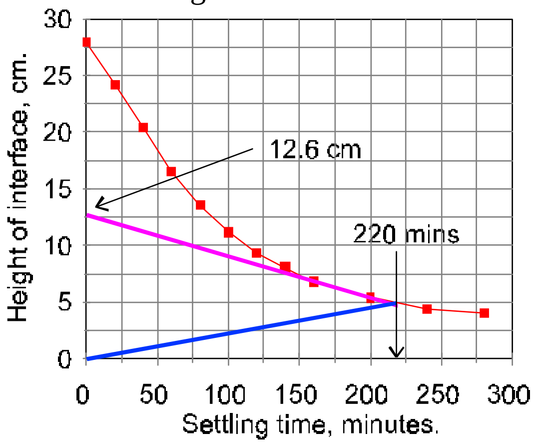
A 3% v/v suspension is to be settled in a batch settling tank prior to water reuse within a process. A sample of the suspension settled with a clear interface when placed in a 1000 ml measuring cylinder. The batch settling curve was as follows:

Time (mins):	0	20	40	60	80	100	120	140	160	200	240	280
Height (cm):	28	24.2	20.4	16.5	13.6	11.2	9.4	8.1	6.8	5.4	4.4	4.0

Plot the settling curve below.



ii). It is proposed to operate the settling tank as follows: on day 1, 1000 m^3 of suspension is run into the tank and allowed to settle, 85% **of the liquid**, i.e. ***not*** including the solids, is recycled to the process on day 2 just prior to running a further 1000 m^3 of suspension into the tank. On day 3 the same amount of liquid is recycled, prior to receiving a further 1000 m^3 of suspension. On day 4 the same amount of liquid is recycled, and the remaining sediment is run off to further processing prior to discharge. The tank is then remployed receiving suspension as per 'day one' above. The total volume of water recylced to the process from day 1 to 4 is (m^3):

2470

The total solid volume in the tank after day 3 is (m^3):.........90........
The total liquid volume in the tank PRIOR TO REMOVAL ON DAY 4 is (m^3):.......1260...........

(THE TANK DESIGN IS NOW BASED ON WHAT HAPPENS ON DAY 3)

iii) It may be assumed that the action of adding suspension on day 3 completely mixes the tank to give a homogeneous suspension leading to a tank solid concentration of (v/v):

a: 6.7 b: 3.0 c: 9.0 d: 7.1

iV) .It is possible to write a mass balance relating the height (H_f) of a uniformly mixed suspension of one concentration (C_f) to the height (H_1) and concentration (C_1) of the **same mass** of solids but mixed to an alternative concentration, as follows:

$$C_f H_f A\rho_s = C_1 H_1 A\rho_s$$

where A is vessel area and ρ_S is the solid density. Thus you have been given the settling data for a 3% v/v suspension above which needs to be converted into settling data at the concentration determined in Question **(iii)**; the height (H_1) required in the above equation is (cm):

a: 28.0 b: 9.3 c: 12.6 d: 14.0

v). Take a ruler and draw a line from the height determined in (iv) making a tangent to the settling curve plotted above. You have now obtained a settling curve for a uniform suspension of the concentration given in (iii). NOTE THAT SETTLING RATE IS INDEPENDENT OF VESSEL DIAMETER (but depends strongly on suspension concentration), hence the settling curve obtained in a 1000 ml measuring cylinder will be the same as that obtained in a large process vessel.

vi). As settling rate is independent of vessel diameter one design is to construct a vessel of height given in (iv). The total vessel volume would need to be sufficient to accommodate the volumes given at the end of (ii). This would make the vessel area (m^2):

a: 4825 b: 1070 c: 48250 d: 10700

vii). At the end of the settlement period, i.e. on day 4 after pumping the supernatant but before pumping the sediment out, the volume of sediment is (m^3):

a: 90 b: 527 c: 437 d: 1351

viii). Hence, given the vessel area from (vi), the height required for the sediment is (m):

a: 0.049 b: 129 c: 0.129 d: 0.00013

ix). Draw a line from the origin of your settling graph to meet the settling curve at the height given in Q.8. This occurs at the time (minutes):

a: 80 b: 160 c: 220 d: 280

You have now completed one design for this settling vessel: the height comes from (iv), the area from (vi), and the time required to settle from (ix).

x). Comment below on your design:

Too wide and short to practically build and operate - so MUST therefore leave to settle longer and design a narrower and taller tank - assume 24 hours is the longest it can settle.

xi). The line you have just drawn from the origin to the settling curve represents a 'solid characteristic' at a concentration greater than that given in (iii). It can be used to provide another vessel design. Assuming that the maximum permissible time for settling is 24 hours, the height of this characteristic after 24 hours is (cm):

a: 12.6 b: 28.0 c: 32.0 d: 56.0

xii). Assuming that this height again represents the depth of sediment in the vessel, the new vessel area required to accommodate the total sediment on day 4 is (m^2):

a: 1650 b: 3290 c: 6590 d: 13200

xiii). Under these conditions the new vessel height will be (m):

a: 4.02 b: 2.17 c: 0.82 d: 0.28

xiv). Explain below how other characteristics can be used to provide alternative designs:

We could have used any characteristic propagating from the origin and any time up to the maximum value. However, the above design is the narrowest and tallest; tanks tend to be wide and short. Additional height is added for solid storage and to reduce turbulences but the key design parameter is the plan area. It is still not a particularly practical design – hence we should investigate altermatives and Question (2) look at continuous settling for this effluent.