Indian Institute of Technology, Bombay / Department of Mechanical Engineering
ME 206 – Manufacturing Processes - I

Time : 45 mins QUIZ - I Total Marks: 35 (14 x 2 + 1 x 7)

Answer briefly and precisely. Reason (in point form) is necessary supporting any answer. No credit will be given for answers without reason. Give a rough, schematic sketch wherever necessary. Your hand-writing must be clear and legible. If answers cannot be read clearly, no credit will be given.

1. In sand casting, the volumetric size of the pattern is
   (i) smaller than the volume to be cast (ii) larger than the volume to be cast
   (iii) same as the volume to be cast (iv) None of these

Reasons –

- Metal expands and contracts on heating and cooling, respectively. Thus, a larger volume pattern is required to accommodate the metal in molten state and the casting solidifies to the desired volume.
- The allowances will be accommodated in the larger volume pattern.

2. In sand-casting, cores are provided to make internal holes. For providing machining allowance to be provided on internal holes, the core is
   (i) Cores are oversized relative to hole (ii) Cores are undersized relative to hole
   (iii) Core sizes are equal to hole (iv) None of these

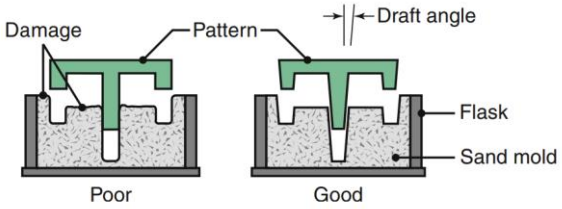
Reasons –

- During cooling metal contracts and the size of the hole increases. So, a smaller core provides the machining allowance

3. The purpose of draft on pattern surface is,
   (i) easy withdrawal of pattern from mould (ii) easy withdrawal of casting from mould
   (iii) easy withdrawal of mould from casting (iv) None of these

Reasons –

- While removing the pattern, the outer surface of the pattern may interfere with the surface of mould and create damages. So, the draft helps in easier removal as shown in the figure below.



4. What are the different stages of contraction, which molten metal (in a mold cavity) will experience from the pouring temperature till it cools down to ambient temperature?

Reasons –

- Contraction of the molten metal as it cools prior to its solidification.
- Contraction of the metal during phase change from liquid to solid (latent heat of fusion).
- Contraction of the solidified metal (the casting) as its temperature drops to ambient temperature.

5. What special features are provided in a horizontal gating system to arrest molten metal impurities before it reaches the mold cavity?

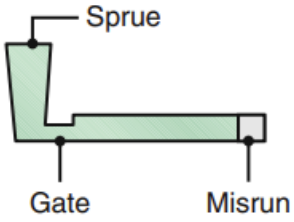
Reasons –

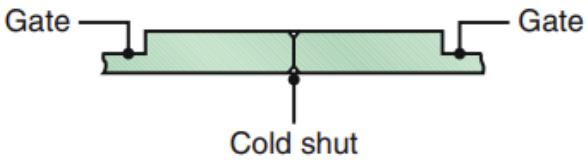
- Skimming
- Using filters
- Using properly designed pouring basins and runner systems

6. What are ‘misrun’ and ‘cold shut’ in sand casting?

Reasons –

- When the molten metal gets solidified before it reaches all parts of the mold cavity, misrun occurs.
- When two molten metal streams meet at a point and gets solidified before proper fusion, cold shut is said to have occurred.





7. Metals with lower specific heat should be poured at a

(i) higher superheated pouring temperature (ii) lower superheated pouring temperature

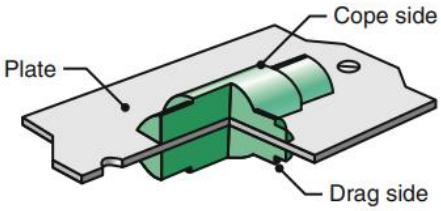
Reasons –

- Metal with lower specific heat solidifies faster. So, to give enough time for the molten metal to fill the mold, higher pouring temperature is advised.

8. What is the difference between a match plate pattern and cope and drag pattern?

Answer –

In a match-plate patterns, the pattern is split into two and is made on the either part of a single plate as shown in the figure. In cope and drag pattern, the pattern is split and separately molded into cope and drag.



9. What are the two major objectives of riser design?

Answer –

- Risers serve as reservoirs supplying molten metal to the casting as it shrinks during solidification.
- Ensure complete filling of the mold cavity (* open riser)
- Improve overall casting yield

10. In sand casting mold, (A/V) ratio of the riser should be smaller than the (A/V) ratio of the casting – is it true or false (where A is surface area and V is volume)?

Answer –

- True, Chvorinov's rule
- Riser should solidify in the last.

11. How “lost foam casting” is different than “lost wax casting?

Answer –

- Molten metal is poured without removing the pattern from mould in lost foam casting.
- Lost wax casting, sacrificial pattern made from a tooled mould and in lost foam casting, it may be made from a mould or from a solid block of foam material.

12. In what way “lost wax casting” or “investment casting” is considered superior to sand casting?.

Answer –

- Better dimensional accuracy and surface finish
- Intricately shaped casting

13. In what way "shell mold casting" is different than the conventional sand casting?

Answer –

- Good surface finish and accuracy
- High tooling cost

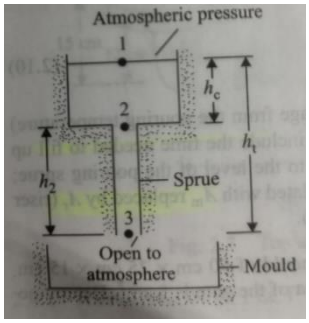
14. How moisture content and grain size may affect the permeability of green sand (used for molding)?

Answer –

- With moisture content, the permeability first increases and then decreases.
- Permeability will increase with the increase in the grain size.

15. Show mathematically following appropriate physical laws that a tapered sprue is more effective in avoiding aspiration effect compared to a cylindrical sprue (with uniform cross-section thru' its length).

Answer –



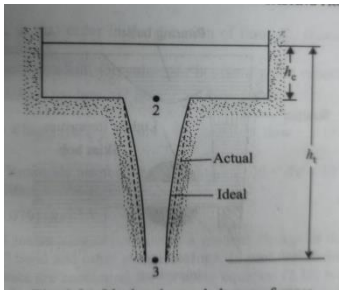
- Cylindrical sprue:

  Applying Bernoulli's equation between points 2 and 3,

$$gh_2 + \frac{p_2}{\rho_m} + \frac{v_2^2}{2} = \frac{p_3}{\rho_m} + \frac{v_3^2}{2}$$

- $p_3 = 0$ (atmospheric), $p_2 = -\rho_m g h_2$ as $v_2 = v_3$
- Aspiration effect due to negative pressure

To ensure positive pressure anywhere in the liquid column, the sprue should be tapered.



- Tapered sprue:

  Let $p_2 = 0$ (limiting case), $gh_2 + \frac{v_2^2}{2} = \frac{v_3^2}{2}$

- Continuity of flow $A_2 v_2 = A_3 v_3,\ v_2 = R v_3,\ R = \frac{A_3}{A_2}$
- $R^2 = 1 - \frac{2gh_2}{v_3^2} = 1 - \frac{h_2}{h_t} = \frac{h_c}{h_t}\ as\ v_3^2 = 2gh_t$
- $R = \frac{A_3}{A_2} = \sqrt{\frac{h_c}{h_t}}$