

Protection of iron and steel

Iron is the most widely used metal in the world, from tin cans to steel bridges. Rusting greatly reduces the strength of iron and steel structures, and it is, therefore, a major economic and safety problem. We can reduce the rusting of iron, and in some cases eliminate it completely.

Exclusion of air

One condition for iron to rust is the presence of air, so any method which will exclude air from the iron will prevent corrosion. Some examples are given below.

1. Greasing and oiling will protect the moving parts of an engine. It will also protect non-moving articles like tools.
2. Painting, plastic coating, or varnishing will protect any non-moving objects that are unlikely to be scratched.
3. Metal plating with Cr, Ag, Au, Cu, and Sn will give an attractive, corrosion-resistant, metallic finish.

Tin plating

Tin cans are in fact steel cans with a thin coating of tin. Tin is used because it is resistant to attack by air and water. The steel to be plated is placed in a solution containing tin ions. The steel is connected to the negative of a supply and so the tin ions are attracted to it. When they reach the steel, they gain electrons, and tin metal is deposited on the surface.

The inside of the can is coated with polyurethane to protect it from attack by acidic juices.

Tin plating can also be done by dipping the substance to be plated in a bath of molten tin.

There is one drawback with tin-plating. If the tin is scratched a cell is set up between the tin and iron. Since tin is below iron in the electrochemical series, the electrons will flow from the iron to the tin, and the iron will rust.

Galvanising

Rusting of iron is an oxidation process which involves a loss of electrons. A supply of electrons to the iron will prevent the iron from losing its electrons and, therefore, will prevent rusting. For example, many modern cars are "negatively-earthed", which means that the negative terminal of the battery is connected to the body of the car. This supplies electrons to the body and helps to prevent the iron from rusting.

Iron is galvanised by dipping it into a bath of molten zinc, which places a coating of zinc on the iron. This method of protection is used for items which are subjected to rough treatment such as dustbins and corrugated iron roofing. When a zinc coating is scratched the iron is still protected since zinc is above iron in the reactivity series, and the electrons will flow from zinc to iron.

The iron will not rust but the zinc will slowly corrode instead. Zinc is never used for food packaging as zinc ions are poisonous.

Alloying

Steel is produced from iron by carefully controlling the amount of carbon present. Most steels contain between 0.1 per cent and 1 per cent carbon. By mixing steel with certain metals, alloys which are resistant to corrosion can be produced. These alloys are called stainless steels. Steel alloyed with chromium or with nickel will produce corrosion-resistant stainless steels. They contain between 10 and 25 per cent chromium or between 8 and 20 per cent nickel.

Sacrificial protection

If we supply electrons to iron, it will not rust. We can do this by attaching a metal higher in the reactivity series to the iron. The metal will corrode preferentially. Underground pipelines are protected in this way. Bags of magnesium scrap are attached at intervals along the pipeline.