METALS. GENERAL PROPERTIES. EXTRACTION AND CLASSIFICATION OF METALS

Workshop

Introduction

When the earth was formed the molten mass contained the many different metals which today we extract and use in huge quantities. Most of the metals combined with rock when molten, to form metallic ores. The most common of these are bauxite, from which aluminum is extracted, and iron ore from which iron is extracted. More than seventy different metals are extracted and used in the manufacturing industries today. Some, like copper and lead for example, can be used in their pure state, to take advantage of their natural properties. But often, we combine different metals, or metal with other materials to form alloys. By making alloys, we can change the properties of a metal to suit our particular needs.

Metals and alloys can be used in many ways. They are important for the transport, telecommunications, machinery, construction and manufacturing industries.

General properties in all metals

- *Physical Properties*:

Metals are hard, non-adhesive, cold and smooth,they are very often shiny and strong. They are also ductille and malleable, do not break easily. Metals are very good conductors of electricity, sound and heat. When temperature rises they expand, and when it falls, they always contract. They can be easily welded to other metals.

- *Chemical Properties*:

Metals react with oxygen in water and air. It's known as oxidation or rusting and it's a reddish- or yellowish-brown flaky coating of iron oxide that is formed on iron or steel, especially in the presence of moisture.

- *Ecological Properties*:

Most metal are recyclable and some metals such as lead or mercury are toxic and they are a danger for humans being and for the environment.

Classification of metals

Ferrous Metals (contain iron)

Pure Iron is of little use as an engineering material because it is too soft and ductile. When iron cools and changes from a liquid to a solid, most of the atoms in the metal pack, tightly together in orderly layers. Some, however. become misaligned, creating areas of weaknesses called dislocations. When a piece of iron is put under stress, layers of atoms in these areas slip over one another and the metal deforms. This begins to explain the ductility of soft iron. By adding carbon to the iron however, we can produce a range of alloys with quite different properties. We call these ***the carbon steels. An alloy*** is a mixture of two or more chemical elements and the primary element is a metal.

Classification of metals: ferrous metals

Carbon Steels: their properties and uses

- Mild Steel: carbon content between 0,1% and 0,3%. *Properties*: less ductile but harder and tougher than iron, grey colour, corrodes easily. *Uses*: girders or beams, screws, nut and bolts, nails, scaffolding, car bodies, storage units, oil drums.
- Medium carbon steel contains between 0,3% and 0,7% carbon. *Properties*: harder and less ductile than mild steel, tough and have a high tensile strength. *Uses*: it's used for the manufacture of products which have to be tough and hard wearing like gears, tools, keys, etc
- High carbon steel contains between 0,7% and 1,3% carbon. *Properties*: Very hard and brittle material. *Uses*: It's used for cutting tools and products which have to withstand wear such as guillotine, springs, etc.
- Stainless steel are iron and chromium alloys. A wide range of steels are available with chromium content between 13% and 27%. *Properties*: Chromium prevents rusting with an oxide film. Ductility, hardness and tensile strength. It's also a shiny attractive metal. *Uses*: Cutlery, sinks, pipes, car pieces, etc.
- Grey Cast Iron is an alloy of iron (94%), carbon (3%) silicon (2%) and some traces of magnesium, sulphur and phosphorous. Properties: brittle but extremely hard and resistant, it corrodes by rusting, Uses: pistons, machinery parts, streets lamps, drain covers, tools.

Classification of metals: ferrous metals

Carbon Steels: their properties and uses

- Other chemical elements can be added to steel, to improve or achieve certain properties. Here you are some examples:
  - *Silicon* makes the alloy magnetic and improves elasticity.
  - *Manganese* makes the alloy harder and heat-resistant. It's used to make stainless steel.
  - *Nickel* improves strength and prevents corrosion.
  - *Tungsten* makes the steel harder, more heat-resistant and prevents corrosion.
  - *Chromium* makes the alloy harder and tougher and more rustproof.

Classification of metals: non-ferrous metals

Non-ferrous metals (contain no iron)

They are metals that don't contain iron. They have a lot of uses but they are often expensive because they are more difficult to extract.

- **Aluminium**
- It's the most abundant metal in the earth's crust and after steel, is the most widely used of all the metals, today.
- *Properties*: Silvery white colour, light, highly resistant to corrosion, soft, malleable and ductile, low density, good conductor of both electricity and heat.
- *Uses*: high voltage power lines, planes, cars, bicycles, light metal work. roofing and windows and doors units, decoration, kitchen tools and drink cans.

- **Copper**
- It's a pure metal that is the world's third most important metal, in terms of volume of consumption.
- *Properties*: a reddish-brown metal, ductile and moderately strong, very good conductor of electricity and heat,It corrodes very easily.
- *Uses*: electrical wire, telephone lines, domestic hot water cylinder and pipes, car radiator core, decoration, architecture.

- **Brass**
- This term "***brass***" covers a wide range of copper-zinc alloys.
- *Properties*: It's gold in colour. It has very good anticorrossive properties and it's resistant to wear.
- *Uses*: Handicrafts, jewellery, plumbing, capacitors and turbine.

Classification of metals: non-ferrous metals

- **Magnesium**
  - It's shiny and silvery white.
  - *Properties*: It's very light, soft and malleable, but not very ductile.It reacts very strongly with oxygen.
  - *Uses*: Fireworks, aerospace industry, car industry.

- **Tin**
  - It's a shiny white metal.
  - *Properties*: It doesn't oxidise at room temperatures, it's very soft.
  - *Uses*: Soft-soldering, tin foil and tin plate.

- **Lead**
  - It's a silvery grey metal.
  - *Properties*: Soft and malleable. It's toxic when its fumes are inhaled.
  - *Uses*: Batteries, it's use as an additive in glass for giving hardness and weight.

- **Bronze**
  - It's an alloy of copper and tin.
  - *Properties*: High resistan to wear and corrosion.
  - *Uses*: Boat propellers, filters, church bells, sculpture, bearings and cogs.

- **Zinc**
  - It's a bluish grey shiny metal.
  - *Properties*: Anticorrosive, not very hard, weak at low temperatures.
  - *Uses*: Roofing, plumbing because it stops corrosion.

Vocabulary: metals

- Lead – plomo
- Zinc – cinc
- Tin – estaño
- Copper – cobre
- Bronze – bronce
- Brass – latón
- Aluminium – aluminio
- Magnesium – magnesio
- Steel – acero
- Iron – hierro

Vocabulary: other

- molten - fundido
- ore - mineral/mena
- alloy - aleación
- gangue - ganga
- ferrous - ferrroso
- cool - enfriar
- weakness - debilidad
- corrode - corroer
- wearing .- desgaste
- gears - engranajes
- stainless - inoxidable
- tensile strength - tracción
- cutlery - cuberteria
- pipe - tuberia