

Enhanced Corrosion Protection by Recycled Polyurethane

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Article Received: 27 February 2018

Article Accepted: 29 April 2018

Article Published: 10 June 2018

ABSTRACT

Corrosion is generally referred as the destruction of metals due to the electrochemical reaction between the metal and the oxygen present in the atmosphere. At present the corrosion is prevented by various methods like electroplating, sacrificial anode potential, etc. The idea is to prevent corrosion by using recycled polyurethane, which is used as a protective layer to cover the iron materials to reduce the amount of corrosion. Iron has lower reduction potential but it is a strong tensile metal in nature. So, iron reacts easily with the oxygen present in the atmosphere. For the experimental determination two iron rods were immersed in separate beakers containing water. One of the rods was coated with recycled polyurethane resin and the other was kept as such. Under the standard laboratorial observation over a period of time, it was observed that the iron rod without the coating has undergone heavy corrosion than the other iron rod. From this it can be inferred that the recycled polyurethane material can be used to coat the iron. Metallic parts in the field of construction and machinery to decrease the maintenance cost for removing the corroded parts.

Keywords: Polyurethane foam, corrosion rate, recycled polyurethane, PU coating.

1. INTRODUCTION

Corrosion is one of the major problems faced in today's industrial societies. According to statistics about 30 to 40% of iron and steel produced annually is used just to replace the rusted iron materials. Since corrosion is a slow oxidation process of metals, it is unpredictable. Therefore, to protect metal from getting corroded, we must prevent the metal coming in contact with the corrosive environment. This can be done by bringing in a physical barrier between the metal and the environment. This barrier is called coating. The idea is to create an organic coating made up of recycled polyurethane.

Polyurethane is versatile in nature, which can be recycled for many cycles. According to statistics about 93,200 tons of waste polyurethane foams is produced every year. The idea is to use this so produced polyurethane waste as an organic coating for prevention of corrosion. During certain recycling process, the polyurethane chain remains intact, hence it doesn't lose its property. The recycled stuff can be converted to resin form which is suitable state form for organic coating. There are many recycling methods for polyurethane like mechanical methods, chemical recycling, feedstock recycling. The basic idea behind organic coating is to act as a physical barrier between the metal and environment. Corrosion is mainly carried out in the presence of oxygen (O₂) and moisture (H₂O). Hence by eliminating these key factors corrosion rate of metals can be reduced.

Polyurethane is tear resistant, resistance to water, oil, grease and inert in nature. Since polyurethane is insulating in nature, corrosion current is neglected. Certain adhesive components can be added to increase the contact strength between the metal and the coating. Since the recycling process of polyurethane is eco-friendly, waste management of polyurethane is enhanced. Thus, the idea gives a spark to improve polyurethane coatings to prevent corrosion and waste management of polyurethane.

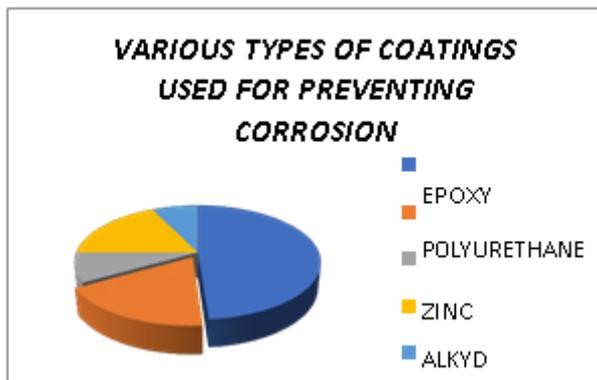


Figure.1. Statistics related to various protective coatings for corrosion

Thermodynamically speaking metal is an unstable form compared to their respective metal compound, except for few metals like noble metals. Thus, to attain stability they try to get converted back to the respective compounds (oxides, sulphates, carbonates etc). Hence metals get converted from elemental state to compound state. This is the basic cause for corrosion. Hence, corrosion can be defined as destruction or deterioration of metal caused by the environment by chemical or electrochemical changes.

Corrosion is very dangerous process and leads to collapsing of buildings and bridges, breaking of oil pipelines, leakage problems in chemical plants, unwanted electrical contacts will cause fires and alternative issues, unsound medical implants which results in blood disorder and many more. Corrosion threatens the safe disposal of radioactive material that has got to be hold on in containers for many years.

Some metals acquire a natural resistance to corrosion. This happens once the metal reacts with the oxygen present in air. This results in a thin compound film that blocks the metal's tendency to bear more reaction. The protection fails if the thin film is destroyed by structural stress, scraping or scratching. In such cases the metal would lose its ability to resist corrosion and the metal will be prone to corrosion.

Corrosion is often prevented in various ways such as treating metals with laser to make it non-crystalline, galvanisation, sacrificial anode, non-metallic coatings and many more.

2. EXPERIMENTATION

Waste polyurethane foam from various scraps is collected and it is segregated according to its quality. Unwanted materials present along with polyurethane foam such as thread, embroidery work etc are removed.

Grinding and Powdering:

Polyurethane foam is reduced to required dimensions. The optimum final particle size lies between 50 and 200 microns (0.05- 0.2 mm), depending on the application. There are a number of ways to produce small particles. One option, already operational for grinding flexible foam, is the two-roll mill process. It consists of two rollers,

rotating in opposite directions and at different speeds to create shear forces in the very narrow gap between them. Another grinding process, successfully used at pilot scale for flexible foams, is the pellet mill. It consists of two or more metal rollers, which press the polyurethane foam through a metal plate with small holes (die). Other technologies, such the precision knife cutter, are also under evaluation for the grinding of flexible foams. A particular process combining cutting and mixing involves a high shear mixer installed in the polyol tank. The added benefit of this process is the prevention of any thermal degradation of the powder during size reduction.

Conversion from foam structure to paint:

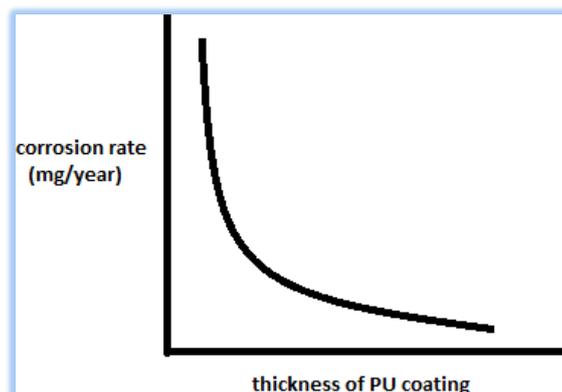
This process is an industrial application. This varies from industry to industry. To attain the required property, needed chemicals are added to enhance insulation, adhesive, resistance to oil/water/ grease etc. The product produced by purely paint constructed with polyurethane as main constituent. The experiment can be done in suitable conditions (i.e.) by maintaining the required standards. The coating is a simple process because the polyurethane has presence of lone pair electrons (i.e.) the amine group with lone pair which can easily get coated on metal surface. After coating, the polyurethane becomes hydrophobic in nature which avoids contact between the metal surface and water molecules. This can avoid forming rust as the water molecule cannot oxidize the metal into its metal oxide. So, the rate of corrosion is expected to reduce by large extent.



Figure.2. Carbon steel coated with polyurethane paint

Theoretical prediction:

Polyurethane's structure remains unaltered up to some extent. So, there is a physical barrier between the environment and the material and hence this can be used as anti- corrosive coating. Graph showing variation of corrosion rate with respect to thickness of the coat.



3. SIGNIFICANCE

Polyurethane is extremely versatile. It is modern, flexible and safe. Due to this, it is widely used in a broad range of applications to produce industrial or consumer products that have a vital role in making lives comfortable and convenient. Since polyurethane acts as a barrier between metal surface and the environment which prevents exposure of metal towards oxygen and moisture. It has appreciable binding capacity and also minimal swelling in presence of water/oil/ grease, hence good corrosion resistance is imparted. It can seal surfaces like metal and wood and can be used as coating to protect such materials from fading or corrosion. Since recycled polyurethane is used, it is economic and environmental friendly.

4. CONCLUSION

Since the recycled polyurethane is hydrophobic in nature, when coated on metal surface prevents the contact between water molecules and metal surface. The polyurethane forms a protective coating around the iron which does not allow the oxidation of the metal with air easily. Since the coating is obtained by recycling polyurethane it is also cost effective. Since incineration of polyurethane is eco- friendly and no harmful gases are produced, hence the recycled polyurethane is valuable. Polyurethane covering (otherwise called PU covering) on metal gives a thin, high sheen complete with phenomenal climate safe qualities.

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