Process and Equipment Selection of Revamping GALVANIZING Line to GALVALUME Line

2018.06.25
01 Product characteristics of GALVALUME

02 Process of GALVALUME line

03 Revamping solution and equipment selection

04 Effect after revamping
Product characteristics of GALVALUME
1. Product characteristics of GALVALUME

GALVALUME (GL) : 55%Al-43.5%Zn-1.5%Si coated sheet steel

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight ratio</td>
<td>55%Al, 43.5%Zn, 1.5%Si</td>
</tr>
<tr>
<td>Volume ratio</td>
<td>80%Al, 18.0%Zn, 2.0%Si</td>
</tr>
<tr>
<td>Density</td>
<td>3.69 g/mm³</td>
</tr>
<tr>
<td>Melting Point</td>
<td>590°C</td>
</tr>
<tr>
<td>Hardness</td>
<td>120 (HV)</td>
</tr>
<tr>
<td>Surface</td>
<td>Silver gray, minimized spangle</td>
</tr>
</tbody>
</table>

GL sheet
<table>
<thead>
<tr>
<th>ITEM</th>
<th>GI</th>
<th>GF(5%Al)</th>
<th>GL(55%Al)</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Life</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Electrochemical Protection</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>N/A</td>
</tr>
<tr>
<td>Welding performance</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Application with Wet Concrete</td>
<td>Good</td>
<td>Poor</td>
<td>Very Poor</td>
<td>Very Poor</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
2. Advantages of GL:

- The corrosion resistance is 3~6 times as high as that of common GI productions
- Thermal resistance: GL product can be used under 315 ℃
- Good thermal reflection coefficient: one time than GI product
- High surface hardness
- Thinner coating layers, you can reduce component weight which also cutting down the cost of raw material
3. GL Product Usage

➢ **Construction industry**
  Roof, walls, blinds etc. for building

➢ **Home appliances**
  Cover plates for TV, air conditioner etc.

➢ **Automotive industry**
  Car muffler, exhaust, sign board on freeway

➢ **Electrical industry**
  Cabinet, vending machine etc.
PART 02 Process of GALVALUME line
1. Process of GALVALUME line

- Entry Section
- Cleaning Section
- Furnace
- APC Section
- SPM+TL+Coater
- Exit Section

Vertical Furnace

Horizontal Furnace
2. Key Points

(1) Cleaning surface

AL-Zn-Si liquid cannot properly immerse to the strip surface because of its high surface tension. The residual iron fine and oil on the strip surface would cause blank dot or spot without AL-Zn-Si galvanizing, and also cause a lot of zinc dross in the pot.

(2) Uniform strip temperature

Uniform strip temperature reduce the zinc dross and ensure good coating quality.

(3) Control of zinc dross

Zinc and iron are two kinds of metals and it is easy to cause inhomogeneous composition in GL pot. Fe and Zn or AL react easily in the pot to form compounds, such as FeZn$_7$, Fe$_2$Al$_5$. And the densities of these compounds are much greater than GL liquid. This will cause a lot of bottom dross in the pot. use a pre-melt pot to make sure the composition and temperature stable in GL pot.
## Process of GALVALUME line

### (4) Heat Cycle (for reference)

<table>
<thead>
<tr>
<th>No.</th>
<th>Steel grade</th>
<th>Heat</th>
<th>Soak</th>
<th>Rapid cool</th>
<th>APC Top roll °C</th>
<th>FCS °C</th>
<th>Water quench °C</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>CQ GI</td>
<td>720</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>2</td>
<td>DQ GI</td>
<td>780±10</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>3</td>
<td>DDQ GI</td>
<td>820±10</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>4</td>
<td>FH GI</td>
<td>560±10</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>5</td>
<td>HSS GI</td>
<td>800±10</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>6</td>
<td>HSLA GI</td>
<td>800±10</td>
<td>≥20</td>
<td>460±20</td>
<td>≤280</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>7</td>
<td>CQ GL</td>
<td>720</td>
<td>≥20</td>
<td>570±30</td>
<td>≤300</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>8</td>
<td>DQ GL</td>
<td>780±10</td>
<td>≥20</td>
<td>570±30</td>
<td>≤300</td>
<td>≤150</td>
<td>≤45</td>
</tr>
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<td>9</td>
<td>DDQ GL</td>
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<td>≥20</td>
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<tr>
<td>10</td>
<td>FH GL</td>
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<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
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<td>HSS GL</td>
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<td>≥20</td>
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<td>≤300</td>
<td>≤150</td>
<td>≤45</td>
</tr>
<tr>
<td>12</td>
<td>HSLA GL</td>
<td>800±10</td>
<td>≥20</td>
<td>570±30</td>
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<td>≤150</td>
<td>≤45</td>
</tr>
</tbody>
</table>
5. **zinc vapor**

   The temperature of zinc pot is around 600 °C and it’s higher than the melting point of Zinc. These would cause a lot of zinc vapor in the snout. Usually we need wet N\textsubscript{2} system (dew point -25°C) at the end of the snout to prevent the zinc vapor from entering the furnace.

   \[ \text{Zn} + \text{H}_2\text{O} = \text{ZnO} + \text{H}_2 \]

6. **Scraper for pot rolls**

   The sink roll and stabilizing roll should be equipped with motorized scraper to keep surface clean. In normal operation, pot rolls will be covered with thick Al-Zn dross, and this will influence surface quality of the strip. The scraper would help us to remove some dross and make the surface of the rolls smooth.

7. **Fast cooling after pot**

   The corrosion resistance of GL products is 3~6 times as high as that of common GI products. In order to achieve this goal, we must refine the dendritic crystal of aluminum-rich in the coating; reduce the distance between the grains; reduce the quantity of zinc-rich grains in intercrystalline gap and make them distribute finely in the coating. It need fast cooling as soon as possible with cooling rate 15~30°C/s
PART 03

Revamping solution and equipment selection
1. Line parameter

A hot-dip galvanizing line of Chinese enterprise was built in 2005 with the annual production of 350,000 t. Due to the market reason and products structure adjustment, the existing hot-dip galvanizing line needs to be relocated and upgraded. After revamping, the line can be used for producing both GALVANIZING (GI) and GALVALUME (GL) products.

Existing line parameters:

- **Steel grade:** CQ, DQ, DDQ, EDDQ, FH, S250G, S350G, HSS
- **Strip Thickness:** 0.2~2.0mm
- **Strip Width:** 700~1550mm
- **Line Speed:**
  - max.240 (Entry & Exit)
  - max.180 (Process)
- **Coating:**
  - GI: 60~450g/m² (both sides)
- **Passivation:**
  - 16~24g/m² (both sides)
Revamping solution and equipment selection

Line parameters after revamping:

Steel grade: CQ, DQ, DDQ, EDDQ, FH, S250G, S350G, HSS

Strip Thickness: 0.2~2.0mm

Strip Width: 700~1550mm

Line Speed: max.240 (Entry & Exit)
            max.180 (Process)

Coating: GI: 60~450g/m² (both sides)
         GL: 60~200g/m² (both sides)

Passivation: 16~24mg/m²/side

Anti-fingerprint: 0.5~1.5μm/side (dry)
Revamping solution and equipment selection

- Mobile cooler
- Induct heater
- Electrolytic cleaning section
- No.2 Coater
- Chilling rolls
- No.2 Pay-off reel
- Zinc pots and pre-melt pot
- New snout with wet N₂ system
- New furnace
- Cleaning section
- Entry looper
- No.2 Pay-off reel
- Strip Direction
2. Main equipment selection

(1) Cleaning section

To ensure 1s contact time and 12A/dm² current density, a vertical electrolytic degreasing unit with 8 electrodes (0.75m long for each) is added. The capacity of the rectifier is 30V 6000A. We also modified the circulation system of degreasing section and add 3 sets magnetic filters (rod-chain type) for iron fine separation, the flow rate of each filter is 60m³/h.
(2) Annealing furnace

GI pot and GL pot requires different bath temperature, the heat cycle of the existing furnace should be modified. The furnace is re-designed according to the new heating cycle. Since the anneal temperature of FH product is lower than the temperature of GL pot, the induction strip heating equipment which supplied by AJAX is added after the rapid cooling section in the furnace. The height of induction heater is 4m, and the power is 1600kw. It is cooled by cooling water.

The strip temperature of GL production before pot is 570~590°C. In order to make sure the uniformity of the strip temperature in width direction, the equalizing section and snout insulation are added after the cooling section of the furnace, and 3 electric radiant tubes are added to keep the strip temperature. We design a wet N$_2$ system (dew point -25°C) at the end of the snout to prevent the zinc vapor from entering the furnace.
(3) Zinc pots

The capacity of GI pot is 300t, and is equipped with 2 inductors, each rated 500kw. The capacity of GL pot is 70t, and is equipped with 4 inductors, each rated 450kw. The fluidity of GL is not so good, it is easy to cause zinc dross. GL pot need 4 inductors (each side has inductor) to make sure the temperature is uniform.

Considering more zinc dross at bottom, the space between sink roll and pot bottom should ≥900mm. The inner hearth dimension of GL pot is 3450mm (W)×3350mm(L)×2300mm (H), and the inner hearth dimension of pre-melt pot is 2743mm (W)×1524mm(L)×1782mm (H).
(4) Air knives and pot rolls

The air knife for both GL and GI products are nearly the same, the difference is:

➢ Cooling fan for edge coating device.
➢ Touch-less edge baffle
➢ Lower pressure (GL 60~100mbar, GI 500mbar)

The design of sink roll for GL and GI is different.
For GI: Ø800mm, grooves and coating, no scraper
For GL: Ø600mm, no grooves and coating, motorized scraper made of cobalt alloy
(5) After pot cooling

After pot we add a mobile cooler above air knife to minimized the spangle. It is on the same rail with maintenance crane of air knife.

Characteristic of mobile cooler:
- Close to air knife as much as possible
- High cooling rate: 15~30°C/s
- Variable frequency fan
- On-line/off-line position
(6) Post-treatment

The post-treatment section is redesigned according to the new PMT temperature form 80°C up to 110°C. No.2 vertical chemical coater is added for coating with anti-fingerprint or passivation solution.

The capacity of strip dryer is designed according to the critical strip dimension at the maximum speed of 110°C. 2 pairs of chilling rolls are added after the dryer.

Characteristic of No.2 coater:

- Speed: pick-up rolls 90~150% line speed
  applicator rolls 50~150% line speed
- Drive direction: both clockwise and anticlockwise
- With pressure gauge
- Quick opening before welding seam
Effect after revamping
Effect after revamping

The line has been put into operation for nearly 3 years. Each guarantee values and production quality have reached the design goal. The operation condition of the equipment is good and the product quality is stable. The residual iron fine and oil on the strip surface $\leq 10\text{mg/m}^2$, strip temperature control accuracy in each section of furnace $\leq \pm 5^\circ\text{C}$ and bath temperature accuracy $\leq \pm 2^\circ\text{C}$. 

First coil - GL

First coil - GI
Thank You!

WISDRI

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