

*Abstract:*

*In order to do so, we must first understand the nature of the problem.*

the bath was feasible. The main problems for operation with an MSA bath at 2ETL were operational stability and the electrolyte cost. This paper describes the equipment improvements carried out to overcome these problems and the results achieved.

## 2. Features and Problems of MSA Bath

The MSA bath is a plating bath which is composed mainly of methane sulfonic acid ( $\text{CH}_3\text{SO}_3\text{H}$ ) and  $\text{Sn}^{2+}$ , and has the following features:

- (1) The proper electrolysis current density ( $10\text{--}55\text{A}/\text{dm}^2$ ) is wide, being similar to that with the halogen bath. This means that it is possible to apply the same cell structure as with the halogen bath.
- (2) Sludge generation is small (no more than 1 t/m; with halogen bath: 15 t/m).
- (3) Because the main components of the sludge are  $\text{Sn}(\text{OH})_4$  and  $\text{SnO}_2$ , recycling is easy.

On the other hand, the following points were a concern, and these were taken up as problems in this project.

- (1) The MSA bath is strongly corrosive ( $\text{pH} < 1$ ).
- (2) Lines in the U.S. which had previously converted to MSA reported problems with bare stain (soiling by cohering oil and tar components), which occurred because the bath temperature exceeded the cloud point of the surfactant in the initial stage of conversion, and rolled-in defects due to precipitation of tin on the conductor rolls.
- (3) The unit cost of the electrolyte is extremely high in comparison with the halogen bath.

To overcome these problems, the cell structure was remodeling and measures were taken to minimize electrolyte loss. The following chapters describe the respective countermeasures and their effects.

## 3. Remodeling of Cell Structure

Based on an advance study, three types of quality problems were feared in the plating cells, bare stain, carbon contamination, and rolled-in defects due to tin deposits on the conductor rolls.

The first problem, bare stain, is a type of contamination that adheres to the steel strip when the oily component dispersed in the bath coheres. This problem occurs when the bath temperature exceeds the cloud point of the brightening agent (surfactant). The “cloud point” is the solubility limit of the brightening agent, i.e., the temperature at which the brightening agent becomes insoluble, resulting in white turbidity, and is approximately  $60^\circ\text{C}$  in the case of the brightening agent used here. With conventional halogen bath operation, bare stain does not occur even if the temperature in the cell exceeds

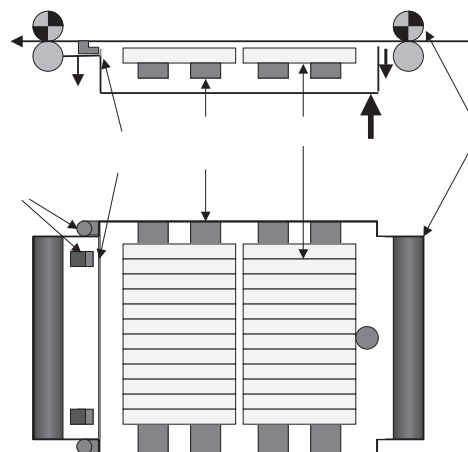
$65^\circ\text{C}$  due to electrolysis, but bare stain does occur when using an MSA bath if the cloud point is exceeded. As a countermeasure for bare stain, plating bath cooling was strengthened to prevent bath temperature rise. The equipment-related countermeasures for preventing bath temperature rise are described below.

- (1) The circulation pump capacity was increased (before remodeling:  $1.14\text{ m}^3/\text{min} \times 14$  pumps, after remodeling:  $1.5\text{ m}^3/\text{min} \times 14$  pumps) to alleviate heat stagnation in the plating cells.
- (2) Because electrolyte accumulation at the delivery side of cells increased due to the increased electrolyte circulation rate, outflow control holes were provided at the cell delivery side and side wall of the delivery side to prevent overflow of the electrolyte (**Fig. 1**).

These countermeasures made it possible to control the bath temperature in the cells to less than  $50^\circ\text{C}$  during high current operation ( $8\,000\text{ A}/\text{cell}$ ). To date, bare stain has not occurred.

Problem 2 was carbon contamination, in which carbon eluted from the carbon plate anode bed used in the halogen bath adheres to the steel strip. This problem was expected if the carbon plate anode bed is immersed in the strongly acidic MSA bath. As a countermeasure, the anode bed material was changed to Ti plate, which is stable in the MSA bath. As a result, carbon contamination has not occurred to date.

Problem 3 was deposition of tin on the conductor rolls, which is thought to occur because part of the plating current which should flow from the anodic electrode to the cathodic steel strip passes directly to the conductor roll. Therefore, a plate was provided to cut off the current between the anodic electrode and the conductor roll (Fig. 1). This measure reduced the frequency of tin deposits on the conductor rolls to approximately 1/5 of the former level.



## 4. Minimization of Electrolyte Loss

### 4.1 Introduction of Countercurrent Rinse

**Figure 2** shows a schematic illustration of the present plater section of 2ETL. The plating cells in 2ETL are horizontal-type cells. Bottom side plating is performed on the 1st floor, and top side plating is performed on the 2nd floor. Before conversion, the electrolyte was recovered by a reclamation tank at the entry side of the 3rd

loss, iron elution, and sludge generation, the equipment was remodeled to enable operation with a variable number of electrolyte-filled cells, so that only the cells where electrolysis is performed are filled. When producing tinfoil with a light coating weight, only about half of the cells are filled with electrolyte. A “keep wet spray” is used to prevent drying of the strip surface in cells which are not filled.

#### **4.3 Negative Effects of Electrolyte Loss Minimization**

Electrolyte loss minimization in the plating sec-