Lustrous carbon inclusions

Characteristic features

The formation of flow marks, inclusions, metal separation through unwetted carbon films, these often being invisible because they can lie perpendicular to the wall of the casting.

Incidence of the defect

Lustrous carbon inclusions occur where there is a surplus of lustrous carbon producers in the moulding and core sand. They are often deposited in regions of the casting in which greater turbulence occurs due to differences in density. In the case of spheroidal graphite (SG) cast iron, they occur more frequently in conjunction with oxide and slag defects.

Explanations

Lustrous carbon forms on inert surfaces through thermal decomposition of hydrocarbon-bearing gases in reducing atmospheres above 650°C.

Lustrous carbon is deposited as a film on the silica grains of the mould. Relatively thick layers of lustrous carbon film can result from the gas pressure which develops, particularly when deposited on core sections.

Possible causes

Resin-bonded sand
- Lustrous carbon producing capacity of the core binder too high.
- Insufficient venting of core gases.

Clay-bonded sand
- Excessive formation of lustrous carbon in the moulding sand.
- Excessive or rapid release of lustrous carbon from the carbon carrier.

Moulding plant
- Gas permeability of the mould surface too low

Gating and pouring practice
- Too much turbulence, leading to inclusion of lustrous carbon
- Pouring temperature too low

The different thermal expansions of the silica and the lustrous carbon deposit can also give rise to the detachment of thicker films.

Fig. 12: Grey iron housing. Area of very large lustrous carbon inclusions in the top part of the casting. Scale: 10 mm = 33 mm

Fig. 13: Grey iron housing. Area of very large lustrous carbon inclusions in the top part of the casting. Puckered lustrous carbon formation. Scale: 10 mm = 8 mm
Remedies

Resin-bonded sand
- Reduce amount of cold-box binder; if necessary, change over to binder with lower lustrous carbon producing capacity.
- Warm up cold-box cores in order to reduce the proportion of solvent.
- Improve the venting of core gases. Check the core print for dressing residues, use coarser sand.
- Add oxidation agent to the cores.
- Dress cores, apply thicker layer of coating.

Clay-bonded sand
- Reduce lustrous carbon production in the moulding sand either by decreasing the amount of additive or by using other carbon carriers with lower lustrous carbon producing capacity and slower release of gases.
- Improve gas permeability of moulding material.

Moulding plant
- Reduce compacting pressure in the moulding plant.
- Increase gas permeability of the mould.

Gating and pouring practice
- Avoid turbulence, ensure laminar flow of the metal.
- Increase pouring temperature.

Background information

The amount of undeveloped lustrous carbon producer in the moulding sand is crucial to the incidence of the defect. Because the oxidation processes causing the low surface finish are similar in the bentonite preclude determination of lustrous carbon production in the sand by established methods, one determines the "active carbon." The normal maximum amount should not exceed 0.6 %.

Beckerer and Spatz¹ examined the mechanism by which lustrous carbon layers are produced. Further experiments on the pyrolytic behaviour of organic substances were carried out by Wörmann and others. They found clear correlations between chemical structure and the formation of lustrous carbon. The highest percentage yield of lustrous carbon was obtained by pyrolyzing anthracene. They demonstrated that, through the use of defined substances, it is possible to establish the relationship between lustrous carbon production and coke formation.

In their studies, Bindernagel and others³ had already highlighted defects due to lustrous carbon inclusion. They recommend using the lowest possible amount of lustrous carbon producer and believe that a lustrous carbon producing capacity of 0.4 % in the moulding sand is sufficient.

In addition to lustrous carbon, soot can also be deposited during thermal decomposition. The conditions which lead to increased soot formation have not yet been exhaustively investigated. Deposited soots do not have a pronounced separating effect on the boundary between the metal and the sand mould. Due to its high specific surface, soot is quickly dissolved by molten metal.

Increasing the gas permeability of the moulding sand reduces the risk of lustrous carbon inclusions. However, to achieve the same degree of surface finish, a greater proportion of lustrous carbon producer must be employed. The influence of fines and the quantity of lustrous carbon producer is described in the concluding report of AIF research project 5405.⁴,⁵

Considerable quantities of lustrous carbon can be produced from the cores (primarily Croning and cold-box cores). The venting of the core gases is therefore very important. The drying of such cores has been carried out at various times to avoid inclusions of lustrous carbon.

Core sand flowing into the bentonite-bonded sand can also significantly increase the formation of lustrous carbon. This must be particularly taken into consideration where cold-box cores are used.

Coarse sands are used for cold-box cores, which may require dressing of the mould parts. Naro⁶ recommends a very thick application of dressing with a low proportion of volatile components. In Germany, the use of water-based dressings to seal cores is becoming increasingly popular. It is just as important to examine whether the pouring temperature can be raised where lustrous carbon inclusions occur. Naro⁷ has found that lustrous carbon inclusions decrease with an increase in pouring temperature. Rapid pouring also reduces the risk of inclusion, provided laminar flow takes place. Where turbulence occurs, graphite films can become detached from the silica surface and lead to inclusions.

References

1 Beckerer, G., Spatz I. Untersuchungen an Glanzkohlenstoffschichten, Entstehungs- und Wirkung von Sorption und Glanzkohlenstoffbildung gebundener Formstoffe auf Gußstückeigenschaften Düsseldorf, 1985
2 Wörmann, H.; Winterhalter, J.; Orths, K. Zum Pyrolyseverhalten organischer Formstoffbestandteile Gießereiforschung 34, 1982, P. 153—159
3 Bindernagel, J.; Kolorz, A.; Orths, K. Ausschuß durch kohlenwasserstoffhaltige Gase im Formhohlräum Gießerei 55, 1968, P. 97—100
4 AIF-Abschlußbericht Nr. 5405 IfG-Institut für Gießereitechnik GmbH Wirkung von Sorption und Glanzkohlenstoffbildung tangegebundener Formstoffe auf Gußstückeigenschaften Düsseldorf, 1985