Metallurgical Aspects

In high purity form, aluminium is soft and ductile. Most commercial users, however, require greater strength than pure aluminium affords. This is achieved in aluminium by the addition of other elements to produce various alloys which alone, or in combination, impart strength to the metal. Further strengthening is possible by means which classify the alloys roughly into two categories, non-heat treatable and heat-treatable.

Non-heat Treatable Alloys

The initial strength of alloys in this group depends upon the hardening effect of elements such as manganese, silicon, iron and magnesium. The non-heat treatable alloys are therefore usually designated in the 1000, 3000, 4000 and 5000 series.

Since these alloys are able to be workhardened further strengthening is possible with various degrees of cold working, denoted by the H series of tempers. Alloys containing appreciable amounts of magnesium when supplied in strain-hardened tempers are usually given a final elevated-temperature treatment called stabilising to ensure stability of properties.

Heat Treatable Alloys

The initial strength of alloys in this group is enhanced by the addition of alloying elements which, either between themselves or in conjunction with aluminium, form compounds which show increasing solid solubility in aluminium with increasing temperature. This phenomenon has enabled this group of alloys to be developed so that their strength may be improved by carefully controlled thermal treatment.

The first step, called heat treatment or solution heat treatment, is an elevated temperature process designed to put the soluble element in solid solution. This is followed by rapid quenching, usually in water, which temporarily "stabilises" the structure and for a short time renders the alloy very workable. It is at this stage that some fabricators retain this more workable structure by storing the alloys at sub zero temperatures until they are ready to form them. At room or elevated temperatures, supersaturated solution begins. After a period of several days at room temperature, termed ageing or room temperature precipitation, the alloy is considerably stronger. Many alloys approach a stable condition at room temperature, but some alloys, particularly those containing magnesium and silicon or magnesium and zinc, continue to age-harden for longer periods of time at room temperature.

By heating for a controlled time at slightly elevated temperatures even further strengthening is possible and properties are stabilised. This process is called artificial ageing or precipitation hardening. By the proper combination of solution heat treatment, quenching, artificial ageing, and cold working the highest strengths are obtained.