MCL Production Line Overview

The MCL Production line is a Multi Coating Line, completed and put into operation on February 27, 2003, production capacity per year is 100 thousand ton unoriented cold rolled electrical steel plate and 50 thousand ton color coated steel plate. Equipment and technology of the production line are at the world’s leading level. As both unoriented cold rolled electrical steel plate and color coated steel plate can be produced, the structure of the products can be adjusted according to the changes of the market, which brings a strong competitiveness.

1. Production Process

[Diagram showing the production process]

Technological process

Material → Batching → Degreasing → Washing → Drying

Electrical steel plate

Material → Batching → Degreasing → Washing → Drying

Color coated steel plate
2. Production equipment introduction

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Main parameters

Weight: 600-1270mm, Thickness: 0.20-1.40mm
Max Entry/Exit speed: 160m/min, Max Process speed: 120m/min, Coil inner dia: 508/610mm, Maximum weight: 25T
3. Introduction of color plate production

High-quality equipment is used to produce excellent surface condition substrates (GI, EGI, CR); after alkali washing, water washing and drying by the pre-treatment equipment, using chromate treatment, increasing corrosion resistance and surface adhesion. After the treatment including initial coating, drying, cooling, finishing coating, back coating, drying to the steel plate, the color plate with excellent properties and workability is produced.

Chapter 3 Uncoiling and connection

Main equipment for the entry section of the organic layer coated steel sheet production line including: Rolling cart, uncoiler, shearing machine, connecting machine, degreasing box, washing tank, dryer, entry looper.

1. Uncoil

Main Equipment:
Pinch roll: It is used to feed the open head of the uncoiler into the shearing machine.
Uncoiler (Pay off reel): Feed the coil into the production line
Mandrel: Fix shaft and coil plate, support coil plate
Deflector Roll: Change the direction of the steel strip
Threading Table: Guide and transfer steel plate
Coil Car: Delivery of rolled plate

The production line is equipped with two uncoiler, it is mainly composed of transmission motor, reduction gear box, core, centering liquid baffle, rotary cylinder for rolling core expansion and expansion and floating hydraulic cylinder. Steel goes in to uncoiler through coil skid and coil car.

2. Connection

Main equipment:
Connecting machine: It is a hydraulic punching device, which is a hydraulic punching device.
Shearing machine: Used for substrate roll cutting and tail cutting.
Working theory: It is used for connecting the front and rear base plate with the roll head and tail to ensure continuous production. It is a hydraulic punching device, which is a hydraulic punching device. Press out at least 2 rows of joints between front and rear steel strips, punch out a hole before the seam for inspection, so as to indicate when passing through the seam in production.
3. **Entry Looper**

1. **Function**: Store the steel strip so that the entry have enough time to connect and the central production line can maintain normal operation. When the connection is stopped, the entry trailer will release the stored steel strip to ensure the continuous production line. After the connection is completed, the entrance section runs at a high speed, the speed of the entrance section exceeds the central speed, and the entrance trailer is filled with steel belt again to prepare for the stop of the next connection.

2. **Storage**: Available for 2 min normal operation, if the line speed is 80mpm, the storage for looper would be 160m, storage of our looper is 240m.

3. **Theory**: When restarting after each steel strip stitching cycle, the entire entry section will over speed until the entry section is full of the steel strip, which will automatically slow down to the same speed as the process section until the coil is finished, and the next working cycle is repeated.
Pretreatment Process

1. Degreasing process

Pre-treatment is mainly to clean the surface of steel dust and impurities and improve the coating effect.

1. Degreasing structure

The pre-treatment process consists of 1# degreasing box, brushing box, 2# degreasing box, 1# water washing box, and 2# water washing box. There are many nozzles inside the degreasing box, which will spray lye on the surface of the steel plate and scrub the brush in the box. The steel plate is mechanically cleaned and finally the residual lye is washed in a water tank.

2. Theory of degreasing

Degreasing mainly adopt alkaline cleaning liquid for surface purification treatment. The oily pollutants attached to the surface of the steel plate are mainly fatty acids and glycerides. These organic substances can cause saponification, emulsification, osmosis and dispersion in the degreasing process of alkali solution. It acts and breaks off the surface of the steel plate under the action of cleaning to achieve the purpose of cleaning.
1) Pre-cleaning tank
   For steel strip pre-cleaning. Remove oil and other dirt from the surface of the steel strip by alkaline degreasing. Including alkali degreasing tank and hot water rinsing tank.

2) Alkali degreasing tank
   It consists of three parts, which are tank, sprinkler system and the heating system, the system can be made of FRP or carbon steel and, the tanks are provided with a plurality of rows of nozzles and degreased lye, which are pumped to the lower nozzle through the circulation pump to the upper and lower sides of the steel strip. The reflux pressure in the tank is about 0.35MPa, and the bath liquid is heated by hot steam. The temperature of the alkali solution in the tank is usually 80 degrees Celsius.

3) Hot water rinsing tank
   The steel strip degreased by the alkali water is put in to the hot water rinsing tank and the lye and dirt on the steel strip are rinsed clean. The tank is heated with steam, water temperature is maintained at 80 degrees Celsius. The tank is made of glass or ordinary carbon steel.

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2. Chemical treatment process

1) Passivation tank
   After phosphating treatment, there are micro defects on the phosphating film required passivation treatment to form new sediments to close the holes in the phosphating wax and increase the corrosion resistance of the film.

2) Hot-air dryer
   Hot-air-dryer is used to dry the surface moisture of the steel strip. It is composed of several v-shaped tube groups, which are divided into several pairs and arranged on the upper and lower parts of the steel plate. The hot air is about 90 degrees Celsius

3) The coater
   The coating machine is usually double head roller coating, which can be applied sequentially or reversibly.
   The roller system principle of the horizontal roll coating type coating machine includes a steering roller, a support roller, a positive coating roller, a positive coating roller, a back coating roller, a back coating reclaiming roller, a lifting roller, etc. The steel belt enters the coating machine through the steering roller, and the passivation liquid is evenly brought to the front of the steel belt by the front coating roller while winding the support roller, and then by the lifting roller to the back coating roller and coating the back of the steel belt at the same time.
   The roller is all active, generally driven by ac frequency conversion motor, and the coating on the paint tray is touched by the feeding roller to the coating roller, which is then applied to the steel belt.
Chapter 5 Paint shop process

1. Color board coating process

Initial coating machine coats the operating strip in the same or opposite direction with a precise uniform primer, while the fine coating machine coats the primed and cured strip with a precise uniform primer or coat of binder for subsequent coating. The coating room, all controls and motors are explosion-proof.

After curing, both the primary primer and the refined topcoat shall be cooled to ensure the performance and surface quality of the coating products. Cooling including water-cooled air cooling and water cooling. The coated steel strip is water cooled and then squeezed out by a squeeze roll.

The film thickness can be controlled by the coating machine by changing the speed of the coating roller relative to the steel strip and adjusting the gap pressure between the coating roller and the supporting roller.

1. Coating device

Coating equipment includes coating chamber, coating machine, air extraction system, curing machine, cooling system, etc.

1) Coating chamber

The coating rooms are equipped with air extraction system that continuously expel air containing large amounts of volatile organic solvents from the room. For fire protection, the coating chamber uses a variety of explosion-proof motors, and most of them are separated from the space in which the coating chamber is located. Many dry powder fire extinguishers are equipped with ventilation ducts to minimize organic solvents.

2) Coater

The modern double-coating and double-baking production line uses four roller coating machines: one chemical coating machine, one primary coating machine and two fine coating machines. Chemical coating machine is used for passivation and other pretreatment; primers are used to coat the front and back primers of steel strips.

Coating machine equipped with the material roller is generally galvanized chrome steel roller, coating roller is lined with rubber steel roll.
Most of the current overseas rubbers are polyurethane rubber.

2. Theory of coating machine (as pictures)

Generally, the coating is made by the two-roll coating roller (AR), the material taking roller (PR), which is used in the production of architectural color plate; Three roller coating; coating roller (AR) material taking roller (PR) measuring roller (MP) can also be used, for the production of home appliances color board. Each roller is independently equipped with drive and transmission device, so the rotation direction and speed of each roller can be adjusted at will.

Most coating machine in the history are multi-slide coating machine, which are generally divided into two rollers and three rollers, the coating roller, feeding roller and support roller are installed on their own slide and control the coating thickness through adjusting the pressure between the rollers which depending on the load sensor. The biggest feature: the coating roller, the feeding roller and the supporting roller are installed on the same slide. The load sensor is directly installed under the bearing seat of the working roller, which improves the control precision of coating and saves the amount of coating.

1) Two-roll coating (As pic)

![Two-roll coating](image)

2) Three-roll coating

![Three-roll coating](image)

3. Coating method (as pics)

When the direction of the coating roller is the same as the running direction of the steel belt, it is called forward coating. When it is reversed, it is called reverse coating.

A. The structure of the coating machine should be determined according
to the specific production conditions of each factory;
B. Two-roll coating machine is used for thin and forward coating;
C. Three-roll coating machine is used for thicker products;
D. Forward coating is used for thin layer with low viscosity, reverse coating is mostly used for thick coating with high viscosity;

1. Reverse coating (R)

Steel strip

Coating plate

In this method, for the backside coating, the coating roller (AR) feeding roller (PR) is in the reverse direction, when the viscosity of the paint is large, it can be adjusted within 10% of the original tip speed ratio. (The back coating can be adjusted within 20%, and the zinc spangle is not recognized within the standard thickness).

2. Forward coating (F)

Steel strip

Coating plate

This method is for the base coating (initial coating), but the white-board is applicable to the reverse coating method. Roller (AR), Coating roller (PR) are forward coating. When the viscosity of the paint is large, it can be adjusted within 10% of the original tip speed ratio.

Equipment for base coating:
4. Tip speed ratio

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<td>Surface 80:72:22(F)</td>
<td>60:81:30(R)</td>
</tr>
<tr>
<td></td>
<td>Back A, 80:80:80(R)</td>
<td>B, 60:60:60(R)</td>
</tr>
<tr>
<td>Fine</td>
<td>Surface 80:108:40(R)</td>
<td>60:112:18(R)</td>
</tr>
<tr>
<td>coating</td>
<td>Back 80:80:80(R)</td>
<td>60:60:60(R)</td>
</tr>
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Note: the above data is only for reference and the actual operation is performed according to the standard.

2. Silicon steel coating process

A distinct feature of cold-rolled silicon steel sheets compared to hot-rolled silicon steel sheets is the application of a coating on the surface during the production process. The coating has not only high insulation properties, but also good corrosion resistance, processing properties, heat resistance, etc., which is therefore well received by users.

1. Insulating coating

Electromagnetic performance is the main index to measure the quality of silicon steel sheet with two important data: magnetic sensation and iron loss.

Silicon steel sheets are used in the form of laminated sheets to manufacture iron cores of a series of electrical equipment such as transformers and generator motors. The purpose is to insulate silicon steel sheet laminates from each other to reduce eddy current losses.

* What are the requirements for insulation layer or isolation of silicon steel sheet?

In order to improve the electromagnetic performance, the electrical silicon steel sheet must be coated with the coating with certain performance requirements.

Requirement for Insulation coating:

(1) High interlayer resistance.
(2) Excellent heat and corrosion resistance to operate in high temperature and corrosive environment.
(3) Good adhesion, hard to peel off during punching or bending.
(4) Good machinability, can play a role in lubrication as the coating has little wear on the mold.
(5) There is a certain tension on the surface of the steel plate to reduce the noise caused by the expansion and contraction.
(6) The coating must be thin and uniform to improve filling performance.

2. Factors affecting coating quantity
   1. Specific gravity of insulating fluid
      The higher specific gravity, the thicker the coating, vice versa.
   2. Roller roll reduction
      The amount of coating is inversely proportional to the amount of coating roller pressure; larger the amount of pressure, thinner the coating.
   3. Roller type of coating roller
      The coating roller is made of acid-resistant rubber. The main influencing factors are the hardness of the rubber roller, the diameter, the angle of the groove, the depth, and the number of teeth per unit length. The larger the hardness, the smaller the diameter, the larger the angle, the deeper the groove, the larger the number of teeth, will cause the coating amount thicker, vice versa.
      The hardness of the coating roller not only affects the thickness of the coating amount, but also affects the uniformity of the coating. As the production speed increases, the uneven coating of the coating on the surface of the steel strip in the form of longitudinal conditions becomes more serious.

Chapter 6 Drying Stove Process

For the steel strip that is finished with the first and final coat, the backside of the primer shall be cured by baking oven.
Most of the existing coated steel plate production units are heated by hot air heating. The heat source can be natural gas, liquefied petroleum gas and sometimes coke oven gas. The organic coating steel plate and the general equipment of the production unit include pre-treatment drying furnace, primary coating drying (curing) furnace, fine coating drying (curing) furnace, incinerator and recovery system.

1. Furnace system equipment
   The pretreatment drying furnace is used to dehydrate and dry the chemical pretreatment liquid, that is, to heat the steel strip so that the moisture of the chromate film on its surface is completely evaporated. The oven is heated indirectly by hot air. On the one hand, the fresh air is preheated for the first time through the heat exchanger of the incinerator; on the other hand, the preheated air is heated again in the heat exchanger of the combustion chamber of the drying furnace so the air rises to the necessary temperature.
and the pretreatment coating of the surface of the steel strip is dried, the exhaust gas in the furnace is discharged from the factory.

The furnace structure includes a combustion chamber, a heat exchanger, a channel and flue.

The primary coating drying furnace and fine coating drying furnace are composed of a combustion chamber, a heat exchanger, a furnace channel and flue. The whole furnace is divided into three sections, each section has the same structure, while the temperature can be controlled independently. The exhaust gas inside the furnace contains volatile components of coatings, which will be discharged from the plant after combustion in the incinerator.

Both the initial coating and the finishing oven are allowed to have a solvent evaporation of 200 L/H. The value is not safe if exceeded, which can be controlled by solvent monitoring device.

2. Green facilities

1. Waste gas treatment equipment

In the production process of organic coated steel plate, there will be a large number of harmful exhaust gas, which mainly comes from the surface pretreatment, coating and baking curing process.

Waste gas is treated by incineration of harmful gases through the incinerator system. The incinerator is connected by a flue and a prime-coating oven to recycle their waste gas for incineration.

Since the 1970s, most of the production units of organic coated steel plates in the world adopt the method of furnace gas cycle and secondary incineration, which can utilize the heat energy in the waste gas and improve the thermal efficiency of the heating and baking furnace. Meanwhile, the harmful waste gas is effectively incinerated. The thermal efficiency of the oven is close to 80%.

Combustion is assisted by gas to burn off the harmful substances in furnace gas. The combustion temperature is about 830 degrees. After incineration, high-temperature gas is generated and preheat the air into the curing furnace by means of heat exchange.

2. Waste liquor treatment equipment

During the pretreatment process of coating production, the treatment liquids in the processes of phosphating and chromizing need to be periodically replaced. The surface treatment waste liquid contains high concentrations of harmful substances (Cr3+, Cr6+, F-, Zn2+, etc.)

The main equipment of the wastewater treatment system includes:

All kinds of tanks, such as concentrated acid concentrated alkali waste tank, chemical condensation reaction reduction reaction tank, neutralization tank, storage tank, residue tank, floating tank and so on;

All kinds of pumps, such as raw material pump, sewage pump, backchannel pump, pump, etc. Hydraulic system, air compressor, fan, etc.

The coating production wastewater generally includes degreased alkaline wastewater, phosphating wastewater containing zinc and fluoride ions, chromium-containing passivation and activated treatment wastewater. To treat these wastewater, the wastewater containing Cr6+ is first reduced to Cr3+ wastewater, and then the PH value is adjusted to make Cr3+ as Cr(OH)3...
precipitation and separated with liquor. Meanwhile, the alkali degreasing wastewater is mixed with the acid washing wastewater and phosphating waste liquid, and the PH value is adjusted with alkali to make the heavy metal precipitation.

ZH-Q pic:

3. Drying oven process

Drying oven (OVEN) is an indispensable equipment in the production line of coated steel sheets and a necessary device for forced drying of paints in a fluid state. The heat transfer methods of the drying furnace include direct heating, indirect heating and semi-indirect heating.

Hot air transport mode: hanging mode and floating mode while we uses the hanging mode. OVEN is divided into 2~4 parts, each part consists of hot air circulation pump, combustion chamber, external air suction port and exhaust port. The heating method is gradually from low temperature to high temperature, and the cooling method is from slow cooling to quenching.

pics of OVEN

Hot air heated drying ovens are horizontal straight-through. Time of the steel strip in the oven depends on the thickness of the steel strip, the type of coating, the thickness, the color, etc.

Each section is heated by a flame burner, and the entry air and the circulating furnace gas with solvent are heated by the flame of the burner, the mixture is burned to generate waste, or silicon is modified to produce silicon, these wastes remain in the furnace wall and fall on the surface of the steel strip after entering the furnace, which must affect the quality of the organic coated steel sheet. In the overhanging furnace, the hot air is blown from the nozzle below the steel belt to the direction of the steel belt. The nozzle is far away
from the steel belt and the wind direction is the same. It can be considered that the wind belt is basically in the free drooping state in the furnace.

The sag of the steel strip in the furnace is large, and when the thickness of the steel sheet is the same, the irregular sag of the steel strip is related to the tension of the steel strip and the length of the overhanging section of the steel strip.

The overhanging furnace has high furnace body, low thermal efficiency and free sagging of steel belt under tension, which is easy to distort and make the temperature of steel belt uneven in horizontal direction.

The tension of the oven has a great influence on the outlet looper tension, Therefore, problems may occur in the unbalanced tension of the looper outlet and oven.

As for the hardening of the coating, the tension in oven is not well adjusted, so the strip is deviated to the upper or lower part, and the heat gained from the deviated side will be relatively large, and the steel belt will be badly scratched. Therefore, the tension shall be adjusted well.

Pic of Fine Oven:

Chapter 7 Coiling and cutting

The equipment for the export section of the organic coated steel sheet production line mainly includes a looper tower, a tension roller, a shearing machine, a coiler and a steel belt trolley.

1. Exit side looper
   The maximum storage capacity of the steel strip of the exit side looper is 240m, which is a horizontal structure.
   The structure of the looper tower in the exit section is the same as that in the entry section. The exit side looper is empty during strip operation. When the exit section is stopped for cutting, the exit section looper continues to store the steel strip from the process section. After the next coil is rolled up, the exit section speeds up and the looper is empty

2. Tension roller
   In continuous strip coating units, the strip must be aligned as shown in pics:
First, the steel belt can be aligned;
Second, improve the uneven shape of the steel strip;
Third, the steel belt in the processing section passes through the coating machine stably;
Fourth, maintain proper draping of the steel strip over a fairly long oven area;
Fifth, the tension of the outlet section can be rolled up with steel belt, and wrong side winding can be carried out when necessary.

3. Correction system
For high-speed continuous operation of the strip production line, the alignment of the strip is a very critical problem, which is related to the normal unit and the quality of the product. Several sets of belt alignment system will be equipped in the unit according to the unit conditions. The whole production line has many sets of rectifying system.
Theory: after the photoelectric detector measures the offset of strip steel edge, it feeds back to the hydraulic servo system, drives the hydraulic cylinder to expand and shrink to make the deviation rectifying roll swing and rectifies the deviation strip back to the central position.

4. Coiling
Exit section coiler is used for coiling finished products.
The composition of the coiler: reel, gearbox, motor, hydraulic cylinder.
The coiler seat is composed of a fixed part and a floating part, the floating part is installed on the fixed part. The floating part is driven by a hydraulic cylinder, which receives edge scanner (photoelectric detector) signals and can make the coil move 150mm left and right on the unit's center line.
Take-up tension control is achieved by the speed difference between the tensioning roller and the coiler
Defect handling
When the steel strip with thick edge defects is winded, the shape of the steel belt is bulging on both sides of the middle concave, and the taking-off tension mainly ACTS on both sides. If the taking-off tension is higher, the side wave will be more serious. It is necessary to immediately reduce the tension of the steel strip and reduce the edge wave defect.
Calculation of steel strip length
L=G*1000 /(D*b*d)
=Roll weight*1000 / ( Thickness * Width * Specific gravity of steel )

Specific gravity of steel : 7.85 ton/meter³

5. Shearing
The shears at the exit section are the same as those at the entry.
After the steel strip is wounded, it is cut through the exit side scissors to separate the rolls and removed from the rolling car, while the coiler rewinds the next roll.
The exit section steel coil car is used for carrying products and its structure is the same as the entry section.
Steering roller and tension roller set
1 ) Steering roller : The effect is to change the direction of the steel strip.
2 ) Tension roller set : Its role is to control the steel belt in each section of the equipment to maintain the necessary tension, so that the steel belt can be stable and in continuous operation.

Pics of taking up: