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Grey Cast Iron and White Cast Iron

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Cast iron is a family of metals produced by smelting metal, and then pouring it into a mold. The primary difference in production between wrought iron and cast iron is that cast iron is not worked with hammers and tools. There are also differences in composition – cast iron contains 2–4% carbon and other alloys, and 1–3% of silicon, which improves the casting performance of the molten metal. Small amounts of manganese and some impurities like sulfur and phosphorous may also be present. Differences between wrought iron and cast iron can also be found in the details of chemical structure and physical properties [1].

Due to the presence of carbon in cast iron, it may sometimes be confused with steel. However, there are significant differences. Steel contains less than 2% carbon, which enables the final product to solidify in a single microcrystalline structure. The higher carbon content of cast iron means that it solidifies as a heterogeneous alloy, and therefore has more than one microcrystalline structure present in the material. It is the combination of high carbon content, and the presence of silicon, that gives cast iron its excellent castability [1].

The differences between grey cast iron and white cast iron emerge from the composition and the colour of the surface of the material after fracturing. Both of these iron casting alloys mainly contain carbon and silicon, but in different proportions. A key difference between grey cast iron and white

cast iron is that after fracturing, white cast iron gives a white coloured crack surface and grey cast iron produces a grey coloured fractured surface. This is basically due to their constituents in the alloy [2].

The most commonly used category of casting alloy is grey cast iron. The composition includes about 2.5% to 4% carbon and 1% to 3% silicon. In the process of making grey cast iron, the proper control of carbon and silicon content and maintaining the proper cooling rate prevents the formation of iron carbide during solidification. This helps to precipitate graphite directly from the melt as regular, commonly elongated and curved flakes in an iron matrix saturated with carbon. When it fractures, the crack path runs through flakes and the fractured surface appears in grey due to graphite present in the material [3].

White cast iron got its name from the white, crystalline crack surface that it imparts after fracturing. In general, most white cast iron materials contain less than 4.3% of carbon and less amount of silicon. This inhibits the precipitation of carbon in the form of graphite. White cast iron is most frequently used in applications, where abrasion resistance is essential and ductility is not very significantly required. Examples are liners for cement mixers, in some drawing dies, ball mills and extrusion nozzles. White cast iron cannot be welded because it is very difficult to accommodate welding-induced stress in the absence of any ductile properties in the base metal. Moreover, the heat affected zone adjacent to the weld may crack during cooling after welding [4].

Mostly, the composition of grey cast iron is about 2.5% to 4.0% of carbon, 1% to 3% of silicon and the remainder balance using iron [5].

Generally, white cast iron mainly contains carbon and silicon, about 1.7% to 4.5% of carbon and 0.5% to 3% of silicon. Also, it may contain trace amounts of sulphur,

manganese, and phosphorus [2]. Grey cast iron has a higher compressive strength and high resistance to deformation. Its melting point is relatively low, 1140 ºC to 1200 ºC. It also has a greater resistance to oxidation; therefore, it rusts very slowly and this gives a permanent solution to the problem of corrosion [5]. In white cast iron carbon is present in the form of carbide of iron. It is hard and brittle, has a greater tensile strength and extremely malleable (ability to hammer or press permanently out of shape without breaking or cracking). It also has high compressive strength and excellent wear resistance. It can maintain its hardness for limited periods, even up to a red heat. It cannot be easily cast as other irons because it has a relatively high solidification temperature [2]. The most commonly used areas of grey cast iron are; in internal combustion engine cylinders, pump housings, electrical boxes, valve bodies and decorative castings. It is also used in cooking equipment and brake rotors [5].

White cast iron is most extensively used in crushing, grinding, milling and handling of abrasive materials [2].

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