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Coating: A vanguard to protect against corrosion invasion

Coatings perform dual functions of giving aesthetic value to the structure and protecting it from damage. It is startling that corrosion causes a loss of about $ 100 billion in India every year. With the Government of India planning to spend over Rs 100 lakh crore for development of modern infrastructure, the demand for anti-corrosive coating (used to protect structures against corrosion) will get a fillip, says Rakesh Rao.

Corrosion, the deterioration of a metal that is caused by the reaction of the metal with the environment, is a common phenomenon witnessed across industries. The extent of corrosion of the material depends on the environment to which it is subjected, and the corrosivity (or aggressiveness) of an environment depends on the material exposed to that environment, according to ASM International. In humid conditions like during rainy season or places near to the sea, the rate of corrosion is particularly highly.

Corrosion in electrical power plant or chemical processing plant can lead to plant shutdowns resulting in heavy losses to the companies. There are many other direct and indirect consequences of rusting.

Jitendra Kalra, CEO, Asian Paints PPG Pvt Ltd, says, "Corrosion can be highly insidious to the economy. It is startling that corrosion is causing a loss of about $ 5,000 billion to the global economy every year. India alone losses more than $100 billion every year due to corrosion. Corrosion can lead to structural integrity, increased capital cost, unplanned shut down thereby impacting productivity and increased maintenance cost. There can be loss of life too due to structural damages caused by corrosion."

Corrosion is not only a problem for industry. It deteriorates several of the day to day appliances, utilities and household objects. "But when we talk of industrial corrosion, its affect is huge and it can lead to untimely accidents, man-hour loss and thus a severe monetary loss to the running industry," observes **Prof Anand Khanna, Proprietor, Surface Engineering & Coating Consultant** (a reliable paint testing laboratory), and Chairman of SSPC India (The Society For Surface Protective Coatings - India) - a non-profit professional society concerned with the use of coatings to protect industrial steel structures.

In general, almost all industries have a problem due to corrosion, but industries using steel as the construction material, or steel equipment, are prone to severe corrosion, especially in corrosive environment, states Prof Khanna.

He adds, "Corrosion in other industries using better materials like stainless steels (SS), special alloys are also prone to corrosion if the ingredients used are strong acids, toxic gases and polar solvents. Stress on materials can further add to corrosion degradation. Thus, oil and gas industry, chemical & petrochemical industries, fertilizers plants, power plants and shipping industry constitute more than 70 per

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cent of the industrial corrosion, though the building & construction, automobile and aerospace industries also contribute to industrial corrosion. Therefore, corrosion prevention is critical to avoid this corrosion."

> "All large infrastructure projects are expected to last for many years. For this, maintenance (of which coatings is also a part) at regular interval is must. With population growing, the need for infrastructure is rising, and this is an area where a lot of corrosion protection coating will be required."
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> **Siddharth Sharma,** Senior Sales and Marketing Manager, Nippon Paint India Automotive Refinish

Protection against corrosion

With increased pollution levels, metals tend to deteriorate much faster which necessitates a better protection of surface treatment for modern and complex materials used in equipment and machines. Speaking on the key hurdles faced by companies who want to prevent rust, Prof Anand Khanna, says, "One of the biggest challenges for already running companies is lack of knowledge of corrosion protection as well as methodology for protection process. As a matter of fact, many big companies such as oil and gas establishments, power plants, chemical and petrochemical plants, hardly hire corrosion engineers to monitor the continuous corrosion process in the plant and create a regular maintenance strategy. When problem occurs, they just approach concerned corrosion protection companies, who sell wrong or may be not a proper system suitable for that environment, which fails again without giving its worth. Thus, these companies and establishments must have a corrosion engineering team with a knowledge of basic corrosion protection methods, selection of paint coatings for specific corrosion problem, create an online monitoring facility using equipment or at least do a periodic visual monitoring, create a maintenance schedule and when work is being done, it is properly supervised with proper quality assurance."

Corrosion, though is a natural process, can be prevented or at least the process can be slowed by adopting right mitigating strategies. According to Prof Khanna, selection of material, proper design, use of chemical inhibitors, use of paint coatings or other metallic coatings, and cathodic protection are the methods of corrosion protection.

Selection of material of construction - like steels, stainless steels, superalloys, non-ferrous alloys such as aluminium (Al), copper (Cu) and titanium (Ti) - is the first basic requirement, he states. He explains, "In case of steel, selection of suitable steel composition (MOC) out of hundreds of various steel composition is very important. A wrong steel may require frequent maintenance, hence proper material selection is of prime requirement."

Prof Khanna adds, "Proper design which assures non-retention of water is considered to be the best. Chemical inhibitors are used in most of the water-based systems, which resist corrosion, either by forming a film on the steel surface or decelerate the corrosion reaction. Paint coating is the most commonly used method of corrosion protection, where selection of paint coatings and its application of paint coating requires special skill and training. Cathodic protection is the most important method for large structures which are either buried under ground or continuously immersed in water, for example underground pipelines and several parts of ships etc."

Protective coating market in India

Coating is considered to be one of the cost-effective ways to arrest rust. Paints act as corrosion inhibitors and barrier to prevent the corrosive environment to come in contact with metal surface underneath. Explaining the importance of coating in corrosion protection, Jitendra Kalra, says, "Various grades of industrial coatings are available for corrosion protection. Corrosion resistance properties can be enhanced through inhibition, sacrificial, and barrier protection approaches. The industry is using various painting systems for corrosion protection. Some of the popular painting systems are zinc ethyl silicate primers, epoxy - polyurethane based systems, high build epoxy system, etc. The choice of coating system depends on the corrosivity of the environment. The coating acts as an insulating layer between the substrate and the environment; thus, creating a barrier and help extend the life of substrate and assets."

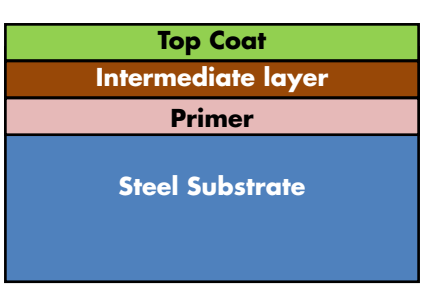

Figure 1: A standard way to protect external structures by paint coatings

According to Prof Khanna, there are many variety of coatings, metallic, organic paint coatings, high temperature coatings, functional coatings and very new concept of smart coatings available in the market. "The protection mechanism is either barrier or cathodic protection or in some cases there is metallurgical bonding. Organic paint coatings usually protect the steel by barrier protection but to give it longer life, a primer coat with corrosion mechanism is usually applied. Thus, many external paint coatings are three-layer coatings - Primer layer, intermediate layer and a top layer," he elaborates. Figure 1 shows the three layers of coating.

One of the most accepted paint coating for an aggressive

environment is a zinc-based primer coating (~50-75 μm), followed by an epoxy coating (100-200μm) and a top coat, polyurethane (~50 μm). "The top coat is usually to protect the intermediate epoxy coating from sunlight and weathering. Many internal tank linings are usually a 1,000 μm linings of epoxy or polyurethanes whose main function is to barrier protect the tank steel from stored fluid," explains Prof Khanna.

Many companies are providing industrial coatings which have high durability owing to properties like being highly anticorrosive and strong barrier effect. For example, Asian Paints, one of the well-known brands in the industry, offers a large range of proven anti-corrosive paint systems. Asian Paints also has joint ventures with PPG Coatings, world's leading anti-corrosive paint company, thereby bringing world-class globally proven technologies as per industry needs in India.

Jitendra Kalra elaborates, "Asian Paints has made huge investments in its Research and Technology center in Turbhe at Navi Mumbai to develop coatings using expertise in innovative polymer technology, anti-corrosive pigment and are working very closely with customers to offer advanced corrosion protection system. The company is servicing various industry sectors including infrastructure, oil & gas both offshore and onshore, power, chemical, pharma, metal & mining, etc. In addition to supplying products, the company has a team of NACE qualified technical service experts who guide customers on effective & correct application methods."

In July this year, Nippon Paint forayed into corrosion-protection coating market in India with the launch of *Protec* industrial paints - which include primers, top coats and specialised coating products - to mitigate the problem of corrosion. "The new range of products is tailor made for industrial users who seek optimised painting solutions for protection as well as maintenance purposes. This range required us to develop technology-driven products that can withstand and protect surfaces under extreme weather and chemical environment. The Protec range is designed to meet industrial standards of corrosion protection, chemical resistance, appearance & performance which deliver maximum results & best value for customers," says **Siddharth Sharma, Senior Sales and Marketing Manager, Nippon Paint India Automotive Refinish**. Nippon Paint expects the Protec brand to add Rs 50 crore to its topline in the next 2-3 years.

Trending anti-corrosive coating solutions

According to Jitendra Kalra, CEO, Asian Paints PPG Pvt Ltd, some of the emerging trends for anti-corrosive coatings are quick to return to service coating system for maintenance and repair, direct to metal coatings thereby improving productivity, environment-friendly coatings, low VOC/water-based, coating system for application on elevated temperature without shutdown, liquid insulation, advanced passive fire protection coating for cellulosic as well as hydrocarbon fire, etc. "Asian Paints has already introduced some of the anti-corrosion coating systems and with the dedicated R&D facility, the focus is on developing and launching more products in the anti-corrosion domain," he adds.

In years to come, coating will remain crucial tool to protect materials from rusting despite new developments in materials. For example, selecting titanium as heat exchanger tube material in place of steel will solve all corrosion problems. But former is so not cost-effective and that is why steel tubes are used with host of chemical inhibitors, says Prof Khanna.

According to him, some of the emerging trends in paint coating are:

Functional coatings which try to tackle the function specific

Smart coatings which in addition to protecting the surface also do some additional function,

The use of **nano modified coatings** - ie coatings where one or more pigments and/or additive used are of nano-size.

Prof Khanna explains the functioning of nano-modified coatings with some examples. If the user wants to protect his roof (concrete or steel) from corrosion, he also wants to reduce the heat on the roof surface. For which he needs functional specific solar heat reflecting coatings, which not only protect the roof but also reduce the roof temperature by 15-24 □C, depending upon the ambient day temperature.

"Several smart coatings exist today - for example, anti-dust, anti-glare, anti-fog, anti-microbial and hydrophobic coatings. Use of nano additives enhance the corrosion resistance, mechanical properties and also UV blocking properties, for example use of graphene, nano ZnO based coatings," says Prof Khanna.

Despite current slowdown in the economy due to COVID 19, India remains one of the fastest growing economies and will be in a better position to recover fast once the impact of COVID 19 fade away. Already, the government has announced National Infrastructure Pipeline (NIP) project envisaging total investment of Rs 111 lakh crore during the period FY 2020-25 for development of modern infrastructure.

"All large infrastructure projects are expected to last for many years. For this, maintenance (of which coatings is also a part) at regular interval is must. With population growing, the need for infrastructure is rising, and this is an area where a lot of corrosion protection coating will be required. As per industry statistics, the usage of metal is increasing compared to concrete in infrastructure/construction projects; hence the need to protect these metal surfaces from corrosion (which may cause structural damage to the structure) is also growing," says Siddharth Sharma.

While investment in infrastructure is critical for growing economies like India, equally important is the maintenance of these infrastructural projects for the long-term benefits. And coating will always be at the forefront in protecting the structure from getting damaged by corrosion. IPF