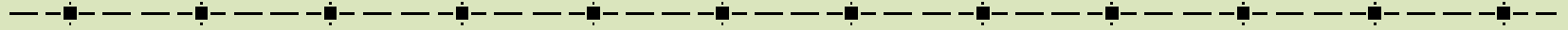


1

Basic Marine Metallurgy



Our last area of science deals with metals only. Since corrosion attacks all metals and many metals are used in boat building, we should have a basic understanding of metals.in general not just for corrosion.

There are a approximately 12 metals on the element table. Mostly they are solids at room temperature with the exception of mercury and bromine which are liquid at room temperature. All metals have some of the following properties, some metals have all of the following properties:

Good Ability to conduct electricity

Good Ability to conduct heat

Hardness

High density

Not transparent

Basic Marine Metallurgy

Some more terms:

Compound: Is a combination of two or atoms of a different kind that forms a third material. Table salt is a compound, it is made up of two atoms, sodium and chlorine gas. Sodium is a metal and chlorine a gas. The result is crystalline salt.

Mixture: Is a combination of compounds or elements that are not chemically joined (bonded). In a mixture all of the compounds and element retain their own characteristics.

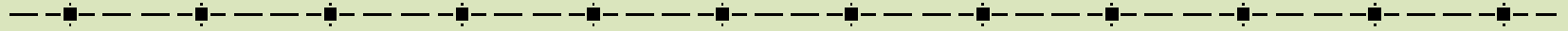
Solution: A solution is a special kind of mixture. When two materials combine to form a solution, one material dissolves the other. Generally one material of a solution is a liquid. Water is the universal liquid part of a solution. The liquid part is known as the **solvent** and the solid part is known as the **solute**.

Solid Solution: A special kind of solution is the solid type. This occurs when some elements or solid compounds are heated to form liquids then mixed together. When cooled you have solid solution.

Alloys: When two or metals are heated and dissolved together in solid solution, the new material is known as an **ALLOY**. The main metal such as iron or copper is the solvent and metals like zinc and tin are the solute. The word ALLOY has two meanings :

- 1 The dissolved metal material
- 2 The solid solution made up of alloys and solvent

Basic Marine Metallurgy



Important Mechanical Properties of Metals

All solid metals have the following properties. These properties apply to pure metals as well as alloys.

Hardness: Which is the metals ability to withstand alteration or breaking from twisting, compression, mechanical shock.

Ductility: Ability of a metal to stretch

Brittleness: A metal that stretches very little before breaking is brittle.

Stress: The amount of effort to fracture a material

Strength: The ability of a metal to withstand permanent damage. To resist the effects of stress

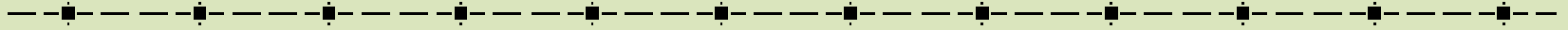
Tensile Strength: How much stress the metal can take when pulled apart

Compressive Strength: Which is the metals ability to withstand being compressed or squeezed.

Torsional Strength: The stress level required to break a metal by twisting it .

Poisson's Ratio: Describes how much a metals cross sectional area shrinks with stretching.

Basic Marine Metallurgy



Miscellaneous Properties of Metal

Corrosion Resistance: The ability of a metal to resist corrosion. Some metals form a covering in the air, others need alloys to help minimize corrosion.

Dielectric Strength: The ability of a metal to withstand high voltages without passing current from itself.

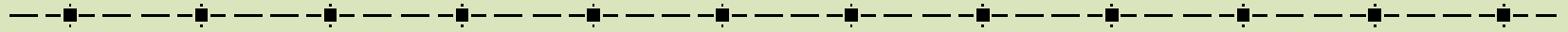
Magnetic: The ability of a metal to become magnetized. Iron is the most magnetic metal of the metals.

Thermal: The effect of temperature on metal such as ‘Coefficient of Expansion’ which is how much does the metal expand when heated. Another important thermal property is the metal’s melting point, which is the temperature at which the metal will turn into a liquid

5

Basic Marine Metallurgy

Commonly Used Metals used on Boats



1. **Steel – used primarily in hulls**
2. **Stainless Steel- Used for fasteners and other boat hardware like safety rails**
3. **Copper – wire, fasteners, some plumbing**
4. **Bronze – propellers, chain plates, through hulls, decorative hardware, fasteners**
5. **Brass – used above waterline mainly for decorative items, but keep dry**
6. **Aluminum- used in boat hulls and some other hardware structural an non structural**
7. **Nickel – used in water tankage, used in other hardware, and used to make hulls.**
8. **Iron – original metal used in making hulls and other structural components. Not used.**

6

Basic Marine Metallurgy

Alloy Content of The Boat Building Metals

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1. **Steel – iron alloyed with carbon**
 2. **Stainless Steel- iron alloyed with carbon, chromium and nickel**
 3. **Copper – pretty much pure there is some alloying for very special coppers**
 4. **Bronze – Copper alloyed with material like tin, zinc, silicon, and aluminum**
 5. **Brass – Copper alloyed with zinc, lead or tin**
 6. **Aluminum- can be alloyed with copper, manganese, silicon, magnesium, zinc**
 7. **Nickel – alloyed with silver, copper, iron**

These are the basic boat building metals and their possible alloying material. This is not a comprehensive list. It is just to show you what common metals may be made of. If you look at a metal manufacturers catalog you will see all kinds of alloying combinations. These alloys are developed to increase strength, ductility, corrosion resistance and other characteristics. Many times simply altering the percentages of an alloying material in a metal will change its characteristics considerably.

The metals in this list are used in boat building for their strength and in some cases for their inherent corrosion resistance. However using these different metals in different applications on the same boat (which is necessary) can contribute to the corrosion problem. This will be covered when we study the corrosion types and processes.