What is Ductile Iron?

Ductile iron is a cast ferrous alloy. It always contains carbon in excess of 1.5 percent and, customarily, in excess of 3.0 percent. It also contains silicon usually from 1.0 to 4.0 percent and manganese up to 1.0 percent. In order to obtain the needed properties both phosphorus and sulfur contents must be low. Phosphorus content is usually less than 0.1 percent, preferably less than 0.05 percent. Sulfur content must be less than 0.02 percent. One more element, magnesium, is always present in ductile irons. Its concentration normally ranges from 0.02 to 0.08 percent.

Why Use Darton Sleeves?

DARTON has been manufacturing precision performance sleeves since 1978. Currently we are the major suppliers of performance sleeves throughout the United States and Canada. The reason for this market share is simple, a very high quality product at the most competitive prices available. The ASTM specifications for performance ductile iron sleeves indicates a minimum tensile strength of 100,000 pounds. DARTON SLEEVES are much stronger than this and will withstand the punishment these sleeves must endure in Top Fuel motors. In addition, ***DARTON sleeve material is much more abrasion resistant and harder on the surface than any other product available.*** This feature provides for good oil retention, ring seal, and the ultimate in leak down performance. DARTON performance sleeves in a “Race Ready” condition are in stock for most all popular applications.

The Difference Between Steel, Ductile Iron and Ordinary Cast Iron

Of these three alloys, steel is basically a pure iron which is strengthened to different degrees by dispersing alloying elements in the crystalline structure of the iron. The most common of these elements is carbon. The effects of carbon are usually enhanced by a variety of chemical elements. Also, there are steels practically free of carbon, the desired properties obtained through alloying with other elements.

Cast iron differs from steel in that it always contains carbon in excess of its solubility in solid iron. This excess carbon precipitates during freezing in the form of pure, crystalline graphite. Ordinarily, the graphite assumes the shape of flakes ranging in length from 0.001 to 0.04-inch (0.025 to 1 millimeter). Through proper treatments the graphite will crystallize in the form of spheroids or nodules. Cast iron with its graphite in spheroidal form is ductile iron.

Why is Graphite Necessary in Cast Iron?

Graphite is necessary in cast iron for a number of reasons. Basically, dissolving carbon and silicon in liquid iron decreases the freezing temperature of iron. Cast iron freezes at approximately 2,100 ° F (1,150 ° C) compared to the approximate 2,730 ° F (1,500 ° C) freezing temperature of steel. All founding characteristics are improved through this lowered freezing temperature. The presence of freezing graphite, also, profoundly influences mechanical, physical and chemical properties.

Is Ductile Iron, Then, Basically Steel with Graphite Spheroids Dispersed Throughout?

For all practical purposes, yes it is. The quantity of graphite is usually between 8 and 12 percent of the volume.

How Does Microscopic Structure Influence the Properties of Ductile Iron?

Graphite – as long as it is in spheroidal form – does not significantly influence properties. On the other hand, the qualities of the metallic matrix (steel) into which graphite spheroids are embedded do alter properties within wide limits.

The Matrices in Ductile Irons and The Influences These Structures Exert

FERRITE: Basically pure iron. Soft. Ductile. Relatively low in strength. Poor wear resistance. High impact resistance. Relatively good thermal conductivity. High magnetic permeability. Low hysteresis loss. In some exposures, good corrosion resistance. Good machinability with proper tooling.

PEARLITE: This component is a mechanical mixture of ferrite and iron carbide. Relatively hard. Moderate ductility. High strength. Good wear resistance. Moderate impact resistance. Somewhat reduced thermal conductivity. Low magnetic permeability. High hysteresis loss. Good machinability with proper tooling.

PEARLITE-FERRITE: A structure consisting of a mixture of pearlite and ferrite. This is the most common grade of ductile irons. Properties are between those with the above two structures. Good machinability with proper tooling.

BAINITE (Acicular Iron): Produced through alloying and/or heat treatment. Harder and stronger than pearlite. Low ductility and moderate impact resistance. Very good high temperature strength and fatigue resistance (to approximately 1,000 ° F – 600 ° C). Adequate machinability.

MARTENSITE: Produced through alloying and quenching. This is very hard and possibly brittle depending on heat treatment, which may be called for when maximum wear resistance is needed. Most often only the surfaces exposed to wear are martensitic. Martensite can be tempered by a low temperature heat treatment. Depending on tempering temperature, a wide variety of strength and wear resistance properties can be produced, all more ductile and easier to machine than untempered martensite. Relatively expensive, usually obtained in centrifugal casting.

AUSTENITE: Like ferrite, this is also a basically pure iron with a different crystal lattice. Relatively low strength and high ductility. High impact resistance, especially at low temperatures. Thermal expansivity can be controlled within wide limits with nickel content. Nickel is always needed in high concentrations (minimum 18 percent) to produce austenitic matrix. Good to excellent corrosion and heat resistance. Very good creep and stress rupture properties up to 1,300 ° F (700 ° C). Very good wear and combined wear-corrosion-erosion resistance. Non-magnetic and fairly easy to machine. Expensive.

CARBIDE: A compound between iron and carbon. This component is seldom desired in ductile iron except when very high wear resistance is needed and low ductility, low strength and poor machinability can be tolerated. Most grades of austenitic ductile iron contain some carbides.

How Does Alloying Affect Microscopic Structure and Properties?

SILICON: Promotes ferrite. High silicon ductile irons (Si>4.0%) are resistant to oxidation but are increasingly more brittle with increased silicon content. Within 1 to 4 percent range silicon markedly increases the strength of ferrite. For this reason ferritic ductile irons – annealed or as-cast – should, normally contain at least 2.75 percent of this element. Exceeding the 2.75 percent limit is not desired in cases where the need for a high impact resistance is clearly indicated.

MANGANESE: Promotes pearlite, harden-ability, and carbides. Because of the last, it is seldom desired for alloying.

NICKEL: Promotes pearlite, bainite and harden-ability without the disadvantages of manganese. Promotes austenite at high concentrations.

CHROMIUM: Promotes harden-ability and carbides. Use is limited to carbide containing grades (such as austenitic grades).

COPPER: Promotes pearlite and harden-ability. Its use is controlled for developing high strength pearlitic grades.

TIN: Acts similarly to copper and percentage of content depends on use.

MOLYBDENUM: Promotes harden-ability, bainite and high temperature mechanical properties.

How Does Heat Treatment Affect Microscopic Structure and Properties?

AS-CAST: Ductile iron is the most economical type and the one most commonly used. With proper selection of the chemical composition, most grades of ductile iron can be produced as-cast.

Why is Centrifugal Casting Used in Sleeve Manufacture?

Centrifugal casting is superior to as-cast in many ways. First and foremost is the ability, by precise control of the rotational speed, to compact the more important strength molecules of the material in different places on the cross section.