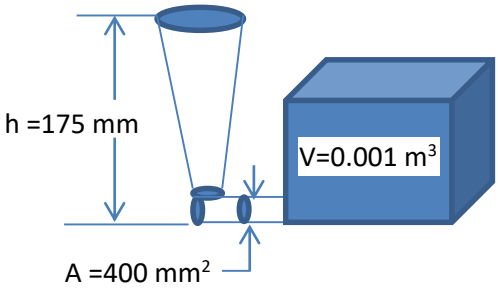
Solving the problems

10.3. The downsprue leading into the runner of a certain mold has a length = 175 mm. The cross-sectional area at the base of the sprue is 400mm^2. The mold cavity has a volume = 0.001m^3. Determine:
(a) the velocity of the molten metal flowing through the base of the downsprue,
(b) the volume rate of flow, and
(c) the time required to fill the mold cavity.



Solution:
h = 175 mm , A = 400 mm^2 , $V_{casting}$= 10^6mm^3
g = 9.81 m/s^2 = 9810 mm/s^2

$v = \sqrt{2h\,g}$, $v = \sqrt{2x\ 175x\ 9810}$

$v = 1852.97\ mm/s$

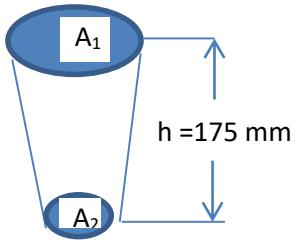
Q = υ x A = 1852.97 x 400

Q = 741188 mm^3/s

$$T = \frac{V}{Q} = \frac{10^6}{741188}$$

T = 1.35 sec.

10.5. The flow rate of liquid metal into the downsprue of a mold = 1 L/s. The cross-sectional area at the top of the sprue = 800 mm^2, and its length = 175 mm. What area should be used at the base of the sprue to avoid aspiration of the molten metal?



Solution:
Q = 1L/s = 1000 cm^3/s = 10^6 mm^3/s , A_1 =800 mm^2
h = 175 mm. , A_2 = ?

$v_2 = \sqrt{2h\,g}$, $v_2 = \sqrt{2\ x\ 175\ x\ 9810}$

$v_2 = 1852.97\ mm/s$

Q = v_1 x A_1 = v_2x A_2

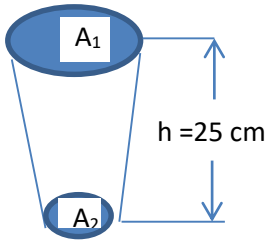
10^6 = A_2 x 1852.97

A_2 = 539.67 mm^2 ,

10.7. Molten metal can be poured into the pouring cup of a sand mold at a steady rate of 1000 cm^3/s. The molten metal overflows the pouring cup and flows into the downsprue. The cross-section of the sprue is round, with a diameter at the top = 3.4 cm. If the sprue is 25cm long, determine the proper diameter at its base so as to maintain the same volume flow rate.

Solution:

Q = 1000 cm^3 , D_1 = 3.4 cm , h =25 cm , D_2 = ?



$$v_2 = \sqrt{2h\,g} \qquad v_2 = \sqrt{2\ x\ 25\ x\ 981}$$

$$v_2 = 221.5\ cm\ /s$$

$$A_2 = \frac{\pi\ x\ D^2}{4}$$

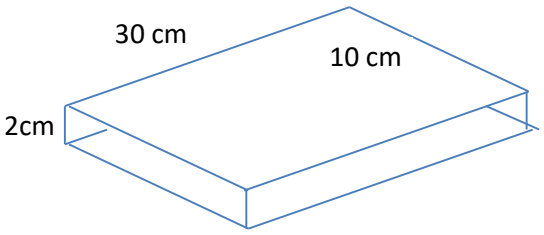
$$Q = \upsilon\ x\ A\ =\ \upsilon\ x\ \frac{\pi\ x\ D^2}{4}$$

$$D_2 = \sqrt{\frac{4\ x\ Q}{\pi\ x\ \vartheta}} \quad = \quad D_2 = \sqrt{\frac{4\ x\ 1000}{\pi\ x\ 221.5}}$$

D_2 = 2.39 cm

10.12. In the casting of steel under certain mold conditions, the mold constant in Chvorinov's rule is known to be 4.0 min/cm^2, based on previous experience. The casting is a flat plate whose length = 30 cm, width= 10 cm, and thickness =20 mm. Determine how long it will take for the casting to solidify.

Solution:



m = 4 min/cm^2 , L= 30 cm , w = 10 cm , t = 2 cm

V = L x W x t = 30 x 10 x 2

V = 600 cm^3

A = 2 (L x W) + 2 (L x t) + 2(W x t)

A = 2(30 x 10) + 2(30 x 2) + 2(10 x 2)

A = 600 + 120 + 40

A = 760 cm^2

$$T = m\left(\frac{V}{A}\right)^2 \quad , \quad T = 4.0\left(\frac{600}{760}\right)^2$$

T = 2.49 min.