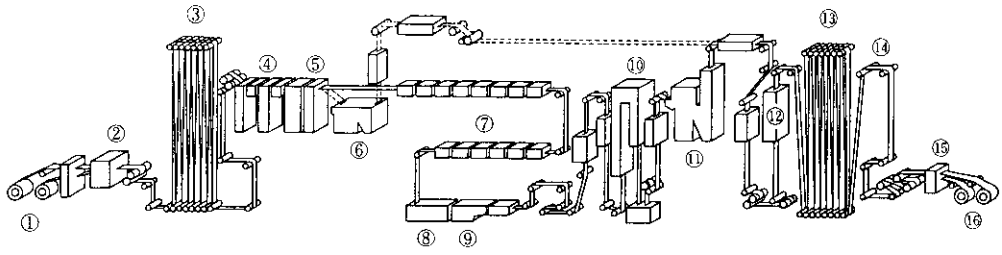

① No.1 and 2 pay-off reels
② Welder
③ Entry looper
④ Cleaning tank
⑤ Pickling tank
⑥ Cr-plating tank (TFS)
⑦ Tin-plating tank
⑧ Reclaiming tank
⑨ Fluxing tank
⑩ Reflow
⑪ Chemical treatment tank
⑫ Oiler
⑬ Exit looper
⑭ Inspection room
⑮ Ship shear
⑯ No.1 and 2 tension reels

Fig. 1 Schematic diagram of ETL

2.2 Center Section

The center section which mainly carries out degreasing, pickling, plating, reflow and chemical treatment consists of many tanks, and in addition, of those units for drying and oiling plated strip. In plating, Kawasaki Steel uses a halogen-type bath based on stannous chloride, known for its established performance. This method features a high level of operability and maintainability while each side of the strip passes through its horizontal tank.

2.3 Exit Section

The exit section inspects the product quality, and winds and divides the strip. It comprises the looper, inspection equipment, snip shear, and tension reels.

3 Improvements to Facilities

It can be said that ETLs constructed for overseas customers have been a series of improvements made to the prototype at Chiba Works. Problems found at an installation of equipment at a point were corrected and put into effect on the next project point. **Table 1** shows a change of these improvements for each line.[1-3] A brief explanation will be made on these features of the equipment technology.

Table 1 History of technology of overseas ETLs

Stage / Line		Prototype	First generation		Second generation	Third generation		
		A	B	C	D	E	F	G
Start of operation		1973	1982	1982	1986	1989	1990	1990
Specific capacity	(t/y)	60 000	90 000	90 000	60 000	150 000	150 000	150 000
Line speed (max.)	(mpm)	150	183	183	150	300	300	300
Number of cell	Top	4	5	5	4	8	5	5
	Bottom	4	5	5	5	10	6	5
Circulation volume in plater cell	(l/min·cell)	240	240	240	670	670	670	670
Edge overcoat defuser[1,2]		—	—	—	—	—	○	—
Roll polisher for conductor roll[3]		—	—	—	—	○	○	—
Flux		$NH_4Cl+HCl$	$NH_4Cl+HCl$	$NH_4Cl+HCl$	HCl only	HCl only	HCl only	HCl only
Shear type		Hallden	NC 300	NC 300	NC 300	NC 600	NC 600	NC 600
Structure		High layer	High layer	High layer	Middle layer	Middle layer	Middle layer	Middle layer
Cellar		○	○	○	—	—	—	—
Pickling acid		H_2SO_4	H_2SO_4	H_2SO_4	HCl	HCl	HCl for Tin H_2SO_4 for TFS	HCl
TFS combination		—	○ (at chemical)	—	—	—	○ (after pickling)	Future (after pickling)

○ : Equipped in the line — : Not equipped in the line

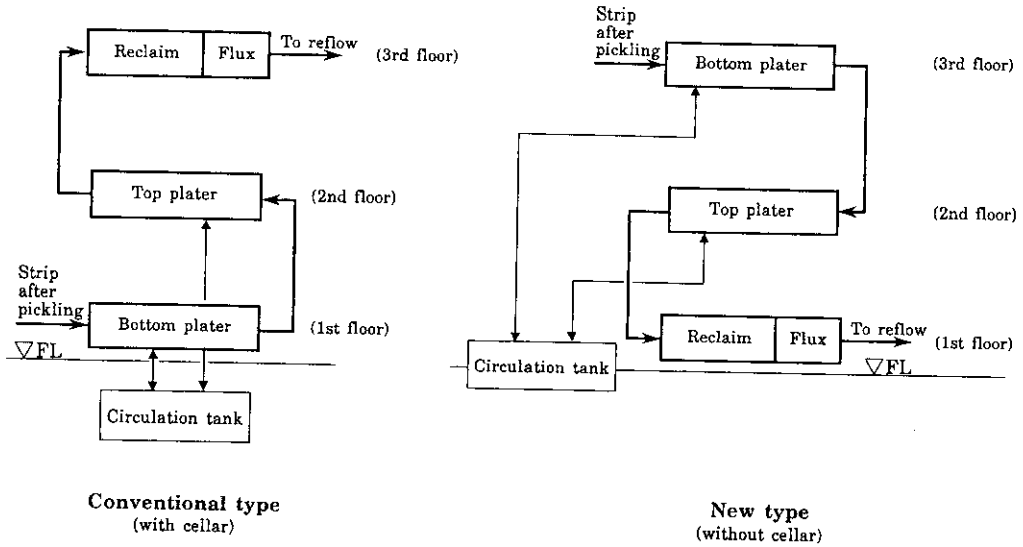

Fig. 2 Comparison of design of strip pass line

3.1 Reduced Construction Cost by Pass Changes in the Plating Section

The strip pass line in the central section was reviewed, and the original flow from the 1st floor to the 3rd floor was changed to be from the 3rd floor to the 1st floor as shown in **Fig. 2**[4,5]. The cellar for installing the circulation tank of the plating solution was discarded, thereby obtaining the following advantages:

(1) Rationalization of the Construction Method
  (a) Dispensing with underground steel columns
  (b) Shortening the construction period for foundation work
  (c) Reducing the foundation work cost
(2) Improvements in Operability and Maintainability
  (a) Since the flux tank which exercises a significant effect on surface quality has been moved to the 1st floor, spraying, cleaning of the roll surface, and control of chemical solutions have all become easier.
  (b) Since the cellar was dispensed with, high temperatures and fume accumulation have been corrected, and operability and maintainability have been improved.

3.2 Productivity Improvement by High Current Density

An increase in the capacity of the circulation pump for the plating solution has resulted in improved productivity and quality as shown in **Fig. 3**. For instance, in the case of producing tin plate of #100 (coating weight 11.2 g/m^3 on one side) by four cells, the quantity of the plating solution being circulated has increased by about three times that in the past. As a result, the allowable current density is more than previously, thereby also increasing the plating speed and improving productivity

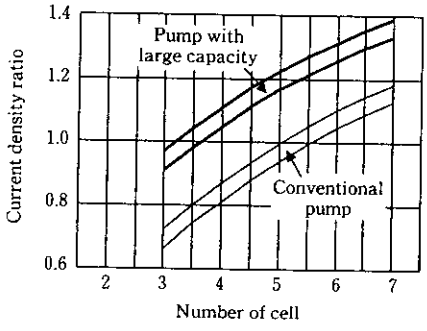

Fig. 3 Increased productivity by high current density

by about 25%. Simultaneously, an abnormal luster has been decreased, contributing to a quality improvement.

3.3 Workability Due to Changes in the Flux Material

Initially ammonium chloride and hydrochloric acid were used as the flux, but this two-solution type gave poor operability and unstable quality. Therefore, a single solution of hydrochloric acid was used, and application by immersion type was changed to spray application. The following effects have resulted:

(1) Decreased fouling from the rolls
(2) Relief from the over-flux phenomenon
(3) Decreased generation of wood grains

3.4 Quality Improvement by Changing the Position of the Tin Free Steel (TFS) Facilities

In the case of the tinning-cum-TFS line of the past, TFS equipment was installed with the chemical treating facilities after reflow. As a result, it was necessary to keep the strip wet during the period up to the TFS

equipment after pickling. An up-to-date ETL incorporates the TFS facilities after the pickling tank, and the following effects have resulted:

(1) Less deterioration in quality (such as spot rust) due to insufficient wetting.
(2) Reduced cost from omitting the keep-wet facilities in the stage up to the TFS facilities after pickling.

4 Operation Records

All the lines have shown improved productivity and yield after rating up, maintaining a high level expected by the clients. For instance, **Fig. 4** shows the improvements in average prime yield ratio after starting the operation of the respective lines. Although these values

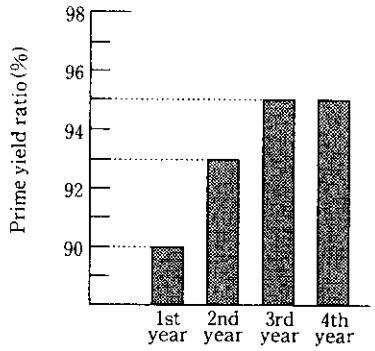

Fig. 4 Start-up performance of prime yield ratio

are significantly governed by the quality of the original strip and operating skill, they reflect that the facilities were easy to operate and nearly trouble-free.

5 Conclusion

The features of ETLs constructed for overseas customers have been reported. With a series of improvements explained above, facilities featuring low costs and excellent operability have been realized and the operation of all these ETLs after completion trial has been running smoothly. Further, some of the customers operating these ETLs have recently acquired Japanese Industrial Standard (JIS) approvals, and all these achievements are highly evaluated by customers.

Finally, the authors express their deep appreciation to all those persons concerned of various companies in Thailand, Malaysia and the Republic of China (Taiwan), to whom ETLs have been delivered, for their kind and valuable cooperation rendered during the construction and operation of the ETLs.

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