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(54) **High corrosion resistance aluminum alloy for sand and permanent mold processes**

(57) An aluminum-based casting alloy having improved corrosion resistance and casting characteristics for sand and permanent mold casting processes. The aluminum-based casting alloy contains from about 4.0 to about 7.0 percent silicon by weight, at least 87 percent aluminum by weight, from about 0.25 percent to about 0.5 percent manganese by weight, a maximum of 0.08 percent copper by weight, and from about 0.2 percent to about 0.8 percent iron by weight.

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Description

Technical Field

[0001] This invention relates to aluminum alloys; particularly, to aluminum casting alloys; and more particularly, to aluminum casting alloys used for sand and permanent mold casting processes.

Background of the Invention

[0002] Components formed from casting of known aluminum alloys may not be sufficiently resistant to corrosion for certain automotive applications. Aluminum automotive components that are exposed to temperature extremes, water, snow, ice and humidity, as well as corrosion inducing materials such as salt, and dirt and road grime that can retain moisture and salt, eventually tend to exhibit significant corrosion.

[0003] United States Patent US 6,733,726 B2 provides for an aluminum alloy that is suitable for die-casting components for automotive applications. The aluminum die casting alloy is characterized by a very low copper content, a manganese content that is sufficient to enhance the stability of the alloy and have a positive influence on the strength properties, and a silicon content that is sufficient to impart excellent fluidity, hot tear resistance and feeding characteristics for good die-castability. The aluminum die casting alloy contains about 4.5 to about 12 percent silicon by weight, at least 87 percent aluminum by weight, about 0.25 percent to about 0.5 percent manganese by weight, and a maximum of 0.08 percent copper by weight. The resulting aluminum alloy has improved corrosion resistance and excellent strength characteristics; however, the alloy is formulated mainly for die-casting processes in which the alloy is subjected to high gauge pressure for introducing molten alloy into the die-cast dies.

[0004] Sand and permanent mold casting may be a more cost efficient alternative to die-casting for forming certain components. As compared to die-casting, both sand and permanent mold casting processes require very low to no gauge pressure in introducing the molten aluminum alloy into the mold. Sand casting is a process in which molten metal is poured into a mold formed of sand under gravity or low pressure or in vacuum and held until the alloy is cooled and solidified. Permanent mold casting is similar to sand casting except that the mold is typically formed of a metal that has a higher melting point than the alloy that is poured into the mold. Components formed from sand and permanent mold casting can be heat treated to obtain the desired mechanical properties. Components formed from aluminum alloys designed for die casting cannot be heat treated, and therefore requires the alloy formulation be tailored to provide the desired mechanical properties in an as-cast component.

[0005] It is desirable to have an aluminum casting alloy best suited for sand and permanent mold casting processes, in which the alloy is highly resistant to corrosion yet exhibits adequate strength similar to that of the aluminum alloy for die-casting as disclosed in US 6,733,726 B2. It is also desirable to have an aluminum casting alloy that is amenable to heat treatment. It is still further desirable to have an aluminum casting alloy that has a reduced natural affinity for the aluminium to attack and dissolve the tooling steel, a condition referred to as soldering. It is an object of the present invention to provide an aluminum alloy with the above mentioned advantages.

Summary of the Invention

[0006] This invention is directed to aluminum alloys having improved corrosion resistance and excellent strength characteristics for sand and permanent mold casting processes.

[0007] An aluminum-based alloy in accordance with the present invention comprises at least about 87 percent aluminum by weight; from about 4.0 percent to about 8.5 percent silicon by weight; from about 0.25 percent to about 0.5 percent manganese by weight; a maximum of about 0.08 percent copper by weight; and from about 0.2 percent to about 0.8 percent iron by weight.

[0008] Relative to known aluminum alloys, the aluminum alloys of this invention are characterized by a very low copper content, a manganese content that is sufficient to input excellent strength properties, a silicon content that is suitable for fluid flow of molten alloy into a mold under normal gravity, and an iron content sufficient to minimize soldering of metallic molds. The lower silicon content provides for improved mechanical properties, while the lower iron content provides for increased strength and better creep characteristics at moderately elevated temperatures and improved ductility.

[0009] These and other features, advantages, and objects of the present invention will be further understood and appreciated by those skilled in the art by reference to the following specification and claims.

Description of the Preferred Embodiments

[0010] In accordance with the principles of this invention, an aluminum casting alloy having improved corrosion resistance and excellent sand and permanent casting properties includes a relatively low copper content that is effective to achieve enhanced corrosion resistance, in conjunction with a relatively lower silicon content for improved mechanical properties, and a lower iron content to increase tensile strength and ductility as well as to reduce shrinkage and soldering.

[0011] The aluminum alloys of this invention typically have a silicon content of from about 4.0 percent by weight to about 8.5 percent by weight; preferably between about 4.0 to about 7.0 percent by weight.

[0012] Iron is preferably added to the aluminum alloys of this invention to decrease the tendency for mold sticking or soldering during casting. A suitable amount of iron

is from about 0.2 percent to about 0.8 percent by weight.

[0013] Conventional aluminum casting alloys typically contain relatively high amounts of copper in order to improve the machinability, strength, and hardness of the casting. However, copper reduces resistance to general corrosion, and therefore, is present in the aluminum alloys of this invention in relatively low amounts, if at all. In order to achieve excellent corrosion resistance, the aluminum alloys of this invention typically contain 0.08 percent copper by weight or less, and more preferably 0.05 percent or less.

[0014] Most aluminum casting alloys have an aluminum content of about 86 percent by weight or less. For example, the most commonly used aluminum die casting alloy (alloy 380.0) contains from about 79 to about 83 percent aluminum by weight. The conventional corrosion resistant aluminum die casting alloys, alloys 360.0 and 413.0, contain from about 85 to about 86.5 percent aluminum by weight and from about 82 percent to about 84 percent aluminum by weight, respectively. In contrast, the aluminum alloys of this invention for sand and permanent mold casting have a relatively high (more than 87 percent by weight) aluminum content, and as a result, exhibit a thermal conductivity that is about 20 percent greater than that of alloy 380.0.

[0015] Manganese is present in an amount from about 0.25 to about 0.5 percent by weight to enhance strength, and more preferably from about 0.3 to about 0.5, with about 0.40 percent manganese being most preferred. These levels of manganese have been found to compensate, at least in part, for the relatively low levels of copper, to enhance strength properties without significantly adversely affecting corrosion resistance.

[0016] Magnesium, nickel, zinc and tin may be present in the alloy in relatively minor amounts, preferably about 1.5 percent or less, more preferably about 1 percent or less, and even more preferably about 0.6 percent or less.

[0017] Other elements are not desirable, and are preferably present in an amount of less than 0.5 percent by weight, and more preferably less than 0.03 percent by weight.

[0018] The aluminum alloys of this invention use lower silicon and higher iron and manganese contents, as compared to known aluminum alloys, to increase strength and control the grain structure. An advantage of having higher manganese content is the increase in the sensitivity of heat treating in obtaining the desired properties. Another advantage of having higher manganese content is that the manganese combines with magnesium to insure a greater degree of stability to the alloy. Also, the higher iron aids in reducing the natural affinity for aluminium to attack and dissolve tooling steel, a condition referred to as soldering.

[0019] In comparison to US 6,733,726 B2, the alloy of the present invention has a lower range limit for the silicon content, and a lower range for the iron content. Lower iron content has been found to reduce shrinkage and increases tensile strength and ductility. Lower silicon provides improved mechanical and elongation properties.

Claims

1. An aluminum-based alloy comprising:

at least about 87 percent aluminum by weight;
from about 4.0 percent to about 8.5 percent silicon by weight;
from about 0.25 percent to about 0.5 percent manganese by weight;
a maximum of about 0.08 percent copper by weight; and
from about 0.2 percent to about 0.8 percent iron by weight.

2. The alloy of claim 2, wherein the silicon is present in an amount of from about 4.0 to 7.0 percent by weight.

3. The alloy of claim 1, having a maximum of 0.05 percent copper by weight.

4. The alloy of claim 1, wherein the aluminum is present in the alloy in an amount of at least 88 percent by weight.

5. The alloy of claim 1, wherein the aluminum is present in the alloy in an amount of at least 89 percent by weight.

6. The alloy of claim 1, wherein the manganese is present in an amount of from about 0.3 percent to about 0.5 percent by weight.

7. An article of manufacture made from an aluminum alloy comprising:

at least about 87 percent aluminum by weight;
from about 4.0 percent to about 8.5 percent silicon by weight;
from about 0.25 percent to about 0.5 percent manganese by weight;
a maximum of about 0.08 percent copper by weight; and
from about 0.2 percent to about 0.8 percent iron by weight.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6733726 B2 **[0003] [0005] [0019]**