Nitrogen in cast iron

How much nitrogen in cast iron?
Up to about 0.04 per cent depending upon the composition of the iron. A very sharp drop in solubility occurs when the iron solidifies, accounting for the tendency of this element to cause blowholes or fissures. In practice, the nitrogen content of sand castings may vary between about 0.001 per cent and 0.015 per cent but above 0.010 per cent castings are likely to be unsound.

Source of nitrogen
Some nitrogen in cast iron is introduced by the charge materials but more commonly it is absorbed into the liquid iron from the blast in the cupola furnace. High nitrogen contents are most likely to occur in cupola melted irons using high steel charges. When recarburising steel scrap charges in electric furnaces, high nitrogen contents can arise from the use of recarburising materials which contain nitrogenous compounds.
Nitrogen can enter the iron during casting when the moulds and/or cores contain high nitrogen content resins.

Metallurgical effects
These are seldom obvious except in very heavy sections.
A compacted form of graphite is produced in heavy sections by nitrogen contents above about 0.008 per cent. Compacted graphite causes an increase in tensile strength but this graphite structure is undesirable in some designs of ingot moulds as it lowers the thermal shock resistance.
An increase in tensile strength of 2-3 ton/in² can result from the increase in nitrogen content arising from the use of high steel charges in the cupola. Some of the advantages claimed for the use of high steel charges for high duty cast irons arise from this effect.
Very high nitrogen contents promote pearlite formation and may lead to white iron structures. In malleable irons very high nitrogen contents stabilise carbide and pearlite and hinder annealing, but problems of this type are very uncommon.
Effect on soundness

Excessive nitrogen contents appear as blowholes and fissures in the castings. It is uncommon for nitrogen blowholes to occur below about 0.013 per cent nitrogen in light section castings and 0.005 per cent in heavy castings. These defects most frequently arise in thick section castings made from cupola iron of low carbon equivalent prepared from high steel charges.

Nitrogen fissure defects occur adjacent to cores bonded with high nitrogen content resins. These often appear as bubbles or fissures close to a re-entrant angle in a casting. Blowholes or fissures due to nitrogen may appear to have bright surfaces or contain a continuous layer of graphite. However, if the defects have been exposed to the air, or the casting has been heat treated, they may have dull oxidised surfaces.

How to avoid the effects of high nitrogen content

The effect of nitrogen can be neutralised by the addition of titanium to give a content of 0.02-0.03 per cent in the iron before casting. Although additions of aluminium (to give a content in the iron of 0.02-0.04 per cent) are used to neutralise nitrogen in the production of large ingot moulds and heavy castings of similar application, aluminium should never be added to iron for light section and general engineering castings because it promotes hydrogen pinholes in such castings (see BCIRA Broadsheet 7).

Carburiser materials having a high nitrogen content must be avoided.

When defects are associated with moulds and cores bonded with high nitrogen content resins, a lower nitrogen content resin should be substituted. Resins having below 3 per cent nitrogen are unlikely to give trouble but sometimes it may be necessary to change to a nitrogen-free resin.

Recommended further reading

DAWSON (J.V.), SMITH (L.W.I.) and BACH (B.B.)

MOUNTFORD (F.A.)

Copies of any BCIRA Broadsheet can be obtained free of charge from British Cast Iron Research Association, Alvechurch, Birmingham, B48 7QB.