

When castings have been heat treated, the heat treatment and the composition of the casting is indicated by the letter T, followed by an alloying number. An example of this is the sand casting alloy 355, which has several different compositions and tempers and is designated by 355-T6, 355-T51, or C355-T51.

Aluminum alloy castings are produced by one of three basic methods: sand mold, permanent mold, or die cast. In casting aluminum, it is important to note that in most cases different types of alloys must be used for different types of castings. Sand castings and die-castings require different types of alloys than those used in permanent molds.

Sand and permanent mold castings are parts produced by pouring molten metal into a previously prepared mold, allowing the metal to solidify or freeze and then removing the part. If the mold is made of sand, the part is a sand casting; if it is a metallic mold (usually cast iron), the part is a permanent mold casting. Sand and permanent castings are produced by pouring liquid metal into the mold, the metal flowing under the force of gravity alone.

The two principal types of sand casting alloys are 112 and 212. Little difference exists between the two metals in mechanical properties, since both are adaptable to a wide range of products.

The permanent mold process is a later development of the sand casting process, the major difference being in the material from which the molds are made. The advantage of this process is that there are fewer openings (called porosity) than in sand castings. The sand and the binder, which is mixed with the sand to hold it together, give off a certain amount of gas, that causes porosity in a sand casting.

Permanent mold castings are used to obtain higher mechanical properties, better surfaces, or more accurate dimensions. There are two specific types of permanent mold castings: permanent metal mold with metal cores, and semi-permanent types containing sand cores. Because finer grain structure is produced in alloys subjected to the rapid cooling of metal molds, they are far superior to the sand type castings. Alloys 122, A132, and 142 are commonly used in permanent mold castings, the principal uses of which are in internal combustion engines.

Die-castings used in aircraft are usually aluminum or magnesium alloy. If weight is of primary importance, magnesium alloy is used, because it is lighter than aluminum alloy. However, aluminum alloy is frequently used because it is stronger than most magnesium alloys.

Forcing molten metal under pressure into a metallic die and allowing it to solidify produces a die-casting; then the die is opened and the part removed. The basic difference between permanent mold casting and die-casting is that in the permanent mold process, the metal flows into the die under gravity. In the die-casting operation, the metal is forced under great pressure.

Die-castings are used where relatively large production of a given part is involved. Remember, any shape that can be forged, can be cast.

Wrought aluminum and wrought aluminum alloys are divided into two general classes: non-heat-treatable alloys and heat-treatable alloys.

Non-heat-treatable alloys are those in which the mechanical properties are determined by the amount of cold work introduced after the final annealing operation. The mechanical properties obtained by cold working are destroyed by any subsequent heating and cannot be restored except by additional cold working, which is not always possible. The “full hard” temper is produced by the maximum amount of cold work that is commercially practicable. Metal in the “as fabricated” condition is produced from the ingot without any subsequent controlled amount of cold working or thermal treatment. There is, consequently, a variable amount of strain hardening depending upon the thickness of the section.

For heat-treatable aluminum alloys, the mechanical properties are obtained by heat treating to a suitable temperature, holding at that temperature long enough to allow the alloying constituent to enter into solid solution, and then quenching to hold the constituent in solution. The metal is left in a supersaturated, unstable state and is then age hardened either by natural aging at room temperature or by artificial aging at some elevated temperature.

Wrought Aluminum

Wrought aluminum and wrought aluminum alloys are designated by a four-digit index system. The system is broken into three distinct groups: 1xxx group, 2xxx through 8xxx group, and 9xxx group (which is currently unused).

The first digit of a designation identifies the alloy type. The second digit indicates specific alloy modifications. Should the second number be zero, it would indicate no special control over individual impurities. Digits 1 through 9, however, when assigned consecutively as needed for the second number in this group, indicate the number of controls over individual impurities in the metal.