

Indian Galvanised Steel Industry - An Overview

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Steel's unique position among the family of various products remains unchallenged even today. Steel touches every aspect of our daily life. Steel is eco-friendly. However, the only demerit of steel perhaps, is its natural tendency to corrode. Corrosion eats away steel, causing, significant loss to the economy of a country and leads sometimes to accidents. It has been estimated by experts that corrosion costs about 4 percent of the GDP of an industrialised country.



Coil Coating

Coil coating, the continuous coating of steel coils, is a step to prevent corrosion in the manufacture of industrial products for use in automobiles, construction projects, building facades, white good etc.

Coating provide corrosion

resistance, colour and texture of the steel surface. Once the metal strip has been coated, the panels are cut, shaped and fitted. These steps often involve high complex processing stages such as deep drawing and roll forming. The coating surface should be able to withstand mechanical damage, heat, chemicals and moisture. For example, a building has to withstand wind, rain and sun attack. In the white goods sector, surfaces are often exposed to various handling during use.

Besides the above, there is a multiplicity of applications for coil-coated materials. For each material

used and each step in various production stages, there is an acknowledged state-of-the-art process which represents current knowledge about the material and its processing.

Thermal Drying Process

In the Thermal Drying process of coil coating, the metal strip is heated to a temperature of about 2400C for 20 to 30 seconds in continuous curing ovens so that the solvents evaporate and the print film crosslinks. The strip is then cooled down to room temperature. The process is expensive and environmentally unfriendly.

Role of UV Curable Primers in Simplifying Drying Process

One approach to simplifying the drying process is to initiate crosslinking using ultra-violet radiation rather than by thermal means. This represents a complete departure from the traditional methods as the primers are required to have a new formulation with different raw materials, based on a completely new type of binders and crosslinking agents. They have to be sensitive to UV light and within seconds. Solvents are no longer necessary for such primer



formulation and viscosity is adjusted by using water. This reduces the dwell time in the oven from 25 seconds in a traditional process to 5/6 percent.

Since no solvents are required in the UV process, the thermal oxidation of oven exhausted gases, which is necessary in case of solvent – based technology, is no longer required.

The advantages of the UV curable system are noted below:

- Lower energy consumption
- Reduced environmental pollution
- Smaller plant foot print.
- Paint Quality is as good as the solvent-based system.

Compared with conventional coil coating system which involves degreasing the metal strip. Pre-treatment, post-treatment, drying the system and finally applying and curing the primer, the use of UV curable pre-treatment primer enables a great deal of complexity to be removed. The process is shorter and lower temperatures are used.

It is also possible to build a coating unit of this type downstream of a galvanizing line so that the primer can be applied at an early stage and pre-primed steel sheet can be produced without a separate coil coating line.

Chromate Coating and Chromate – Free Coating

A vast majority of traditional coil coating primers contain chromium compounds such as strontium and zinc

chromate to achieve the necessary corrosion resistance of the final product.

Hexavalent Chromium Compounds (Chromium VI) serves as an electro-chemical coupler that can inhibit corrosive reactions on metal surfaces. However, hexavalent chromium compounds, are classified as CARCINOGENS (Category 1 and 2) as being toxic and dangerous to environment. As such, these were banned by EEC long back.

Development of Chromate Free Primers

BASF coatings started to explore options for replacing toxic chromate pigments in the early eighties of the last century. It was clear from the start that an alternative to chromate containing primer had not only to be chromate – free but had to match or surpass the overall performance of its chromate-containing rivals.

In 1992, first generation universal chromate-free primers for external application were introduced. In 1995, there was a decisive break-through. BASF's chrome-free universal primer on galvanized steel surfaces gave superior results over both chrome-free and chrome-containing coil. First completely chrome-free coil system was thus produced continuous adoption and optimization of coil coating technology during the subsequent years lead to further improvements.

The main resin system of

chromate-free primers consists of a mixture of high molecular weight polyester and epoxy resins, crosslinked in a system based on amino resins. The pigmentation too is not only chromate-free, but also free of any other heavy metal or carcinogenic materials.

The coil coating technology with its progressive development during the 21st century has created a significant market for it especially in the chemical and coated steel industry.

Zinc Coating

Zinc-coated or galvanized steel sheets offer a unique combination of high strength, good formability, light weight, corrosion resistant aesthetic, recyclable low cost material which is unmatched by any other material. As a result, galvanized steel is an ideal material for multitude of applications like in automobiles, household appliances including white goods and also for residential, commercial and industrial construction.

The function of the zinc layer on black steel is mainly three-fold:

- To retain the steel intact with its full initial strength.
- To provide the surface a more pleasing appearance.
- To increase the life of any suitable system applied over it.

Two – Fold Advantage of Zinc Coating

(a) Zinc coating prevents steel from corrosive attack in most atmosphere, acting as a continuous and lasting shield between the steel and atmosphere, as long as the zinc sheath remains unbroken.

(b) It acts as a galvanic protector, sacrificing slowly in presence of corrosive elements, by continuing to protect the steel even when moderate areas of the bare metal has been exposed. This ability of zinc results from the fact that zinc is more electro-chemically active than steel.

Of all industrial coating materials zinc alone possesses this dual capability.

Due to the above qualities of zinc coating the manufacturers and consumers of coated steel all over the world are now demanding a higher

content of zinc in construction, automotive and white goods sectors. There are more than 800 galvanising line in operation throughout the world at present.

When steel is water-logged in molten zinc, the chemical reaction bonds the zinc to the steel through the process of galvanizing. So, the zinc cannot be termed as a sealer like paint, as it does not coat the steel but actually becomes a part of it. The zinc goes through a reaction with iron molecules within the steel itself to form galvanized steel.

Galvanizing Process

There are two major processes used in the manufacture of galvanized steel. These are :

- Hot-dipped Galvanising and
- Electrolytic Galvanising

Hot-Dipped Galvanising

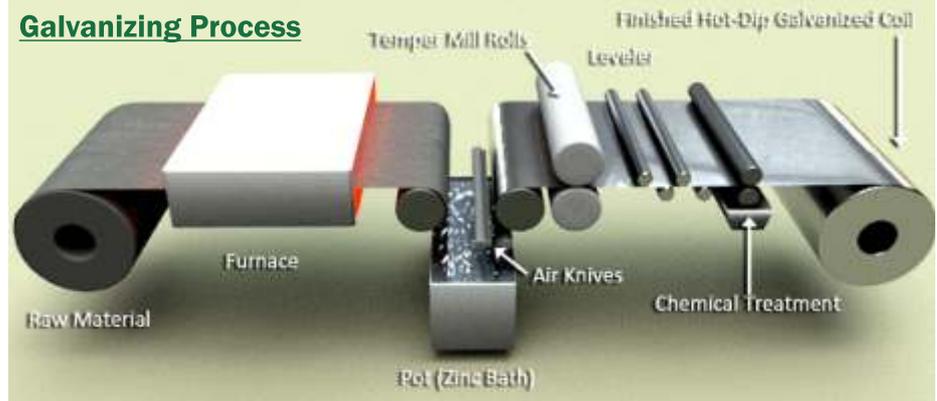
It is one of the basic and efficient corrosion resistant technologies for producing galvanized steel. During this process, steel coils are previously cleaned, pickled and then dipped in a bath of molten zinc to form a series of zinc / iron alloys integrated with the surface of steel. As steel is removed from the zinc bath, a layer of relatively pure zinc is deposited on the top of alloy layer. On solidification, the zinc assumes a crystalline metal structure called "Spanglings". Spangles can be enlarged or reduced depending on the end-use.

In this process, the temperature of the molten zinc bath is kept at about 4600C. Exposed to atmosphere, zinc is converted to zinc oxide which again reacts with carbon dioxide to form zinc carbonate that helps further corrosion resistance, protecting the steel below.

Earlier, though hot-dipped galvanized products effectively met corrosion resistance but had limited formability and locked the surface quality. Hence, they were used in non-stringent areas like construction but were found unsuitable for the auto and white goods sectors.

However, with the dramatic innovations in technology during the last two decades and specially with the development of galvannealing (GA)

Galvanizing Process



process, there has been a major shift in the use from electro-galvanising to hot-dipped galvanized steel, particularly in the automotive sector.

Electro-Galvanising

In the electro-galvanising process, zinc ions from the electrolyte are deposited on the strip surface (cathode) under the influence of electric current using either soluble or insoluble anodes.

The electrolyte is usually zinc sulphate or zinc chloride or mixed. The electro-galvanised strips are post-treated with passivation solutions such as phosphates or chromates. The plating process controls the coating thickness and helps to achieve much thinner sheets as well as double side coating. These sheets have excellent surface finish and press formability for corrosion protection of the auto body fuel tanks, exhaust pipes etc.

The investment cost of an Electro-Galvanising Line (EGL) is almost the same as that of a Continuous Hot-dipped Galvanizing Line (CGL) with GA facility. However EGLs do not have the annealing and temper cooling facilities in-built in the system. Thus, to produce annealed electro-galvanising products, annealing and temper cooling have to be done prior to electro-galvanising. This requires an additional investment cost on capacity which makes the process expensive. Besides the cost of electricity in India is much higher than that of developed countries which makes the operation cost of EGLs more expensive. Hence, under the Indian conditions, CGLs are more attractive.

Flash Cooling Technology for HSS Galvanised Steels

During the last decade, the demand for high strength galvanized steel has increased manifold mainly due to the requirements of automotive, building and pipeline markets. To meet this demand, a wider range of High Strength Steels (HSS) have been developed. Thanks to the improvement of coating process, these steels are increasingly hot-dipped galvanized after rolling instead of zinc coating by electro deposition.

Flash cooling developed by Five Stein used the high concentration of hydrogen in cooling gas and optimized blowing conditions to achieve the necessary cooling rate for HSS quality and water must with nitrogen for Advanced High Strength Steels (AHSS).

The advantages of using high concentration of hydrogen in cooling gas atmosphere are as follows:

- Less alloying elements for better zinc adherence and weldability.
- Reduced steel fluttering in the cooling section due to lower gas impingement.
- Smaller re-circulating blower and associated circuit and lower electricity consumption.
- Dramatic increase in cooling efficiency.

Special Quality Galvanised Products Galvanised Products (GA Products)

The galvannealing process was developed to satisfy the stringent quality requirements of the automotive industry, for corrosion protection of outer and inner panels of automotive at optimum cost. In this process an intermediate layer of iron and zinc is formed on the surface of the strip by



diffusing iron (to the extent of 7~12 percent) in the coating from the substrate into the zinc coating. The substrate characteristics become more important in galvanealing than in ordinary galvanizing. Typical range of coating in GA products is 60~200 gm/m² (both sides). These steels are used in the automobile industry because of their improved manufacturing performance in models that use lighter and stronger grades of steel.

Galvalume or Zinalume

Galvalume (also known as zinalume) contains 55 percent aluminium, 43.5 percent zinc and 1.5 percent silicon by weight. Galvalume provided a tough barrier between atmospheric condition and the inner core of steel. Protection is offered by the corrosion resistance of the coating itself. Galvalume protects steel from corrosion at cut edges and scratches which is achieved by the sacrificial protection of zinc in the coating. Galvalume has a life equivalent to about three times more than that of ordinary galvanized steel.

Advantages of using Galvalume as a substance are :

- **Yield Advantage :** Aluminium makes up 55 percent of Galvalume by weight but comprises 80 percent by volume. So, the coating weighs less, giving end-users more square feet by tonne than ordinary galvanized steel.

- **Formability :** Galvalume is suitable for all but severe forming operations. It

can be easily bent, roll formed and drawn without sacrificing coating adhesion.

- **High Temperature Resistant :** Galvalume can easily withstand temperature up to 6000F without surface decoloration. Galvalume, therefore is not only a superior material for roofing but also ideal for a range of other applications such as toasters, ovens and gas heaters.

- **Thermal Reflectivity :** Due to its good thermal reflectivity, Galvalume steel roofs combined with insulation makes it a cost-effective roofing system.

Limitations of Using System

Galvalume coated steel cannot be used in frameworks in contact with wet concrete, products to be embedded in concrete, animal shelters where ammonia levels are high, fertilizer storage sheds, culverts where the material is buried in the ground, water tanks and in high alkaline environment.

Galfan : Galfan is 95 percent zinc and 5 percent aluminium. When used as a substrate, the longevity of the product increases significantly. Galfan finds applications in marine wire ropes, small springs, pre-painted building panels, automotive parts. Galfan is noted for its outstanding coating adhesion making it an ideal material for deep-drawn and zero-thickness bend applications.

Galbo Sheets : Galbo Sheets are special zinc-coated products with good corrosion resistance possessing good formability, durability and paintability.

Galbo sheets are used in white goods manufacture and in the production of colour coated sheets.

Galvano Sheets : Galvano galvanized sheets with zero spangles have been developed by Tata Steel. These are environmentally safe and economically advantageous. It has a superior surface finish and mechanical properties capable to meet the stringent quality requirements of the customers. Higher chrome passivation ensures white rust resistance – zero spangles coupled with skin passing together with uniform zinc coating ensures high corrosion resistance. It has superior formability, bendability, durability and high paint adhesion quality. This is being used successfully in general engineering applications.

Environment

Zinc is a natural element that is essential to all forms of life, including humans, animals, plants and micro-organisms. While small quantities of zinc washes off from coatings exposed to outer environment, this has very little or no impact on the surrounding ecosystem.

On a macro-scale, the excellent corrosion protection provided by zinc coatings contributes significantly to the durability and life-expectancy of steel products, which in turn helps to conserve valuable natural resources and reduce the cost of maintenance, repair and replacement for the industry.

Life of Galvanised Steel

The use of galvanized steel for auto body panels allows the present day automakers to guarantee a corrosion free life of 12 years or more, adding only a fraction of the total cost of production.

In the appliance manufacturing sector, galvanized steel sheets are used in white goods and other household products providing a corrosion-free life of over 15 years.

In the construction sector, zinc-coated products have a useful corrosion-free life of over 40 years.

Indian Galvanised Steel Industry

The Indian Galvanised Steel Industry has developed its production process

and upgraded technology remarkably and is now capable of producing world-class products for high-end applications. These products have been well-accepted in the global market.

Broad Sector-wise Consumption of Galvanised Sheets in India

Broad sector wise consumption pattern of galvanized steel in India is shown below :

| Sector | % Share in Consumption |
|---------------------------|------------------------|
| Construction | 50 |
| Consumer Durables | 12 |
| Drums/Barrels/Containers | 5 |
| Railways/Power/Irrigation | 5 |
| CPWD/PWD/Other Govt. | 5 |
| Tube Makers | 4 |
| Furniture Makers | 4 |
| Engg. Units | 4 |
| Colour Coated Sheets | 5 |
| Automobile | 5 |
| Others | 1 |
| Total | 100 |

N.B. The figures are indicative.

Production for Sale of GP / GC Sheets in India

Production for sale of GP/GC Sheets in India between 2003-04 and 2012-13 are shown in Table-1.

| Table – 1 : Production for Sale of GP/GC Sheets in India ('000 tonnes) | | |
|--|---------------------|------------------|
| Year | Production for Sale | Y-o-Y Growth (%) |
| 2003-04 | 3130 | == |
| 2004-05 | 3672 | 17.32 |
| 2005-06 | 3782 | 3.00 |
| 2006-07 | 4321 | 14.25 |
| 2007-08 | 4381 | 1.39 |
| 2008-09 | 4554 | 3.95 |
| 2009-10 | 4470 | (-) 1.84 |
| 2010-11 | 5556 | 24.30 |
| 2011-12 | 5681 | 2.25 |
| 2012-13 (P) | 6532 | 14.98 |

Data Source : JPC (P) = Provisional

Production for sale is arrival at after deducting Inter-Plant Transfer (IPT) and producers own consumption from gross production.

Imports of GP/GC Sheets by India

Imports of GP/GC Sheets by India between 2004-05 and 2012-13 are shown in Table-2.

| Table – 2 : Imports of GP/GC Sheets by India ('000 tonnes) | | |
|--|---------|------------------|
| Year | Imports | Y-o-Y Growth (%) |
| 2004-05 | 106 | == |
| 2005-06 | 134 | 26.42 |
| 2006-07 | 195 | 45.52 |
| 2007-08 | 268 | 37.44 |
| 2008-09 | 288 | 7.46 |
| 2009-10 | 292 | 1.39 |
| 2010-11 | 353 | 20.89 |
| 2011-12 | 368 | 4.25 |
| 2012-13 (P) | 432 | 17.39 |

Data Source : JPC (P) = Provisional

Exports of GP/GC Sheets by India

Exports of GP/GC Sheets by India between 2004-05 and 2012-13 are shown in Table-3.

| Table – 3 : Exports of GP/GC Sheets by India ('000 tonnes) | | |
|--|---------|------------------|
| Year | Exports | Y-o-Y Growth (%) |
| 2004-05 | 1843 | == |
| 2005-06 | 1244 | (-) 32.50 |
| 2006-07 | 2173 | 74.68 |
| 2007-08 | 2026 | (-) 6.76 |
| 2008-09 | 1849 | (-) 8.74 |
| 2009-10 | 1287 | (-) 30.39 |
| 2010-11 | 1312 | 1.94 |
| 2011-12 | 1443 | 9.98 |
| 2012-13 (P) | 1509 | 4.57 |

Data Source : JPC (P) = Provisional

India was not exporter of GP/GC Sheets between 2004-05 and 2012-13.

Apparent Consumption of GP/GC Sheets in India

The apparent consumption of GP/GC Sheets in India between 2003-04 and 2012-13 is shown in Table-4.

Colour Coated Sheets

Colour coating usually refers to the application of paint coat over the substrate in an automatic continuous process after pre-treatment. The pre-painted colour coated steel is a very high value-added product that

Table – 4 : Apparent Consumption of GP/GC Sheets in India ('000 tonnes)

| Year | App. Consumption | Y-o-Y Growth (%) |
|-------------|------------------|------------------|
| 2003-04 | 1691 | == |
| 2004-05 | 1926 | 13.90 |
| 2005-06 | 2051 | 6.49 |
| 2006-07 | 2400 | 17.02 |
| 2007-08 | 2617 | 9.04 |
| 2008-09 | 3018 | 15.32 |
| 2009-10 | 3358 | 11.27 |
| 2010-11 | 4658 | 38.71 |
| 2011-12 | 4538 | (-) 2.58 |
| 2012-13 (P) | 5524 | 21.73 |

Data Source : JPC (P) = Provisional

N.B. The figures shown in Tables 1 to 4 also contain GP Coils.

combines the best properties of the substrate and organic coating imparting it an aesthetic finish, high degree of durability and high corrosion resistant capability.

Substrate

Colour coating is done on various substrates to produce the most cost-effective, quality assured production with the top coat compatible with environment.

The substrates usually used are :

- Hot-dipped Galvanised Steel
- Electro-galvanised steel
- Galvalume
- Galbo
- Aluminium

Pre-treatment

Pre-treatment of the substrate is a very important operation required for better adhesion, formability of the pre-painted steel sheets.

Leading colour coated steel producers in India have introduced NO-RINSE technology in place of phosphating (phosphate coating) over galvanized strip for pre-treatment because of better both maintenance, uniform crystal structure of coating as well as to meet the demand of the end-users for more flexibility of colour coated steel. NO RINSE coating pre-treatment is a very thin layer of chemical treatment that bonds the coating surface of steel to the subsequently applied point to ensure

excellent paint adhesion and corrosion resistant of the steel surface.

Primer

After pre-treatment, a primer of uniform layer is applied on the pre-treated surface. The primer provides flexibility to the paint system and helps corrosion resistance since it contains corrosion inhibitors. The primer is cured in the oven with accurate temperature controls with great precision.

The success of the entire colour coating system depends on the primer—the crucial first coating layer applied on the pre-coated metal sheets.

Various types of primers are available based on different resins like epoxy, polyester, polyurethane and PVC. Epoxy primers are preferred for use in roofing as it has chromate pigment for better corrosion resistance. The established dangers in using certain chromium coatings have been discussed earlier.

Top Coat

After pre-treatment, the primer surface is coated at uniformly coated thickness and then cured in the oven. The top coat contains a combination of coloured pigments and additives which provide the required colour and other performance properties like ultra-violet resistance. The coated product is thereafter rigorously tested before clearing for further application. Most of the roofing construction markets for colour coated sheets use top coats which are based on polyester, fluorocarbon (PVDF), Silicon Modified Polyester (SMP) and plastisols for cost-effectiveness and durability.

Producers of Colour Coated Steel in India

Among the major producers of colour coated sheets in India Jindal South West (JSWL) has enhanced the capacity of its colour coating line at Tarapur to 2.76 lakh tonnes per year from 2.32 lakh tonnes earlier. It has also commissioned a state-of-the-art new colour coating line at Vasind with an annual capacity of 1.50 lakh tonnes. JSW Ispat Ltd. is expanding the capacity of its Kalmeshwar Colour Coating line to 1,00,000 tonnes per year from 50,000 tonnes earlier.

Essar Steel Ltd. has a colour coating line at Pune in Maharashtra with an annual capacity of 4 lakh tonnes. Bhushan Steel Ltd. has a colour coating line at Khopoli in Maharashtra with a capacity of 120,000 tonnes per year. Uttam Galva also has a colour coating line at Khopoli with an annual capacity of 80,000 tonnes.

Tata BlueScope joint venture on 50:50 basis is operating a metallic and colour coating / painting facility at Bara near Jamshedpur in Jharkhand which has an annual capacity of 150,000 tonnes of pre-painted zinc and aluminium steel branded as COLOR BOND.

Estimated Demand of Colour Coated Sheets in India

According to industry sources the estimated demand of colour coated sheets between 2005-06 and 2012-13 were as follows :

| ('000 tonnes) | | |
|---------------|-----------------|------------------|
| Year | Domestic Demand | Y-o-Y Growth (%) |
| 2005-06 | 85 | == |
| 2006-07 | 110 | 29.41 |
| 2007-08 | 140 | 27.27 |
| 2008-09 | 175 | 25.00 |
| 2009-10 | 215 | 22.86 |
| 2010-11 | 260 | 20.93 |
| 2011-12 | 285 | 9.62 |
| 2012-13 | 300 | 5.26 |

Performance of Indian Galvanised Steel Industry in H1 of FY'14

The performance of the Indian Galvanised industry during April-September, 2013 (H1 of FY'14) is presented below :

| Production for Sale ('000 tonnes) | | |
|-----------------------------------|-----------------|----------|
| H1 of FY'14 (P) | H1 of FY'13 (P) | % Change |
| 3425 | 3237 | 5.81 |
| Imports ('000 tonnes) | | |
| 212 | 225 | (-) 5.78 |
| Exports ('000 tonnes) | | |
| 785 | 789 | (-) 0.51 |
| Consumption ('000 tonnes) | | |
| 2888 | 2729 | 5.83 |

Data Source : JPC (P) = Provisional



Conclusion

The Indian steel industry has grown remarkably in the last 15 years or so. The producers are continuously upgrading their production technology to produce materials for high-end applications. India's galvanized products have been well-accepted in the global market and exports of these products have been the highest in volume terms among the finished carbon steel products.

The colour coated steel industry is also growing significantly. Increase in construction activity and rural steel consumption is likely to see a significant growth of the industry during the 12th plan.

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