The carbon flotation problem with hyper-eutectic ductile irons

A common defect in ductile iron is associated with the flotation of graphite nodules. The problem commonly appears in foundries of all sizes.

Foundries generally are aware of the fact that with high carbon equivalent irons carbon flotation can occur to the upper parts of the solidifying casting resulting in a zone of high nodule number which has reduced mechanical properties, and an inferior appearance on machining. The flotation also aggravates the problem of dross defects at upper cast surfaces.

Causes

The use of high carbon equivalent liquidus values is commonly justified by the claim that improved metal fluidity, reduced shrinkage and minimised chilling result. It is also known that, unlike grey irons, the mechanical properties of ductile irons are little affected by the amount of graphite present if uniformly distributed.

Problems begin when the C.E.L. is too high - above 4.25 and within the hyper-eutectic range. The noted higher incidence of flotation defects suggests that this range is being inadvertently reached. Possible causes are straightforward lack of control or an increase in the silicon content of the iron to avoid the formation of eutectic carbide and to promote a high ferrite content, thereby resulting in the production of a hyper-eutectic iron.

Carbon determinations

If the carbon and silicon contents are known accurately and controlled carefully, the risk can be avoided. However, it is common practice these days to use spectrographic analysis for quality control purposes and carbon is a difficult element to determine accurately with this technique, especially where the carbon equivalent value of the tested metal is high and the metal is highly nucleated (as with a treated ductile iron). Under these conditions it is impossible to obtain a fully chilled, graphite-free test sample and accurate analysis results cannot be assured.

Casting size

Another factor which influences attitudes towards graphite flotation problems is the size of castings being produced. It is generally believed that the problem is likely only with large-section, slow-cooling castings. In reality the casting depth, or potential flotation height, is also important. The general ruling section of a casting is not the only criterion, therefore, for the likelihood or not of flotation problems occurring.

This has a further implication where test bars are cast for control purposes. These normally have a head attached, which is discarded before testing. If flotation has occurred, the evidence can be discarded with the head, leaving a bar of apparently good structure and properties but bearing little relation to the structure and properties that will result at the upper parts of castings.

Avoiding carbon flotation problems is a matter of vigilance - confirming the accuracy of carbon determinations, appreciating the effects of design, particularly of potential flotation height, and recognising that evidence of a real problem may be thrown out with the discarded test bar head.