The Natural Composite: spheroidal Graphite Iron

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Abstract:

The conventional materials are nowadays not sufficient to cater to the variety of uses and exposure to various environments that may take place while they are put into use. Hence this leads to the development of composites, which nearly suffice the above two conditions. Composite material is a material composed of two or more distinct phases (matrix phase and reinforcing phase) and having bulk properties significantly different from those of any of the constituents. In this developing age for iron industry there is large demand for spherodial Graphite iron (S.G. Iron). S.G. Iron also known as a composite in which the matrix consists of ferrite and/or pearlite and reinforcing component is graphite nodules which present in it. SG Iron also referred to as nodular cast iron or ductile cast Iron or spherulitic graphite cast iron. The scientist discovered the S.G. Iron in 1948. It is a special variety of cast iron having carbon content more than 3% and has graphite present in compact, spherical shapes. These compact spheroids hamper the continuity of the matrix much less than graphite flakes which results in higher strength and toughness which imparting superior mechanical properties i.e. much higher than all other cast irons and which can be compared to steels. This unique property enables S.G. irons to be used for numerous industrial applications. Tensile strength of S.G. Iron will be about 47-55 kg/sq. mm with an elongation of 10-25%. The excellent combination of mechanical properties obtained in S.G. iron can further be informed by the heat treatment. The use of this type of cast iron as an engineering material has been increasing day by day ever since its discovery. It is now replacing steel in many important engineering applications. The production of S.G Iron increased to a large extent during last two decades.

Key Word: Spherodial Graphite irons (S.G. Iron); Morphology; Nodularity.

Introduction:

Cast iron is an alloy of iron containing more than 2 % carbon as an alloying element which has almost no ductility and must be formed by casting. Ductile iron structure is developed from the melt of cast iron. The presence of Si in higher amount promote the graphitization inhibiting carbon to form carbides with carbide forming elements present the carbon forms into spheres when Ce, Mg, are added to the melt of iron with very low sulphur content having this special microstructure containing graphite in nodular form gives ductile iron. Now-a-days much research has been done about Compacted Graphite Iron (CGI) [1-4]. CGI is a form of cast iron that mixes some of the beneficial properties of gray iron and ductile iron to produce a material that is neither a grey iron nor a fully ductile iron but can be described as a “Half Way House” between the two. In grey iron the free graphite forms as thin flakes which run through the ferrite/perlite matrix, hence the alternative name of flake graphite iron. The most recent development in this regard is the production of Austempered Ductile Iron (ADI). Austempering is a critical heat treating process in which austenite transforms isothermally to lower bainite rather than martensite and thus objectively reduces distortion and cracks. It is possible to achieve much larger ranges of tensile strength, ductility with toughness. So it is necessary to find some attractive methods for property development in S.G. iron. Combining the strength, ductility, fracture toughness and wear resistance of a SG iron with the easy castability and production which presents a good economy than that of conventional ductile Iron. It offers the designer an exceptional opportunity to create superior components at reduced cost. A stage has been reached in the development of the material to merit serious attention to design components to suit its own properties to drive full economic and technical advantage from the use of this material. Much of the production of ductile iron is in the form of ductile iron pipe, used for water and sewer lines. It competes with polymeric materials such as PVC, HDPE, LDPE and polypropylene. The applications of S.G. Iron are numerous likely from Flywheel to Tractor life arm, Boiler mountings and can be found almost in every branch of industry.

Experimental Result & Discussion:

Generally in the field of shape analysis to specify at least two different shape parameters: the first one being a global measure of the particle and the second one is concentrating on its morphological details [5]. In the special case of SG Iron, which would give a vivid or an all encompassing characterization of deviations from a spheroidal graphite to forms such as spiky, chunky, fern-like, doughnut, cabbage, stubby, wormy, crab, octopus, irregular spheroids, near/semi-nodule, etc. The descriptor should also indicate the potency or suitability of the graphite nodulariser/modifier used and the treatment practice. In order to eliminate the effect of pseudo-nodules, some researchers [6-7] have recommended the combination of several shape factors in order to adequately describe the graphite morphology and/or form. For every graphite particle, the degree of smoothness, sphericality, elongation or slimness, extent, solidity, convexity and branching; with reference to a complete sphere, parameter was first proposed by Tsutsumi and Imamura [8] and measured by Tsutsumi et al [9] using an image-analyzing computer. However, there are recognizable limitations in the technique used, particularly in the preparation of the specimens to the required standard of the surfaces to be examined. Again, being a purely twodimensional profile or surface analysis, it would be difficult to gauge the extent to which misleading results might be obtained as a result of variation in structure at such a surface, in relation to the bulk material. Thus, the procedure is useful only as a check that a very high proportion of the graphite has a good nodular (with a circle as reference in this case) form or if the form of the non-nodular graphite is always similar. Previous experience [10, 11, 12] confirmed in this work, shows that by deep etching (with the matrix etched away to reveal the 3-dimensional form of the graphite) and subsequent examination using a stereo projection microscope (to take care of the projected height and structure of graphite particles) and complemented with data from SEM interfaced to a computer based image analyzer, the complete feature specific three-dimensional form of fully nodular or spheroidal, fairly nodular (near-nodule) and non-nodular graphite forms i.e. compacted/vermicular. InFigure-1 (a) & (b), there is a emage of spherodial Graphite iron showing the speroidallity.

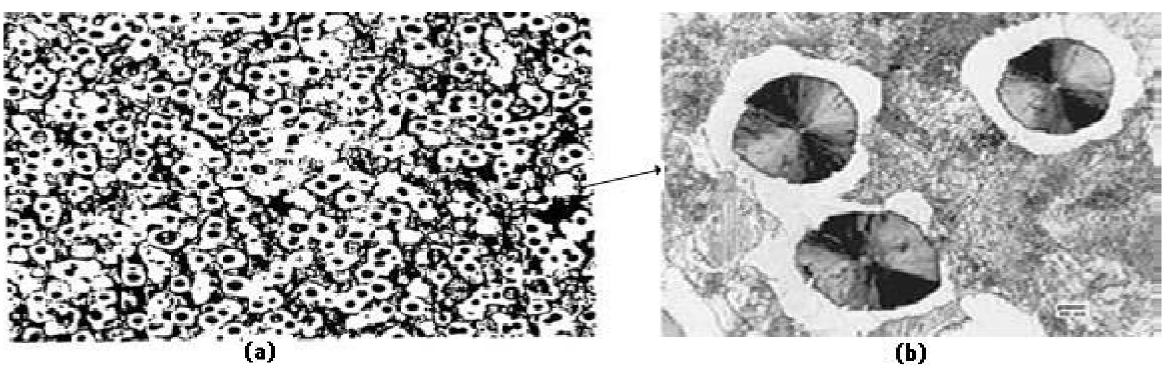

Figure 1. (a) Microstructure of spherodial Graphite iron and (b) Magnified spherodial Graphite iron.

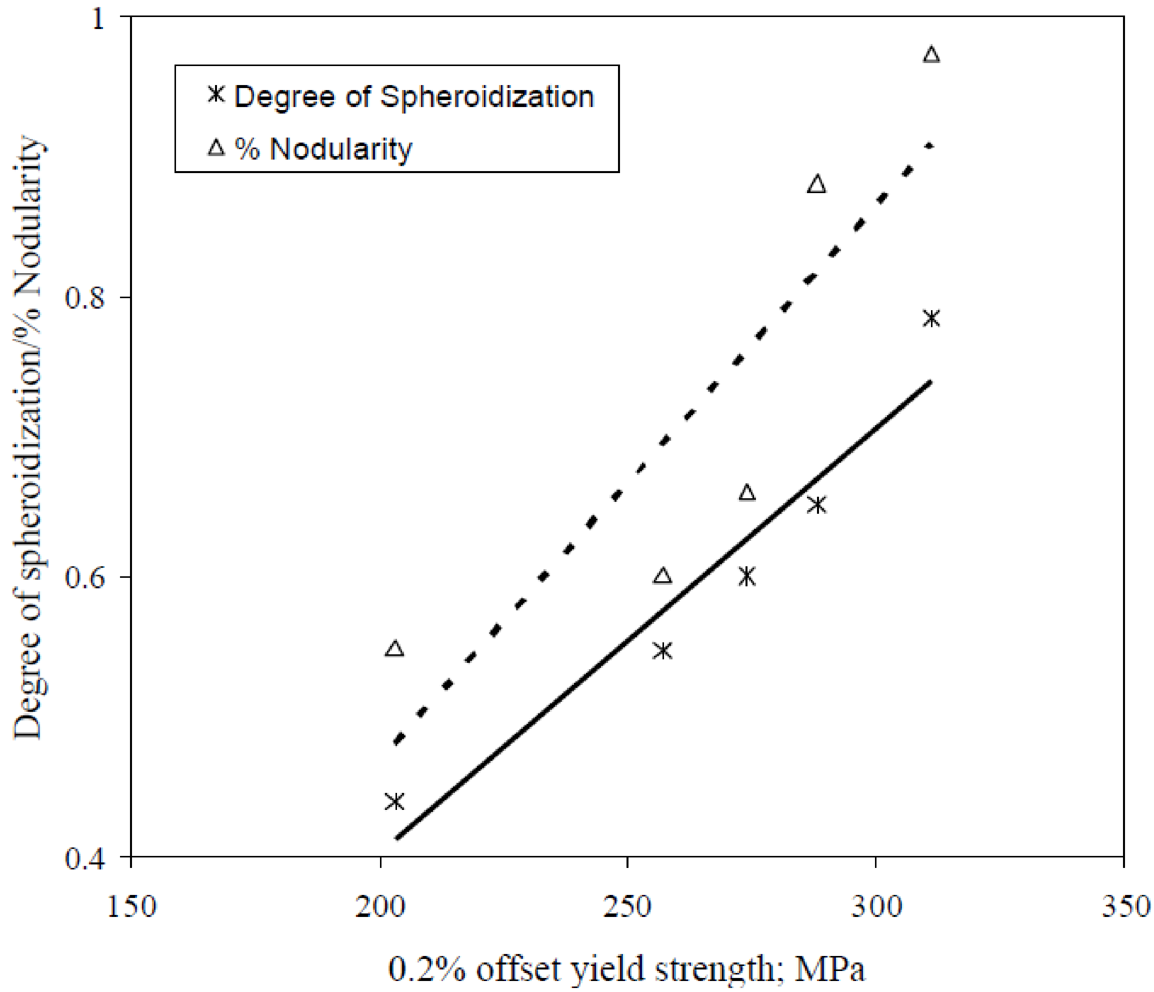

Figure 2. Dependence on Graphite Degree of Spheroidization and % Nodularity.

Conclusion:

A correlation has been established between variation in graphite degree of spheroidzation and 0.2 % yield strength for the iron series investigated. The results obtained showed clearly that the properties of the irons depend largely on the form and/or morphology of graphite precipitated, in the castings.

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