## ***Aluminum – General Information***

Aluminum is a silverish white metal that has a strong resistance to corrosion and like gold, is rather malleable. It is a relatively light metal compared to metals such as steel, nickel, brass, and copper with a specific gravity of 2.7. Aluminum is easily machinable and can have a wide variety of surface finishes. It also has good electrical and thermal conductivities and is highly reflective to heat and light.

- At extremely high temperatures (200-250°C) aluminum alloys tend to lose some of their strength. However, at subzero temperatures, their strength increases while retaining their ductility, making aluminum an extremely useful **low-temperature alloy**. Aluminum alloys have a strong **resistance to corrosion** which is a result of an oxide skin that forms as a result of reactions with the atmosphere. This corrosive skin protects aluminum from most chemicals, weathering conditions, and even many acids, however alkaline substances are known to penetrate the protective skin and corrode the metal.
- Aluminum also has a rather **high electrical conductivity**, making it useful as a conductor. Copper is the more widely used conductor, having a conductivity of approximately 161% that of aluminum. Aluminum connectors have a tendency to become loosened after repeated usage leading to arcing and fire, which requires extra precaution and special design when using aluminum wiring in buildings.
- Aluminum is a very versatile metal and can be **cast in any form** known. It can be rolled, stamped, drawn, spun, roll-formed, hammered and forged. The metal can be extruded into a variety of shapes, and can be turned, milled, and bored in the machining process. Aluminum can riveted,

welded, brazed, or resin bonded. For most applications, aluminum needs no protective coating as it can be finished to look good, however it is often anodized to improve color and strength.

## ***Aluminum Alloy Designations***

| Designation | Major Alloying Element |
|---|---|
| 1xxx | Unalloyed (pure) >99% Al |
| 2xxx | Copper is the principal alloying element, though other elements (Magnesium) may be specified |
| 3xxx | Manganese is the principal alloying element |
| 4xxx | Silicon is the principal alloying element |
| 5xxx | Magnesium is the principal alloying element |
| 6xxx | Magnesium and Silicon are principal alloying elements |
| 7xxx | Zinc is the principal alloying element, but other elements such as Copper, Magnesium, Chromium, and Zirconium may be specified |
| 8xxx | Other elements (including Tin and some Lithium compositions) |
| 9xxx | Reserved for future use |

## ***Aluminum Alloy Characteristics***

***1xxx Series.*** These grades of aluminum are characterized by excellent corrosion resistance, high thermal and electrical conductivities, low mechanical properties, and excellent workability. Moderate increases in strength may be obtained by strain hardening. Iron and silicon are the major impurities.

***2xxx Series.*** These alloys require solution heat treatment to obtain optimum properties; in the solution heat-treated condition, mechanical properties are similar to, and sometimes exceed, those of low-carbon steel. In some instances, precipitation heat treatment (aging) is employed to further increase mechanical properties. This treatment increases yield strength, with attendant loss in elongation; its effect on tensile strength is not as great. The alloys in the 2xxx series do not have as good corrosion resistance as most other aluminum alloys, and under certain conditions they may be subject to intergranular corrosion. Alloys in the 2xxx series are good for parts requiring good strength at temperatures up to 150 °C (300 °F). Except for alloy 2219, these alloys have limited weldability, but some alloys in this series have superior machinability.

***3xxx Series.*** These alloys generally are non-heat treatable but have about 20% more strength than 1xxx series alloys. Because only a limited percentage of manganese (up to about 1.5%) can be effectively added to aluminum, manganese is used as major element in only a few alloys.

***4xxx Series.*** The major alloying element in 4xxx series alloys is silicon, which can be added in sufficient quantities (up to 12%) to cause substantial lowering of the melting range. For this reason, aluminum-silicon alloys are used in

welding wire and as brazing alloys for joining aluminum, where a lower melting range than that of the base metal is required. The alloys containing appreciable amounts of silicon become dark gray to charcoal when anodic oxide finishes are applied and hence are in demand for architectural applications.

***7xxx Series.*** Zinc, in amounts of 1 to 8% is the major alloying element in 7xxx series alloys, and when coupled with a smaller percentage of magnesium results in heat-treatable alloys of moderate to very high strength. Usually other elements, such as copper and chromium, are also added in small quantities. 7xxx series alloys are used in airframe structures, mobile equipment, and other highly stressed parts. Higher strength 7xxx alloys exhibit reduced resistance to stress corrosion cracking and are often utilized in a slightly overaged temper to provide better combinations of strength, corrosion resistance, and fracture toughness.