Coated and Colour Coated Steel Industry - An Overview

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Introduction :

Steel is, perhaps, the most useful product for mankind. It is a material that has a wide range of applications from a small pin to manufacture of automobiles, ships, railway materials, aircraft, big construction projects, nuclear power station and so on. But the inherent weekness of steel products is that they are prone to corrosion.

Galvanised steel products are value-added materials that are sturdy, light weight, bright in appearance and corrosion resistant.

Galvanised steels are basically zinc coated products and includes a range of hot-dipped and electro-galvanised steels. The function of the zinc layer is mainly threefold :

- 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 finishing system applied over it.

The zinc coating offers a two fold advantage :

a) It protects the steel from corrosive attack in most atmosphere, acting as a continuous an lasting shield between the steel and atmosphere, as long as the zinc sheath remains unbroken.

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

Due to the above qualities, the manufacturers and consumers of galvanised steel all over the would are now demanding a higher content of zinc-coated steel in construction, automotive and white goods sectors. These are about 700 continuous galvanizing lines globally in operation at present.

Recyclability of Coated Products :

All types of zinc-coated galvanised steel products are recyclable. The Electric Arc Furnace (EAF) is the principal recycling route for zinc-coated steel. According to industry sources, about 80 percent of zinc available for recycling in India is being recycled.

Application of GP/GC Sheets :

Galvanised steel products (GP/GC sheets) are used in the construction sector in roofing, side claddings, agricultural sites, railway platforms, factory sheds and in various areas of housing etc.

These coated products have also major uses in the automobile and appliance sectors.

With the new thrust given by the government on housing in both urban and rural areas, the consumption of these coated sheets is likely to grow at a much faster space in future. In the construction sector, zinc-coated products have a useful life of 50 years.

The use of galvanised steel sheets for automotive body panels allows the present day automakers to guarantee a corrosion free like upto 12 years, adding only a fraction of a percent to the total cost of production.

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

Experts opine that on a macro scale, the excellent corrosion resistance provided by zinc-coated galvanised steel greatly improves the durability and life-cycle of steel products, thus helping in the conservation of valuable natural resources.

Common Uses of Various Zinc - coated Steel Products :

Table 1 : Shows Common Application and Key Attributes of Various Zinc-Coated Products.

Table 1 : Applications and key attributes of Various Zinc-Coated Products.

Coated Product	Application	Key Attributes
Galvanised	Steel framing heating ventilation, air-conditions, roof and floor decking, pre-painted building panels, agricultural storage bins, autobody innerparts	Formability and durability, range of coating thickness, strength and speed of installation, easy paintability and cost- effective
Electrogalvanised	Autobody outer panels, computer cases	Good surface finish, weldability, electro-magnetic shielding.

Coated Product	Application	Key Attributes
Galvanneal	Autobody outer panels, pre-painted appliance wrappers	Weldability, paintability and formability,
Galvalume	Bare and painted roofing and siding	Corrosion performance for bare coating, paintability.
Galfan	Prepainted architectural panels, automotive equipment	Corrosion performance, very good formability and paintability.
Galbo	White goods manufacture, colour coated steel sheets	Corrosion performance, formability, durability and paintability.

Special Quality Galvanised Coated Sheets :

(i) Galvannealed (GA) Products :

The galvannealed process was developed to satify the stringent quality requirements of the automobile industry for outer and inner panels at optimum cost. In this process, an intermetallic layer of iron and zinc is formed on the surface of the strip by diffusing iron (to the extent of 7~12 precent in the coating) from the substrate into the zinc coating. The substrate characteristics become more important in galvannealing than in galvanising. Typical range of coating in GA products is 60-200 gm/m^2 (both sides). These steels are used in automotive industry because of its improved manufacturing performance in models which use lighter and stronger grades of steel.

(ii) Galvalume or Zincalume :

Galvalume (also known as zincalume) consists of 55 percnet aluminium, 43.5 percent zinc and 1.5 percent silicon.

It provides a tough barrier between the atmospheric condition and the inner core of steel. Protection is offered by the corrosion resistance of the coating itself. Secondly, galvalume protects steel from corrosion at cut-edges and scratches which is achieved through the sacrificial protection provided by the zinc in the coating. Galvalume has a life three times more than that of ordinary galvanised steel.

Advantages of using Galvalume as a substrate are :

- **Corrosion Resistance :** Resistance to atmospheric corrosion, cut edge protection and crack protection.
- **Yield Advantage :** Aluminium makes up 55 percent of Galvalume steel by weight. But it comprises 80 percent by volume. So, the coating weighs less, giving the end-users more square feet per tonne than ordinary galvanised steel.
- **Formability :** Galvalume is suitable for all but most severe forming operations. It can be easily bent, rolled formed and drawn without sacrificing the coating adhesion.
- **High Temperature Resistant :** Galvalume can easily withstand temperature up to 600^0F without surface discolouration. Galvalume is therefore, not only superior material for roofing but also ideal for a range of other applications such as components in toasters, oven and gas heaters.
- **Thermal Reflectivity :** Due to its good thermal reflactivity, Galvalume steel roofs combined with insulation, make it a cost-effective, energy efficient roofing system.
- **Limitations of Using Galvalume :** 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 constantly high, fertilizer storage sheds and containers, culverts where the material is buried in the ground, water tanks and in high alkaline environments.

(iii) Galfan :

Galfan is 95 percent zinc and 5 percent aluminium. It is about 2 to 3 times more corrosion resistant than the Commercial Quality galvanised steel. When used as a substrate, instead of ordinary galvanised steel, the longevity of the products increases substantially. It finds applications in marine wire ropes, small springs, pre-painted building panels as well as in appliances and automotive parts. Galfan coated steel is noted for its outstanding coating adhesion, making it an ideal material for deep drawn and 'zero thickness' bend applications.

(iv) Galbo Sheets :

Galbo sheets are special zinc-coated products, where the base material is cold rolled in Grade D, is skin passed and stretch leveled with normal spangles. The users of Galbo sheets are white goods manufacturers followed by the colour coated industry.

Galvanising Process :

There are two major processes used in the manufacture of galvanised products. These are:

- Hot-dipped Galvanising
- Electrolytic Galvanising

(i) Hot - Dipped Galvanising :

It is one of the basic and efficient corrosion resistant technique for producing galvanised steel. During this process, steel coils are previously cleaned and pickled and then dipped in a bath of molten zinc to form a series of zinc / iron alloys integrated with the steel surface. As steel is removed from the bath, a layer of relatively pure zinc is deposited on the top of alloy layer. On solidification, the zinc assumes a crystalline metallic structure, often called 'Spangling'. The spangles can be enhanced or reduced depending on the end-use.

Earlier, hot-dipped galvanised steel products effectively met the corrosion requirements but had limited formability and

lacked in surface quality. Hence they were used in non-stringent areas like the construction sector and were unacceptable to the automobile industry. However, with the dramatic development in technology in the last two decades like use of radiant tube furnaces, coating control, and specially with the development of galvannealing (GA) process, there has been a significant shift in the use from electrogalvanised to hot-dipped galvanised (HDG) steels, particularly in the automobile sector.

(ii) Electrogalvanising :

In the electrogalvanising process, zinc ions from the electrolyte, is 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 electrogalvanised strips are post-treated with passivation solutions such as phosphate or chromate. The plating process control the coating thickness which helps in much thinner as well as double side coatings. The sheets have excellent surface finish and press formability for protection from corrosion of autobody fuel tanks, exhaust pipes etc.

The investment cost of an Electrogalvanising Line (EGL) is almost the same as that of continuous Hot-Dipped Galvanising Line (CGL) with GA facility. However, the EGLs do not have annealing and temper rolling facilities in-built in the system. Thus to produce annealed electrogalvanised products, annealing and temper cooling have to be done prior to electrogalvanising. This requires an additional investment cost on capacity in annealing unit and skin pass mill and makes this process more expensive.

The cost of electricity in India is much higher than that in the developed countries which makes the operation cost of EGL more expensive. Hence in Indian conditions, CGLS are economically more attractive.

Spangled Products :

Spangles are flowery patterns observed on the surface of galvanised sheets, formed by the natural crystallization of zinc. Spangles are produced by adding small quantities of lead, tin or antimony into the molten zinc bath. Spangles are desirable in applications like corrugated sheets used for roofing or in applications where the parts are not exposed or do not require painting. For other applications, the strip has to undergo either skin passing operation after galvanising to remove the spangles or undergo a mini-spangle treatment so that the spangle formation can be minimised.

Outer covers of computers, audio equipment etc. require mini-spangled galvanised products.

Leading Indian producers of galvanised products are manufacturing both mini-spangle and zero spangle products.

The Indian Scenario :

The production of galvanised products in India has gone up remarkably in recent years. The Indian producers are manufacturing high quality products for high-end applications and the country's galvanised products, have been well accepted in the global market. India export 1.61 Mt. of these products in 2002-03.

(i) Broad Sectorwise Consumption of Galvanised Steel in India :

The broad sectorwise consumption of galvanised steel products in India is shown in Table 2.

Table 2 : Broad Sectorwise Consumption of Galvanised Steel Products in India

Sector	Share in Consumption (%)
Construction	44
Consumer Durables	10
Drums, Barrels, Containers	9
Railways, Power, Irrigation	8
CPWD, PWD, Other Govt. Depts.	7
Tube Makers	4
Furniture Makers	6
Engineering Units	6
Automobiles	4
Others	2
Total	**100**

(ii) Capacities of Major GP/GC Sheet Producers in India :

The annual production capacities of some of the major galvanised steel producers are furnished in Table 3

Table 3 : Capacities of Major GP/GC Steel Producers in India

Producers	Annual Capacity ('000 tonnes)
SAIL, Rowrkela Steel Plant	160
SAIL, Bokaro Steel Plant	170
Tata Steel	400
Bhushan Steel & Strips Ltd.	360
Jindal Iron & Steel Co.	550
Ispat Industries	780
Uttam Galva	350
Sipla Coated Steels	100
Lloyds Steel Ltd.	125
Shree Pre-coated Steels	510
National Steel	150
Jai Corporation	100
Essar Steel Ltd.	500

Production of GP/GC Sheets in India :

Production of GP/GC sheets in India between 1992-93 and 2005-06 are presented in Table 4.

Table 4 : Production of GP/GC sheets in India ('000 tonnes)

Year	Production			YOY
	ISPS	Secy. Prod.	Total	Growth (%)
1992-1993	296	270	566	–
1993-1994	290	315	605	6.89
1994-1995	300	456	756	24.96
1995-1996	311	547	858	13.49
1996-1997	301	686	987	15.03
1997-1998	345	777	1122	13.68
1998-1999	301	911	1212	8.02
1999-2000	286	1144	1430	17.99
2000-2001	423	1497	1920	34.27
2001-2002	521	1835	2356	22.71
2002-2003	666	2124	2790	18.42
2003-2004	774	2356	3130	12.19
2004-2005	804	2868	3672	17.32
2005-2006	807	3020	3827	4.22

(P) - Provisional ISPS - Integrated Steel Plants. Data Source : JPC

The high growth of 24.96 percent in 1994-95 over the previous year was due to a hike of 141,000 tonnes in the production of the secondary producers. The same reason may be attributed to the high growths after 1999-2000.

The production of the ISPS has also increased substantially between 2001-02 to 2003-04. This was due to the commissioning of the galvanising lines of Tata Steel's world class **CR Mill Complex.**

Import and Export of GP/GC Sheets by India :

Import and Export of Figures of GP/GC sheets by India are Shown in Table 5.

Table 5 : Import & Export of GP/GC Sheets by India : 1999-2000 to 2005-2006 ('000 tonnes)

Year	Import	Export	Net Export	Export As% of Production
1999-2000	75	320	245	22.38
2000-2001	73	589	516	30.68
2001-2002	97	695	598	29.50
2002-2003	92	1610	1518	57.71
2003-2004	102	1486	1384	44.48
2004-2005	106	1843	1737	50.19
2005-2006	134	1244	1110	35.51

Data Source : JPC (P) = Provisional

It may be observed from the above table that in 2005-06, the import of galvanised products have increased by 28,000 tonnes while its export has declined by 601,000 tonnes. This has happened due to an increased domestic demand for high quality products for high-end applications particularly of colour coated sheets. It may be mentioned here that the apparent domestic consumption of galvanised products in India has gone up by 764,000 tonnes in 2005-06 over the previous year.

Growth in Apparent Consumption:

The apparent consumption of GP/GC sheets in India between 1999-2000 and 2005-2006 are shown in Table 6.

Table 6 : Apparent Consumption of GP/GC Sheets in India ('000 tonnes)

Year	App. Consumption	Y-O-Y Growth (%)
1999-2000	1204	--
2000-2001	1393	15.70
2001-2002	1750	25.63
2002-2003	1265	27.71
2003-2004	1691	33.68
2004-2005	1926	13.90
2005-2006	2690	39.67

Data Source : JPC (P) = Provisional

It may be seem from the above table that apparent consumption of galvanised product recorded a negative growth of 27.71 percent in 2002-2003 due to a decline in domestic demand. But in that year export reach 1.61 Mt. the highest ever. The average yearly growth of apparent consumption between 1999-2000 and 2005-2006 has been as high as 20.57 percent.

Colour Coated Sheets :

Colour coating usually refers to application of liquid paint-coat over steel substrate in an automatic, continuous process after pre-treatment. The pre-painted colour coated steel is a high value-added product that combines the best properties of both substrate and organic coating, additionally imparting it an aesthetic finish, high degree of durability and corrosion resistance.

Increasing demand of colour coated sheets are found in building and construction 40 percent, Domestic Appliances 55 percent and other industries 5 percent.

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

The substrates are :

- Hot-dipped Galvanised Steel (HDG)
- Electro galvanised Steel (EC)
- Galvalume
- Galfan
- Aluminium

Galvalume is becoming the most preferred substrate for colour coating as it has a life more than three times of ordinary galvanised steels.

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

Major colour coated steel producers in India have introduced the NO-RINSE technology in place of phosphate coating over galvanised strip because of bath maintenance, uniform crystal structure of coating as well as due to the demand for more flexibility of coated steel by the domestic appliance manufacturers.

NO-RINSE coating pretreatment is a very thin layer of chemical treatment that bonds the coated surface of steel and to the subsequently applied paint to ensure excellent paint adhesion and corrosion resistance of the steel substrate.

a) Primer : A uniform layer of primer is applied on the pre-treated surface. The primer provides flexibility to the paint system as well as corrosion resistance since it contains corrosion inhibitors. The primer is cured in the oven with precise temperature controls.

b) Top Coat : After pre-treatment, the primer surface is over coated with top coat at uniformly controlled thickness and then cured in the oven. The top coat contains a combination of colour pigments and additives, which provide the required gloss, colour and other performance properties like ultra-violet resistance. The coated product is then rigourously tested before cleaning for further application.

Types of Coat :

i) Primers : Various types of primers are available based on different resins like epoxy, polyester, polyurethane and PVC. Preferably, epoxy primers are used for roofing containing chromate pigments for better corrosion resistance. Hexavalent Chromium compounds (chromium vi) serves as an electro-chemical coupler that can resist corrosion action on most metal surface. However, these compounds, widely used in industrial metal coating, are classified as CARCINOGENS (category 1 and 2) as well as being toxic and dangerous to environment. Hence, some producers have developed chromate free primers.

ii) Top Coat : Most of the roofing and construction markets for colour coated sheets use it is cost-effective and durable. Some of the popular material used for top coats are based on Polyster, Flurocarbon (PVDF), Silicon Modified Polyester (SMP) and Plastisols.

Producers of Colour Coated Sheets in India :

Till recently, there were only two producers of colour coated sheets in India. These were Ispat Industries Ltd. at Kalmeshwar near Nagpur and Shree Precoated Steels Ltd. (SPSL) at Pune. Each of them had a production capacity of 50,000 tpy.

Presently, Ispat is planning to expand its capacity substantially and SPSL has already increased its capacity to 510,000 tpy. The new colour coating line of SPSL has been provided with NEAR INFRA RED (NIR) curing techniques.

New Entrants :

- Bhushan Steel and Strips has commissioned a 120,000 tpy. capacity colour coating line at Khopoli in Maharashtra.
- Tata Steel and BlueScope Steel of Australia have entered into a Joint Venture (J.V.) on 50:50 basis for setting up a metallic coating and painting facility at Bara in Jamshedpur at an investment of Rs. 1,400 crore. The new facility will have a metallic coating capacity of 250,000 tpy. and a painting line of 150,000 tpy capacity. Commissioning of the plant is scheduled for 2008.
- Jindal Iron & Steel Co. (JISCO) is setting up a 100,000 tpy capacity colour coated steel facility at Tarapur at an estimated cost of Rs. 21 crore. It is likely to be operational by mid-2007.
- Uttam Galva Steel is constructing a 80,000 tpy capacity colour coating line at Khopoli which is likely to bee commissioned by 2007.
- Steel Corporation of Gujarat, now acquired by Essar Steel, is setting up a new colour coating line of 50,000 tpy capacity.
- SAIL's Bokaro Steel Plant has planned to setup a 50,000 tpy capacity colour coating line. The work will be taken up by 2008-2009.

Use of Galvanised Rebars :

Galvanising is an useful means of protecting steel reinforcement and other embedded components against corrosion in concrete.

In India, the famous lotus temple in Delhi has used galvanised rebars. In Western India, such rebars has been successfully used in port structures, port trust buildings and residential complexes. Galvanised rebars have also been used in hotels, railway coach washing facilities, railway platforms and in other facilities used by the general public.

Galvanised rebar has an unlimited potential especially in the context of massive construction and infrastructural activities in the country in future years. According to industry experts, galvanising is an established means for protecting steel reinforcement and other embedded components against corrosion in concrete. It has been widely used for more than 70 years in many countries for a range of concrete constructions in both mild to moderate and aggressive environments.

During the last 10/12 years, there has been a higher market demand for galvanised reinforcement steel. The galvanised product has been successfully used in :

- Light weight precast cladding elements and architectural building features.
- Surface exposed beams and columns and exposed slabs.
- Prefabricated building units such as kitchen and bathroom modules and tilt-up construction.
- Immersed or buried elements subject to ground water effects and tidal fluctuations.
- Coastal and marine structures.
- Transport infrastructure including bridge decks, roads and crash barriers.
- High risk structures in aggressive environments.

Galvanised Steel for Automobile Industry :

Galvanised steel sheets are being-extensively used in bus and truck body building.

Galvanneled Steel (GA) is used in automotive industry especially autobody outer panels because of its improved manufacturing performance in models which use lighter and stronger grades of steel.

Electrogalvanised steel has an ultra smooth surface finish which is desirable for surface critical parts such as automotive exterior body panels. The coating thickness for electrogalvanised sheet is typically lower than that for a hot dip galvanised product.

Galfan steel is also used for severally formed components such as automotive parts, domestic appliances prone to corrosion.

In India, Tata Steel was first to develop Galvannealed steel for auto industry.

Demand of Galvanised and Colour Coated Sheets :

The Joint Plant Committee had estimated the annual demand GP/GC sheets at 2 Mt in 2004-05. The apparent consumption of GP/GC sheets reached about 1.93 Mt in 2004-05.

Industry experts estimate that the demand growth of the galvanised products in India may reach a level of over 10 percent per year up to 2011-12 if the manufacturing and construction sectors record high growths of over 10 percent. This may be possible due to higher off takes by the housing sector and of colour coated sheets.

The domestic demand for colour coated sheets which was 39,000 tonnes in 2002-03 rose to 60,000 tonnes in 2004-05. The demand for these sheets is estimated to reach levels of 85,000 tonnes, 110,000 tonnes and 140,000 tonnes in 2005-06, 2006-07 and 2007-08 respectively.

Price :

Pointing out at the increased input cost as one of the main reasons, the Indian galvanised steel producers announced a price hike between Rs. 1,000 to Rs. 1,600 per tonne from May, 2006.

JSW Steel was the first to announce a rise of Rs. 1,000 per tonne which was followed by Uttam Galva Steel and Ispat Industries raising their prices by Rs. 1,600 and Rs. 1,000 per tonne respectively.

Shri M.V.S. Seshagari Rao, Director, Finance, JSW Steel said the nickel was owing to a further increase in input costs, primarily of zinc in the international market.

The prices of the galvanised products which was Rs. 34,000 per tonne in the Mumbai market in January, 2006 rose to a level of Rs. 37,000 37,500 per tonne in May, 2006. Pre-painted galvanised steel sheets fetches an additional Rs. 10,000 per tonne over plain galvanised steel sheets as it is used as a raw material for production of high value white goods and building materials, particularly roofings.

Conclusion :

The growth of the galvanised steel industry in India will be accelerated by substitutions of cold rolled steel sheets by galvanised and colour coated sheets in many applications like automobiles, consumer durables, and various areas of construction. Replacement of asbestos sheets by galvanised sheets in the housing sector will also help to boast its consumption.

Galvanised steel products have a higher price elastic city of demand. Therefore, the price is critical for expansion of its market. Since in the production of galvanised products, the cost of zinc is the real incremental cost, the price of it will critically influence its market expansion potential.

The major Indian producers of galvanised steel are installing the latest state-of-the-art production facilities which has enabled them to produce high quality products that has successfully faced competition in the global market.

Considering all aspects, it seems that the future of Indian galvanised steel industry is quite bright.

Acknowledgement :

1. Articles by Shri. L. Pugazenthy, ED, ILZDA, in JPC Bulletins April 2004 and January, 2006.
2. Article by Shri. V.B. Phalaket all of SPSL in JPC Bulletic, May 2005

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