Blowholes

Blowhole defects from moulds and cores

The action of heat on cores and moulds is to liberate gas from the binders; if this gas does not have an opportunity of escaping freely, bubbles will be trapped in the liquid metal filling the mould. The holes caused by these bubbles in the metal give rise to defects which are true blowholes.

Core problems

There are two main divisions in factors which may cause blowholes to be formed from the cores: those due to foundry practice, and those due to the coresand mixtures.

Foundry practice

Blowholes may arise from low core permeability—resulting from the use of a very fine sand, or from the incorporation of fine material into the mixture. Most cores have to be vented through the prints, and it is common practice for these prints to be kept small for economic reasons. A normal coresand with a permeability number of 150 may vent quite satisfactorily through a print 50 mm in diameter (Fig. 1), but if the same amount of gas has to escape through a print 12 mm in diameter (Fig. 2) without giving rise to unwanted back-pressure, the equivalent permeability number would need to be 2400. (No sand is a permeable as this).

For this reason most cores require additional venting, and this is usually done by piercing the green core with a wire. The diameter of this wire is important; the hole produced has an overriding influence on the permeability of the core in general. These vents should receive very careful attention, to avoid trouble arising in the following ways.

1. Vents placed too near the core surface.
2. Diameter of vents insufficient.
3. Blocked vents owing to metal penetration or careless gluing during assembly.
4. Multiple vents not correctly connected.
5. Vents not open to the atmosphere.
6. Cracked cores, allowing metal to penetrate and block the vents.

Figs. 3–5 show blowhole defects caused by blocked core vents. Very often in severe cases the casting appears to be mis-run, as in Fig. 3, and indeed the gas pressure in the mould due to the blocked vents may easily prevent running of the metal in thin sections. Fig. 5 shows a blowhole revealed on machining of the valve plug. The prints of this core were relied on for venting, but had ‘flushed’ over with metal owing to a poor fit in the mould, and gas exit was thus prevented.

Localized blowholes may arise from the design of the core, the core often being very difficult to vent properly because of complicated changes in section and contour. Water-jacket cores in automobile and other water-cooled cylinders are particularly difficult in this respect, and frequently the venting problems are much more difficult to solve and control than all the other coremaking problems put together.
Wax vents are only satisfactory when the wax is completely evaporated during baking. New developments in this respect are glass fibre tubes, which can be baked in with the core; these, and the perforated steel tubes often used for venting and simultaneously supporting radiator cores, are advantageous in that they do not decompose and liberate further gas on heating.

Blowholes can be produced by placing cold cores in hot sand moulds. The water condensed upon the surface will liberate steam very rapidly on casting.

**Variables affecting the quantity and rate of evolution of gas from the coresand mixture**

Assuming that the correct quantities of binder are used, the most important factor is the degree of baking. An underbaked core has a very high gas-evolution rate, and should be avoided at all costs. An ovenbaked core, on the other hand, while having a lower gas evolution is much more liable to break or crack and allow metal to enter the vents. Blowholes may be formed in either instance.

In oil sand cores, the principal gas-evolving material is not the oil, but the green binder. Fig. 6 shows a blowhole produced by an underbaked core and Fig. 7 shows gas evolution rates for various binders and degrees of baking. The two lower curves are for 1 per cent linseed oil on its own, and the 1 per cent linseed + 1 per cent dextrin correctly baked mixture has the lowest gas evolution for a practical coresand mix. Underbaking approximately doubles the amount and rate of gas evolution.

In other binders, gas evolution is not dependent on green binder additions and is usually about 15–20 mL/g.

**Mould problems**

If we now consider the effect of mould variables on the production of blowholes, these may also be divided: into materials, and methods.

A blowhole arising from the mould is shown in Fig. 8. The principal sources of gas in greensand moulds are moisture and coaldust, and both these substances liberate the gas quite rapidly. There is a large difference in permeability between various types of sand, and naturally-bonded greensands usually have a low permeability number. The effect of moisture and coaldust is to lower this permeability number even further, at the same time increasing the gas-producing potential of the mixture. Thus a drop in permeability base sand at a lower water content.

Similar considerations apply to the use of coaldust. These are accentuated by the fact that a sand having a high coaldust content will usually require more moisture to bring it to a workable condition. It cannot be emphasized too strongly that control of moisture content will go far to eliminate blowhole defects in greensand moulds. If the gas liberated from a mould cannot vent freely, the overall permeability may be increased by the well-known method of piercing the sand from the back of the mould with a vent wire. To be effective, the holes should come to within 6 mm of the pattern face.

Other methods of increasing permeability are to insert coke lumps into large cods of sand, or to ram-up large pieces of waste core inside the cods. Vent tubes made from perforated gas-piping may also be used.

The importance of allowing the gas to escape from the back and sides of the mould must be observed. This gas escape can be assisted by placing moulds on a sand bed, or by using perforated moulding-boxes and perforated bottom plates. Weights placed on moulding-boxes should not seal off the top of the box, since undesirable gas pressure may be built up inside the mould cavity as a result.
Mould inserts

It is frequently necessary to employ inserts in moulds and these may take the form of pieces of metal used for the following purposes:

Densening—Horseshoe nails, wire spirals, gauze tubes, etc., and cast iron chills.

Locating—Chaplets and studs, springs.

Composite construction—'Cast-in' : partially welded tubes, plates, spokes in large wheels, end plates in brake drums, steel clamps in brake shoes.

In all these cases it is important that the metal parts should be free from moisture, dirt and oxide (rust). Where possible, tinning of the parts should be carried out and the plating should be of high purity, because lead dissolved from a lead/tin coating may produce a structure in cast iron giving low strength. Galvanizing is not suitable and causes blowholes.

Fig. 9 shows large number of studs in a mould assembly, and Fig. 10 shows the blowholes and bad adhesion caused by using dirty studs. Fig. 11 shows blowholes in a brake shoe produced from a steel locater insert which had not been cleaned before assembly in the mould. The most important point is to avoid rusting and condensation on the inserts during and after assembly. Cast iron chills and denseners frequently give trouble in repeated use, owing to oxidation of graphite at the face of the chill and formation of iron oxide.

Coatings

Care should be taken when drying mould coatings because flames produce water vapour by combustion of hydrocarbons, and this water vapour may condense on any denseners present in the mould face.

A considerable amount of gas is evolved from the core coatings. Fig. 12 shows how spirit-blacking can add to gas evolution, and Figs. 13–14 show a gas defect caused by too heavily blacking the surface of the mould with a resin-containing mould dressing.

The effect of a mould or core coating is to reduce the permeability of the mould or core surface to almost nil. For this reason, cores which are coated may only be able to vent through their prints, making properly designed vent passages essential. Fig. 15 shows the reduction in surface permeability of a core originally having permeability No.225 by a single application of blacking, giving a surface permeability of nil.
Fig. 1 Coreprints adequate for venting core.

Fig. 2 Coreprints too small for venting.

Fig. 3 Severe blowhole defect caused by blocked core vents.
Fig. 4 Blowhole defect due to blocked core vents.

Fig. 5 Blowhole defect, caused by blocked core vents, revealed by machining.

Fig. 6 Blowhole caused by an underbaked core.

Fig. 7 Gas evolution v. baking time, various binders.
Fig. 8 Blowhole caused by the mould.

Fig. 9 Mould assembly with many studs.

Fig. 10 Blowholes and poor adhesion caused by using dirty studs.

Fig. 11 Blowholes caused by dirty locating insert (steel).
Fig. 12 Gas evolution from blacking and coresand.

Fig. 13 Gas defect caused by excessive blacking.

Fig. 14 Gas defect caused by excessive blacking.

Fig. 15 Effect of core coating on surface permeability. Original permeability No. 225, single blacking coat giving permeability No.10, and single zircon wash coat giving permeability nil.