THICKENER DESIGN

A continuous thickener is to be designed to deal with the effluent from the last question. It will treat 1000 m^3 per day of suspension fed at 3% v/v solids concentration and is to discharge underflow at 13.8% v/v solids. Use the settling curve and the following relation:

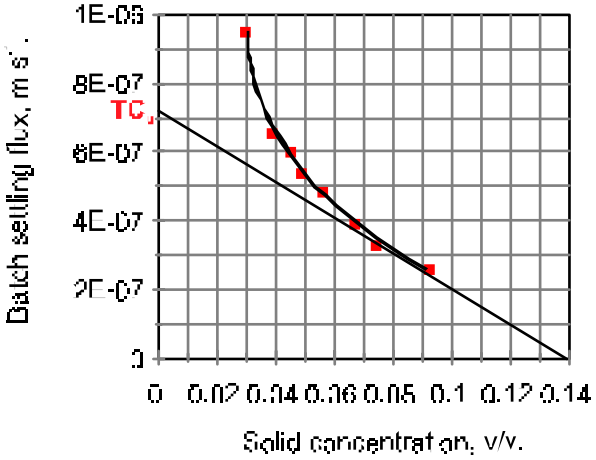
$$C_0 H_0 A \rho_s = C_1 H_1 A \rho_s$$

to complete the following table.

Concn (v/v):	0.03	0.039	0.045	0.049	0.056	0.067	0.074	0.092
Height for H_1 (cm)	28	21.5	18.7	17.1	15	12.5	11.4	9.1
Velocity (m s^{-1}):	3.2×10^{-5}	1.7×10^{-5}	1.3×10^{-5}	1.1×10^{-5}	8.6×10^{-6}	5.8×10^{-6}	3.5×10^{-6}	2.1×10^{-6}
Batch flux (m s^{-1}):	9.5×10^{-7}	6.5×10^{-7}	6×10^{-7}	5.4×10^{-7}	4.8×10^{-7}	3.9×10^{-7}	3.3×10^{-7}	2.7×10^{-7}

note that the batch flux is the product of the settling velocity and the solid concentration

Plot the batch flux curve below.



Now a flux balance on a thickener provides the following result:

$$A(TC_u) = FC_0 = YC_u$$

where A is the thickener area, (TC_u) is the critical thickener flux which is the intercept of a line drawn as a tangent to the batch flux curve and going through the desired underflow concentration, F and Y are the volume feed and underflow rates respectively, C_0 and C_u are the volume fraction feed and underflow concentrations respectively.

Note that T is, in effect, the velocity of solid movement in the thickener caused by underflow withdrawal at the solid concentration C_u.

The critical flux in this thickener giving an underflow discharge concentration of 13.8% v/v solids is (m s^{-1}):

a: 10×10^{-7} b: 8.5×10^{-7} c: 7.2×10^{-7} d: 5.8×10^{-7}

The minimum thickener area for this duty is (m^2):

a: 480 b: 29000 c: 16000 d: 960

If the thickener is circular in cross-section the minimum thickener diameter is (m):

a: 25 b: 190 c: 140 d: 35

The underflow rate is (m^3 $hour^{-1}$):

a: 1.25 b: 2.4 c: 4.6 d: 9.1

The overflow rate is (m^3 $hour^{-1}$):

a: 40.4 b: 39.3 c: 37.1 d: 32.6

An existing 5m diameter thickener is to be used to thicken 2400 tonnes per 24 hours of flocculated slurry containing 10% solids by mass (0.037 v/v) in water. The density of the solid is 2900 kg m^{-3}. The following batch sedimentation results were obtained:

Time (mins):	0	2	4	6	8	10	12	20	30
Interface height (cm):	45.6	36.5	28.0	21.6	16.8	14.5	13.2	10.6	9.7

What will be the underflow concentration? (Ans 19% by **mass**)

Calculate TC_u from operating data and draw a tangent to batch flux curve to give 0.075 v/v which converts to 0.19 by mass or 19%. Note flux theory is useful in predicting the behaviour of existing thickeners under differing operating conditions, not just for "paper" designs.