TECHNICAL REFERENCE

Hints for Busy Foundrymen: Reducing Surface Defects on Large Steel Castings

Sand and Refractory Defects

1. Document all raw materials and consumables and assure their quality.

2. Before and after Shot Blasting, carefully inspect the as cast surface of the casting, ingating system and feeders.

3. Take photographs of any discontinuities-: Veins, Paint flake, boils, chill placements, mismatch, Inclusions etc.

4. Identify that the defect is-: Sand, or Refractory and confirm by chemical analysis where practical.

5. Having identified the type of defect review the data gathered and decide on possible sources.

6. Sand / refractory defects –:

7. Check that all loose sand has been removed from moulds and no crushing has occurred.

8. Check general cleanliness of ladles

9. If the ingating system is made from moulding sand is there any erosion. If so, does the metal velocity in the system exceed 1m/sec? If so this is the probable cause of the sand erosion. Redesign the ingating system so that velocities fall below 1m/sec. If this is not practical consider changing it to a high quality refractory system.

10. If the ingating system is made from refractory and there is erosion, check that the metal velocity in the system does not exceed 3.5m/sec, if so redesign system, if it does not check quality of refractory.

11. Does the ingate velocity exceed 1m/sec or the height of jump from the gate exceed the wall section of the casting, resulting in erosion around the ingate area, if so reduce the velocity by redesigning the system, consider using Hevi-Sand locally to improve heat resistance.

12. Are the inclusions on vertical walls or at the transition from a small section to a large section? If so check the metal rising speed in this area it should be 30-50mm/sec. if not increase pouring speed.

13. Are the inclusions on the top face of the casting? If so improve flow characteristics to get the inclusions to float into top feeders or vents, if this is not possible increase machining allowance in this area.

14. Has the surface of the mould been eroded? If so, check paint and painting practice to ensure good paint adhesion with no veining or flaking. Moulds should be left to cure for at least 4hrs after stripping to avoid softening back of resin or adhesion problems. Excess resin additions can also cause adhesion problems. Typically Hevi-Sand requires 40% less binder by weight than an equivalently sized silica sand.

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15. Has the surface of the mould been eroded or exhibit veins? If so, check that the correct resin and hardener additions have been made and that the acid demand values of the base sand have not changed. If all ok consider a 2% iron oxide addition to reduce veining or Hevi-Sand to avoid the expansion problems associated with silica sand. Hevi-Sand will also increase the chilled skin thickness created during mould filling improving mould face stability.

16. Research shows that >90% of casting inclusions come from ladles. It is essential to ensure that refractory quality is both good and suitable for your practice. The nozzle area and the ramming and patching materials used are often neglected by foundries as is ladle cleanliness. Some foundries patch ladle bottoms with sand, given tat velocities often exceed 3.5m/sec this is obviously undesirable . Good practice should involve the use of well blocks and single use of conventional nozzles and stopper rod covers. If one considers conventional ladle practice and an example ladle containing 2tons of refractory, with a 40 use life expectancy. If the refractory lining is replaced when 50% has been consumed then 1000kgs/40 uses = 25kgs of refractory disappears every time the ladle is used. Fortunately most of it floats to the surface of the ladle as slag. However, the high ware areas in most ladles are the nozzle area, the bottom and bottom corners and the slag line. While the slag line is not a problem obviously the other areas are a problem.

Technical Information

Ingating systems for steel castings when using bottom pour ladles

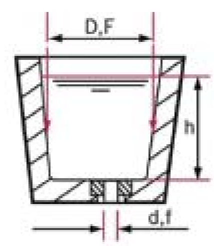
Ladle Characteristics

$Q = f \times v$ (litres/sec) (Formula 24)

Where Q is the pouring capacity
f is the nozzle cross-sectional area (dm2)
v is the rate of flow (dm/sec)

$v = \sqrt{2gh}$ (Formula 25)

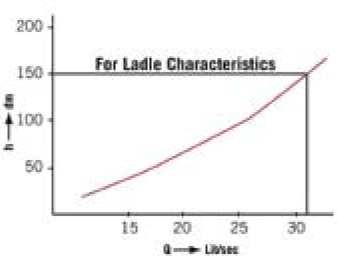
Where g is 9.81m/sec²
h is 75% of the height of the steel surface of the ladle and taken as a functional height for the Q – calculation.



Calculation Example:

A 50 ton ladle with effective volume of about 7000 litres.

Ladle Diameter = 1848mm
Ladle Height = 2588mm
Ladle Nozzle Diameter = 90mm, therefore f = 0.64dm²



If the sliding gates are properly assembled, the practical values of the pouring characteristics hardly deviate from these theoretical ones.

Technical Information (continued)

Ingating systems for steel castings when using bottom pour ladles

Time of Emptying Bottom Pour Ladles (Z)

The time for emptying bottom-pour ladles is as follows:

$$Z= \frac{F \times 2\sqrt{h}}{F \times \sqrt{2h}} \text{ (sec)} \qquad \text{(Formula 26)}$$

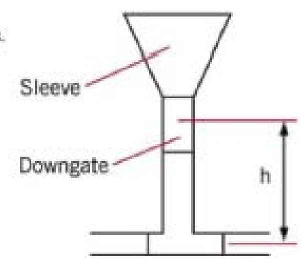
Where F is the surface area of the ladle (inner diameter D) (dm^2)
g is gravity = 98.1 dm/sec^2
h is the maximum height of the steel surface (dm)
f is the surface area of the nozzle (dm^2)
Z is the emptying time (sec)

Pouring System

In principle steel moulds have to be filled as quickly as possible. However, the speed in a sand-moulded runner system must not exceed 1 m/sec. If this speed is exceeded, the respectie part of the runner system should be lined with a refractory material. The maximum speed in refractory runner is between 3.5 and 4.0 m/sec (depending on the quality of the refractory). Further to this, the cross sectional area of the pouring system must not be reduced after the downgate and the rate of flow into the mould ingate should not exceed 1.0 m/sec.

Downgate Design

The bushes, downgates and distributor should always be made in refractory materials.



The back pressure in the downgate capacity Q (litres/sec) of the ladle is calculated with Formula 30.

Where Q = ladle capacity (litres/sec)
F = total surface area (dm2)
g = gravity (98.1 dm/sec2)

$$H= \frac{Q^2}{F^2 \times g} \text{ (dm)} \qquad \text{(Formula 30)}$$

The minimum downgate height should be determined using a 50% safety factor and shorter downgates should be avoided in order to prevent overflows at the pouring bush.

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Runner Systems

Distributor

The distributors are usually 'L', or 'T' or '+' shaped with the choice being dependent on the running speed in the runner system.

Runner

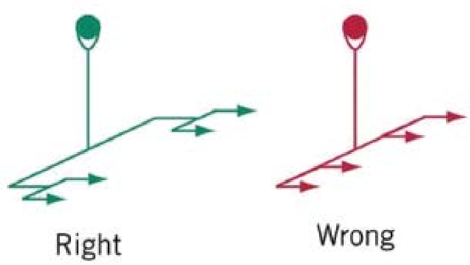
The speed in the downgate should be a minimum of 2.4m/sec as below this speed there is a danger of sucking air through the downgate. The maximum runner speed is 3.4 m/sec, at speeds in excess of this erosion of standard refractory materials will occur. The speed in the runner is calculated by the following formula:

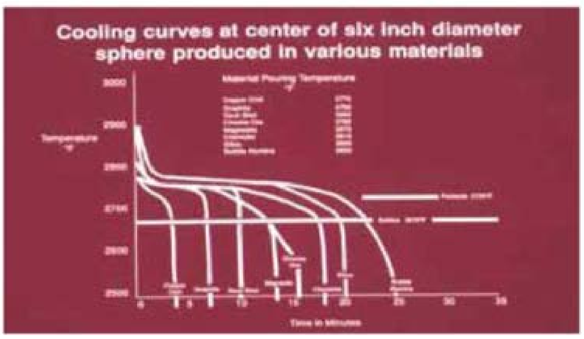
Where Ftotal is the total surface area of the runner (dm^2)
VR is the velocity in the runner system. (m/sec)

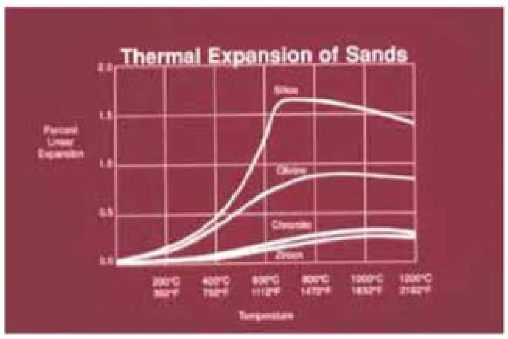
$$VR = \frac{Q}{10 \times F_{total}} \text{ (m/sec)} \qquad \text{(Formula 31)}$$

Layout of Runner System

The cross section of a runner or the ingate should never be smaller than the cross section of the downgate. There should be a positive symmetrical division of the runner system with the aim to have equal flow rates in all runners after division.







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