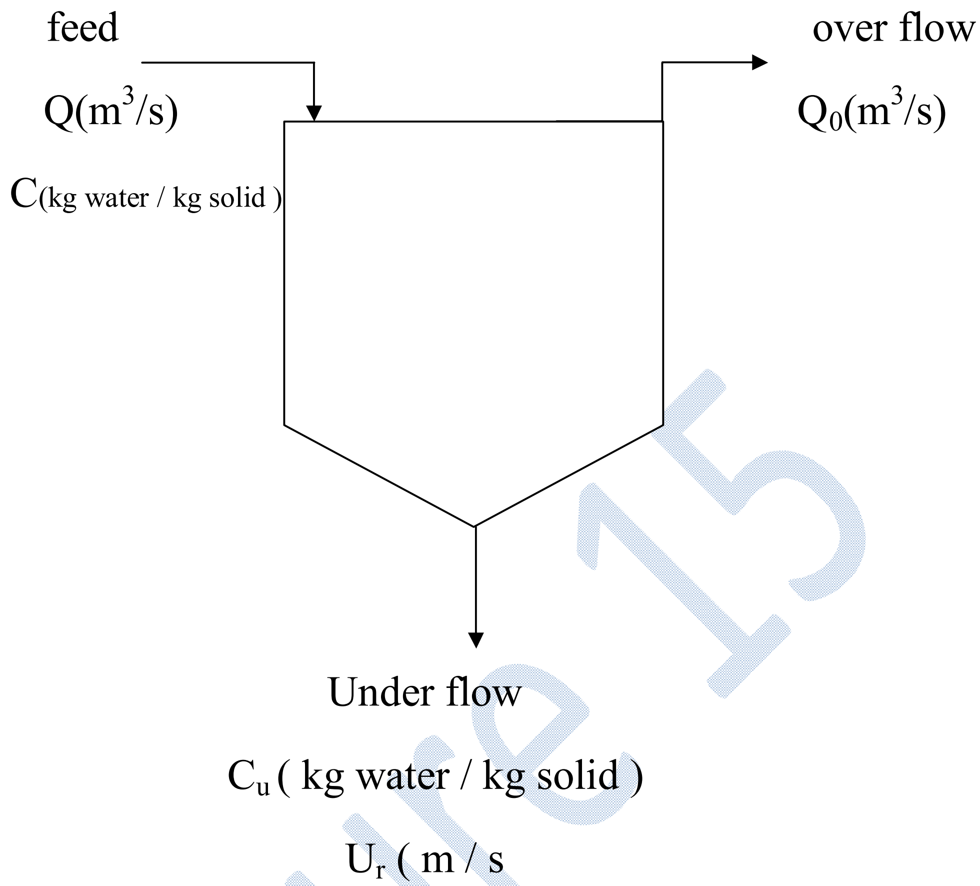

$q = (U_c + U_r)A_c$ (1)

Where :

U_c : is the sedimentation velocity at cen. (C) in a batch sys.

In the under flow , the corresponding relation is

$q = (U_u + U_r) A\, C_u$ (2)

where :

C_u : is the cen. in the under flow

U_u : is the sedimentation velocity at a cen. C_u in a batch sys.

From eq.(2)

$$U_r = \frac{q}{AC_u} - U_u \qquad (3)$$

Sub. In eq. (1) :

$$q = (U_c + \frac{q}{AC_u} - U_u)A_c$$

$$\frac{q}{A} = \frac{U_c - U_u}{\left(\frac{1}{c}\right) - \left(\frac{1}{c_u}\right)} \qquad (4)$$

If the sedimentation rate in the under flow is small compared with that in the settling zone (i.e. $U_u << U_c$)

$$\frac{q}{A} = \frac{U_c C}{1 - \left(\frac{C}{C_u}\right)} \qquad (5)$$

Thus if suspension of cen. (C) is fed to the tank at a volumetric rate Q :

Solid input = $Q_c = \frac{AU_cC}{1-\left(\frac{C}{C_u}\right)}$ eq. (5)

Thus

$$\left(\frac{C}{C_u}\right) = 1 - \frac{U_c A}{Q} \qquad (6)$$

The liq. Flow rate in the overflow Q_0 is the difference between the feed rate to the thickener and the rate at which sitkaves with under flow

Thus :

$$Q_0 = Q\,(1 - C) - Q_c\left(\frac{1-C_u}{C_u}\right) \qquad oR \quad \frac{Q_\circ}{Q} = 1 - \frac{C}{C_u}$$

From eq. (6)

$$A = \frac{Q}{U_c}\left(1 - \frac{C}{C_u}\right) \qquad \text{area of thickener} \qquad (8)$$

Interns of the mass ratio of liq. To solid in the feed (Y) and the corresponding value (U) in the under flow

$$Y = \left(\frac{1-C}{C}\right)\frac{\rho}{\rho_s} \qquad and \quad U = \left(\frac{1-C_u}{C_u}\right)\frac{\rho}{\rho_s}$$

Then

$$C = \frac{1}{1+Y\left(\frac{\rho_s}{\rho}\right)} \;, C_u = \frac{1}{1+U\left(\frac{\rho_s}{\rho}\right)}$$

and

$$A = \frac{Q}{U_c}[1 - \frac{1+U\left(\frac{\rho_s}{\rho}\right)}{1+Y\left(\frac{\rho_s}{\rho}\right)}]$$

$$A = \frac{Q(Y-U)\rho_s}{U_c\,\rho}$$

The value of (A) should be calculated for the whole range of cen.s present in the thickener and the design should then be based on the max. value so obtained .

EXAMPLE

A continuous separating tank is to be designed to follow after a water washing plant for liquid oil. Estimate the necessary area for the tank if the oil, on leaving the washer , is in the form of globules 5.1×10^{-5} m diameter , the feed concentration is 4 kg water to 1 kg oil , and the leaving water is effectively oil free . The feed rate is 1000 kg/h , the density of the oil is 894 kg/m^3 and the temperature of the oil and of the water is 38°C. Assume Stokes' Law .

Viscosity of water = 0.7×10^{-3} N s/m^2

Density of water = 1000 kg/m^3

Diameter of globules = 5.1×10^{-5} m

$$V_m = \frac{{D_p}^2 g(\rho_p - \rho_c)}{18\mu}$$

$V_m = (5.1 \text{ x } 10^{-5})^2\times9.81\times(1000 - 894)/(18\times0.7\times10^{-3})$

$V_m = 2.15\times10^{-4}$ m/s = 0.77 m/h

since F = 4 and U = 0,

Q = flow of minor component = 1000/5 = 200 kg/h ;

A = 4×200/(0.77×1000) = 1.0 m^2