Corrosion - two case studies: aluminium and iron

- Iron rusts, but aluminium does not
- The chemistry of corrosion
- Corrosion experiment
- Permeable vs impervious
- Protecting iron from rusting

Aluminium and iron in the form of steel are the two most widely used metals. Although iron has been in use since the beginning of the Iron Age (around 1000BC) this has not always been the case for aluminium.

Although aluminium is very common in the Earth's crust, the extraction of aluminium from its ore, Bauxite, is difficult and it has only really been commercially available since the early 1900s.

Both these metals are used in construction and industry where exposure to water, air and pollution can potentially cause great damage to the metals. A quick look around the average house soon shows that if iron, or its alloy steel, is left out in the wet, it will soon corrode and rust. A piece of aluminium in the same conditions seems to last quite well, showing little signs of corrosion.

Iron rusts, but aluminium does not

Aluminium really should not be able to be used as it is in high tension power lines, planes, ships, building and cans to name but a few. Its relatively high reactivity should make it impossible to use safely. Aluminium can be made to corrode quickly in air and even burn violently on heating, but it does not usually react, lasting longer than the less reactive iron in normal environments.

What is happening?

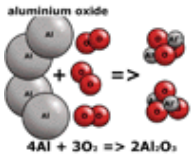
The chemistry of corrosion

Corrosion, or rusting, occurs when oxygen gas and water react with a metal to form a new chemical on the surface of the metal called an oxide. Most metals corrode. For some like sodium, it is such a fast and violent reaction that the metal burns in contact with water and is soon nothing but oxide or hydroxides!

At the other end of the spectrum is gold and the other precious metals which resist corrosion and form only very thin oxide layers or do not react at all with water and oxygen.

Like most other metals, aluminium and iron react relatively slowly to form oxides and corrode. The reactions can be represented by chemical equations.

The two equations for aluminium and iron respectively are:



Note: This is not the only possible reaction for iron, but it is a fair representation of the effect of many different reactions. This process can be speeded up by placing the metals in salt water.

Corrosion experiment

Try a small experiment with steel wool. Place three pieces of steel wool on a bench top. One is kept dry, one is placed in some fresh water (do not cover the steel wool

Subject List

Print Topic

FAQ:
- Why do cars rust more quickly near the beach?
- Why do you have to clean silver?

Related Topics:
- Metals and non-metals
- Properties of metals
- Refining metals
- Iron (Fe)
- Gold (Au)
- Mercury and heavy metal pollution
- Production of iron
- Production of aluminium

Quiz:
- Question 1
- Question 2
- Question 3
- Question 4

Sites:
- N/A

Glossary

- N/A

with water) and the third placed in salt water. Watch for a few days. The corrosion will soon become quite evident!

Chemists call corrosion "oxidation". Oxidation literally means "to combine with oxygen". Corrosion occurs fastest when the metal is in contact with air, water and salt.
Why does iron rust when aluminium will remain untouched by corrosion?

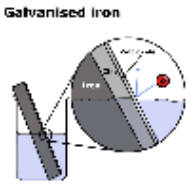
Permeable vs impervious

When it starts to corrode, aluminium forms an oxide layer, which is impervious to water and oxygen. Iron, on the other hand, forms a permeable oxide layer which allows both water and oxygen to pass through and keep attacking the underlying iron.

The impervious aluminium oxide layer protects the aluminium from further corrosion whereas the rust on the iron flakes off, exposing more metal iron to attack.

Protecting iron from rusting

The best way to protect iron or steel is to make an impervious layer on the metal and protect it the same way as aluminium does naturally. This is why engineers paint, grease, oil or tar steel to stop water and oxygen getting to the iron.



Another method is to dip the iron in hot liquid zinc. This is called galvanising. What happens is that the zinc binds to the iron and then corrodes instead of the iron. An added advantage is that the zinc forms an impervious oxide layer like aluminium does and this further protects both the iron and the zinc.

Iron and steel can also be protected electrically, by stopping and reversing the oxidation process. This occurs when lumps of zinc or magnesium are welded onto the hulls of ships or the piers of an oil rig. The more reactive zinc or magnesium is corroded before the iron, thus sacrificing themselves to corrosion instead of the iron. As a result of this behaviour, zinc or magnesium are known as "sacrificial anodes"!

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