EX:- Calculate the SDAS (and the tensile strength you expect) to find at the center) of an aluminium alloy casting with dimensions 25 mm X 200 mm X 300 mm. The mould constant in Chvorinov's rule for aluminum alloys is 0.072 min mm^{-2}.

Ans : $V_{casting} = (25)(200)(300) = 15 \times 10^5 \ mm^3$

$A_{casting} = (2)(25)(200) + (2)(25)(300) + (2)(200)(300)$

$= 1.45 \times 10^5 \ mm^2$

From Chvorinov's rule

$$t_s = B\left(\frac{V}{A}\right)^2$$

$$= 0.072\left[\frac{15 \times 10^5}{1.45 \times 10^5}\right]^2 = 7.7 \ min$$

$$= 462 \ s$$

$$SDAS = (8 \times 10^{-3})\, t_s^{0.42}$$

$k = 8 \times 10^{-3} \ mm$

$n = 0.42$

$$= (8 \times 10^{-3})(462)^{0.42}$$

$$= 105 \times 10^{-3} \ mm$$

$$= 0.105 \ mm$$

tensile strength = 270 MPa (from fig 9)

Ex- Three pieces of metal being cast have the same volume, but different shapes. One is a sphere, one a cube, and one a cylinder with a height equal to its diameter. Which piece will solidify the ~~fs~~ faster, and which one will solidify the slowest?

Sol^n: Since all three pieces ~~has~~ have the same volume, we can just set this volume at unity. So

$$\text{Solidification time} \propto \frac{1}{(\text{surface area})^2}$$

The respective surface areas are calculated as follows

sphere: $V = \frac{4}{3}\pi r^3$ so $r = \left(\frac{3}{4\pi}\right)^{1/3}$ thus $A = 4\pi r^2 = 4\pi\left(\frac{3}{4\pi}\right)^{2/3} = 4.84$

cube: $V = a^3$ so $a = 1$ thus $A = 6a^2 = 6$

cylinder: $V = \pi r^2 h = 2\pi r^3$ so $r = \left(\frac{1}{2\pi}\right)^{1/3}$ thus

$$A = 2\pi r^2 + 2\pi r h = 6\pi r^2 = 6\pi\left(\frac{1}{2\pi}\right)^{2/3} = 5.54$$

therefore the respective solidification times are

$t_{sphere} = 0.043C$ $\quad t_{cube} = 0.028C$ $\quad t_{cylinder} = 0.033C$

Therefore, the cube-shaped casting will solidify the fastest, and the sphere shaped casting will solidify the slowest.

Cooling Curves :-

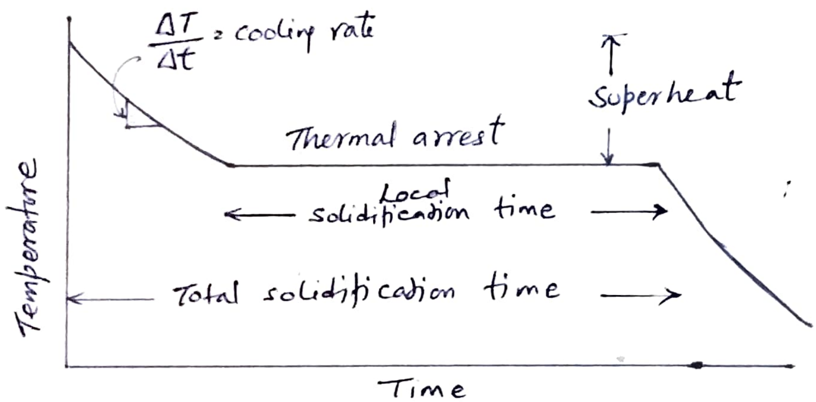
We can summarize our discussion to this point by examining a cooling curve, or how the temperature of the metal changes with time (fig 10).

The liquid metal is poured into a mold at the pouring temperature.

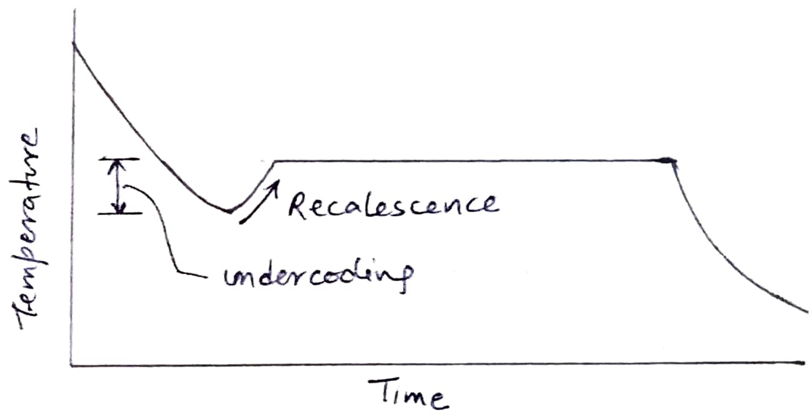
The difference between the pouring temperature and the freezing temperature is the superheat.

The liquid metal cools as the specific heat of the liquid is extracted by the mold until the liquid reaches the freezing temperature.

The slope of the cooling curve before solidification begins is the cooling rate $\Delta T / \Delta t$.



(a)



(b)

Fig 10 : cooling curves for (a) liquids that nucleate with no undercooling and (b) liquids that require large undercoolings for nucleation.