PRODUCT, PRETREATMENT & PAINT OPTIONS IN COIL PAINTING

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The aim of this paper is to outline the various options of product, pre-treatment and paints available when considering the installation of a Coil Paint Line. There are a number of options available, and each option is designed to provide certain advantages. As with all choices, each may have some disadvantages and these will be discussed . Often the final decision becomes one based on local conditions of feed availability and market requirements.

1. PRODUCT OPTIONS

There are a number of product categories globally available to a potential coil coater. As mentioned the choice of product type is usually influenced by the end user's requirements and available feed.

The feed coils presented to the Paint line can be:

- Aluminium
- Zinc coated steel - galvanised
- Zinc/Aluminium (45% Zinc /55% Al with trace Si) coated steel- trade name Galvalume®
- Zinc/ Aluminium (95% Zinc / 5% Al) coated steel – trade name Galfan®
- Other alloys of Zinc/Aluminium (mainly Magnesium, Nickel or Silicon) coated steel- trade names Supadyma®, ZAM® and Ecogal®
- Uncoated Steel

1.1 Aluminium

This is the most expensive substrate, but arguably the most long-lasting. It is very good for extreme environmental conditions, for example close to the sea, exposed to chemicals or high humidity atmosphere. It does not have the strength of steel, and hence is limited in its application. It is easily pre-treated in a coil paint line and this results in extremely good paint adhesion and surface appearance.

1.2 Zinc coated steel

This is the oldest technology for the protection of steel. It is also the most economical general purpose product available. The coating is zinc with minor amounts of other elements added to promote the adhesion of zinc to the steel base and, at times to promote a smooth surface. The product can be produced on Non Oxidising Furnace lines, Wet Flux lines and Dry Flux lines. It performs better than the Zinc/Aluminium product when used in wet applications, i.e. in the ground or in heavy snow areas,

due to better galvanic protection at cut edges. The life of the product is typically less then Zn/AL coatings. Typically 10-15 years could be expected depending on application.

1.3 Zinc/Aluminium (45% Zinc/ 55% Al) coated steel - Galvalume®

This is a steel substrate that is coated with 55% aluminium and 45% zinc coating. It is good for most external applications and has a life span to 25 years and beyond, depending on its application. As with aluminium, pre-treatment of this product is very simple and a high level of paint adhesion is obtained. The surface is inherently very smooth. This product is not suitable for applications that are continually exposed to moisture and alkaline conditions, for example, cool room panels or panels into soil. This product is manufactured on Non Oxidising Furnace (NOF) Metal Coating lines. It is generally more expensive than zinc coated as the process equipment is more involved and due to the addition of aluminium. (Aluminium is generally more expensive than zinc). Usually Zinc/Aluminium lines are very large and require high volumes to be competitive, in excess of 120,000 tpa. The technology of Zinc / Aluminium coating is more complex than Zinc, however, it is seen to be a superior quality product as the surface is very smooth, paint adhesion is excellent and overall outside corrosion resistance is very good.

1.4 Zinc /Aluminium (95% Zinc /5% Aluminium) coated steel

This is a galvanized steel product that has approximately 5% aluminium in the zinc coating. Usually a License is required to run this product called Galfan®. It is more economical than straight zinc as the coating mass can be reduced to obtain the same performance characteristics. The product is not as widely processed as the Zn/AL and Zn. The equipment used to produce Galfan® is basically identical to that for producing Zinc coated steel. However the higher amount of zinc does mean better edge galvanic protection than the 55% Al/45% Zn coatings provide.

1.5 Other alloy coatings of Zinc and Aluminium

Following the successful development and marketing of the above two Zinc/aluminium coatings the search for coatings with an even better combination of surface protection and paintability has continued. This has resulted in at least three different alloy combinations of Zinc and Aluminium coatings being developed in Japan. These include :

a) an alloy of 11% Aluminium/3% Magnesium/0.2% Silicon

b) an alloy of 6% Aluminium / 3% Magnesium

c) an alloy of 5% Aluminium and minor amounts of Magnesium and Nickel.

As with other Zn/Al coatings production equipment similar to the larger NOF lines is required. This obviously makes capital costs higher but some of the claimed increase in corrosion protection can lead to large reductions (eg up to a half) in the coating

weight . This can lead to large raw material costs savings to the steel producer and their customers.

1.6 Uncoated

This is uncoated, non-protected, cold rolled steel. Hot rolled steel can also be painted but this is rare. It is only suitable for internal applications. It is more economical to purchase than zinc coated steel. Painted Cold Rolled Steel is sometimes used for external applications in some developing countries, but the expected life span is extremely limited.

The painting process of all the different substrates is similar but there will be some differences in the cleaning processes before painting, depending on the substrate type and the protective coatings.

2. PAINT AND PRETREATMENT OPTIONS

There are a number of pre-treatment chemical and paint alternatives available. It is very often said that the success of a coil coater is due to how closely he marries his operation with pre-treatment and paint suppliers. There should be constant communication at all levels to be sure that the most economical and suitable quality is being achieved. Those that do not practice this can soon fall behind the market.

Typical cleaning and pre-treatment section of a coil paint line

2.1 Pre-treatment

No matter what the feed coil type, the strip must be pre-treated before paint is applied to obtain any acceptable level of prolonged paint adhesion and corrosion resistance.

Prior to pre-treatment the feed is cleaned to remove oil and any other surface contaminants. This is done in high pressure spray tanks with contact times of between 2 and 5 seconds. The solution is normally hot (60 -70 degC) alkali although acid based cleaners are also available. Following the cleaning tanks usually two hot (50 -60 degC) water spray tanks are used to be sure that the alkali from cleaning is not carried through to the pre-treatment stage. Between each spray tank rubber squeegees also prevent carry through of the solution from one tank to the next.

Following cleaning, the pre-treatment is applied. This is usually chromic or phosphoric acid based although chromium free systems are now available. The pre-treatment performs a dual function.

- It creates a very high bond between the paint and the base metal.
- It provides corrosion protection. Without the pre-treatment protection, any cuts, holes or scratches will expose the base metal and this will corrode and/or result in blistering and flaking of the paint from the base. Also paint is porous, that is, moisture will transfer through the paint and attack the substrate if there is no corrosion barrier provided.
- Due to the move toward maintaining the environment, chemical companies are developing chromium free pre-treatment chemicals. A number of these are now commercialised and are being used globally.

Generally there is an ability to include chemicals which can pre-treat a range of substrates in the one line. However, it is very important when designing a line to, very early, discuss and decide on the markets being targeted, thus dictating which base feed will be used. In some cases the pre-treatment supplier may need to be provided with typical product so that he correctly nominate what cleaners and pre-treatment should be recommended. Often, it is the cleaner section that is important.

For example in the case of uncoated steel, the base needs to be abraded using “Scotchbrite” brushes between the two alkaline cleaning stages. The pre-treatment is usually a mixed oxide type system, for example, Henkels Bonderite 901) . This results in the best paint adhesion. In the case of galvanised steel, sometimes phosphate based systems, for example, Henkel’s Bonderite 37S is used. This type gives the best corrosion resistance under most conditions and in special cases, like in whitegood appliances, may be the preferred choice. However, in other cases like

normal building and construction, chromium, or recently developed chromium free systems will be adequate.

Pre-treatments can be applied by spray, dunk or roll coater systems. The final choice is dependent on the desired line speed and the capital available. Bronx International have engineered and installed all these types of pre-treatment systems.

However, the most common approach is to use roller coating systems. These may be using any of the following:

a) horizontal pull through undriven rolls – solution is applied to the strip , as a pool just in front of the rolls

b) horizontal pull through driven rolls – solution is transferred from a tray to a pick up roll and then to a rubber applicator roll which then applies the solution to the strip.

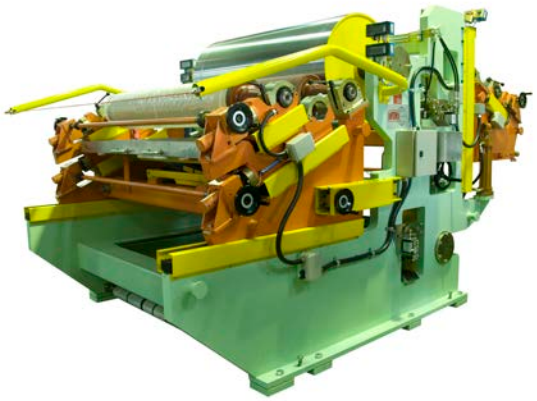
c) standard S wrap coaters.

In general type a) is the least expensive and used on low speed (20 -40 m/min) lines, b) is used on medium speed lines (40 – 90 m/min) and c) on higher speed lines.

The pre-treatment is applied very thinly, typically 1 – 3 μm and requires complete drying before application of the primer. As the drying is carried out at a strip temperature of 60-70 degC the strip is cooled by a cold air blast before priming.

a) Horizontal pull through system, undriven rolls

b) Horizontal pull through, driven rolls



c) S wrap coater

2.2 Primers:

Primers can be used between the pre-treatment and the top coat to enhance paint adhesion, but mainly to improve the corrosion protection for the base metal. The primer paint is rich in chromium and provides excellent corrosion resistance. The primer is applied thinly at 5 – 7 μm dry film thickness. The primer must be fully cured at approximately 220-235°C.

Previously, the most common type of primer used was an epoxy primer. This paint is typically supplied at 35-40% solids. However, polyester primers are now being used and are increasing in popularity, due to their cost effectiveness and improved adhesion and corrosion performance. Water based primers are also available, but should only be used with water based top coats. Generally water based paint systems are not very popular as they tend to be a little more expensive and operationally a little more difficult. However, they do have very good adhesion properties.

Special High Build Primers (often polyurethanes) are also available where the dry film thickness of the primer paint is increased significantly. These high build primers provide much greater corrosion protection particularly in severe environment conditions such as marine applications.

2.3 Top Coats

There are a number of different top coats available. The most popular is a polyester system, typically used for external roofing and walling applications. Other systems are acrylic, polyurethane, plastisol, water based, silicon modified polyesters, vinyls and alkyds. Each system has its advantages depending on performance requirement and price. The top coat and the primer must be compatible for best results. The top coat can be applied to any base metal.

There is also an expanding range of highly durable top coats available. The fluorocarbon paints are very high quality and provide excellent protection against adverse environmental conditions. These are the top coat of choice for high build primer systems but are also commonly used over normal primers and give excellent extra corrosion resistance as well as protection against weathering. These are, however the most expensive systems available.

Pattern coatings are also gaining popularity. Patterns can be designed at will for whatever the customer requires. The process involves applying the ink over a base coat (either with or without primer, depending on final application) by either 'rotogravure' or 'flexographic" techniques. For best wearing characteristics a thin (5um) layer of clear coating is applied over the pattern coat.

2.4 Backing Coats

Whenever a top coat is applied to the strip, some form of backing coat is also recommended. If a backing coat is not applied, there is a very high risk of the top coat being 'scuffed' by the unpainted bottom surface as the strip is recoiled. It is best that the gloss level of the backing coat matches the gloss level of the top coat. The backing coat is normally applied at 5 - 7μm dry film thickness. The backing coat is normally applied at the same time as the top coat and cured simultaneously with the top coat as the strip passes through the curing oven. Backing coats can be any type of paint, but for economical reasons alkyd or polyester paints are usually used. On aluminium, often the backing coat is a clear or coloured lacquer.

2.5 Pretreatment Primers (for the near future)

Both chemical and paint companies have been working on providing a solution that performs the functions of the pretreatment chemical and the primer paint within one solution. Obviously this could lead to much lower equipment costs for a paint line. Bronx International are monitoring these ongoing developments.