Pinholes formed by hydrogen gas during solidification of iron castings

Where in the casting do they occur?

Hydrogen pinholes occur in the subsurface skin adjacent to any face of a sand mould (see diagram). They are most prevalent in sections thinner than 25 mm and cast in greensand, and they occur first in areas remote from the down-sprues. The pinholes may become visible after heavy shot-blasting but are usually found during the first machining cut.

What is their appearance?

The pinholes are spherical cavities with a shiny surface-lining consisting of a continuous graphite film. They are quite small (up to 3 mm in diameter) and will not contain non-metallic inclusions.

Pinhole defects caused by high nitrogen contents may also contain graphite films but these are most prevalent in the hottest areas near to the down-sprues, when moulds made with chemically bonded sands are used.

Fracture containing pinholes.
Close-up of fracture showing shiny lining of the pinholes.

* Revised June 85.
How are they caused?

The defect is caused by contamination of molten iron with aluminium. Trace amounts of aluminium (0.005–0.02 per cent) are sufficient to have a harmful effect. The contaminated iron, when in contact with moisture or hydrocarbons from the surfaces of sand moulds, readily dissolves hydrogen which separates to form pinholes on solidification of the iron. Hydrogen picked up from damp launder and ladles by the contaminated iron, before it is poured into the mould, can intensify the defect.

Titanium contents above about 0.04 per cent promote the occurrence of hydrogen pinholes and tend to decrease the formation of nitrogen defects.

What confirmatory tests are necessary?

Confirmation of the presence of aluminium in the iron may be undertaken but it is often unnecessary.

What preventive measures must be taken?

1. Eliminate all sources of aluminium contamination from the melt, such as:
   - Aluminium components contained in bought scrap; for example, pistons in automobile engine blocks.
   - Excessive additions to the ladle of inoculants containing aluminium.

2. Completely dry all refractory linings in launder and ladles before use.

3. Control the moisture content of the moulding-sand so that it does not become excessively high.

4. Maintain an adequate level of coaldust in the moulding-sand.

5. Avoid, wherever possible, long runner systems which increase the time the molten metal is in contact with the greensand mould face.

RECOMMENDED FURTHER READING


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