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Short Report

Experiment (7) :Gravity Sedimentation

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Abstract

Gravity Sedimentation is one of the most common methods used to separate solid particles from a liquid. Since this method depends on the gravity force it is relatively cheap and simple, and its used wildly in waste water treatment plants and other industries. In this experiment the particles concentration effect on a batch sedimentation is being investigated. The results of this experiment could be helpful in designing a thickener / clarifier unit.

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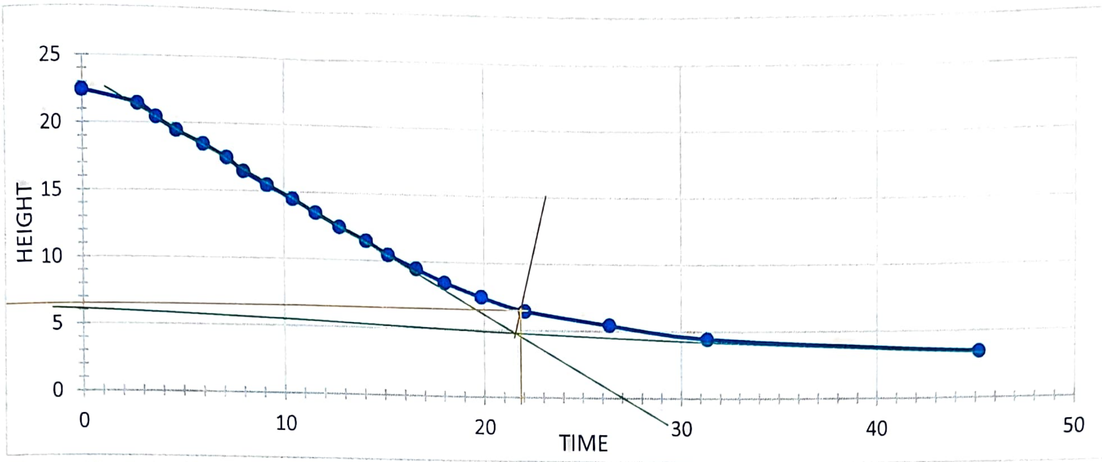
Results:

Table (1): Results of calculations

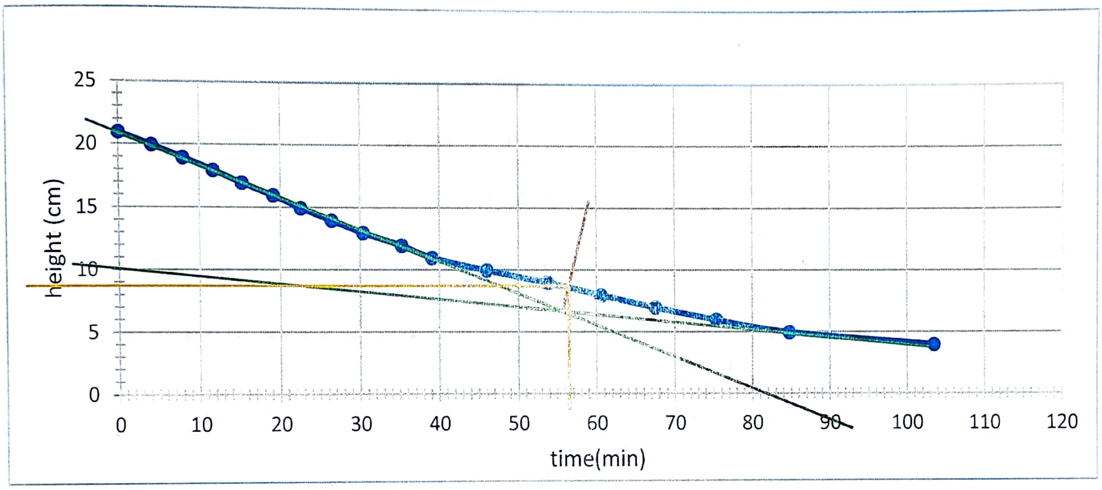
initial concentration (Co)	g/L	100	150	200
initial height	cm	22.5	21	20
critical time (tc)	min	21.65	56.4	96
critical height(Zc)	cm	6.8	8.8	9.1
settling velocity(Uc)	cm/min	0.0314	0.0156	0.0948
Zi	cm	13.6	17.6	18.2
critical concentration (Cc)	g/L	65.441	179.877	173.077
$Z\,min$	cm	8.9	3.4	2.8

Table(2): Calculations for the minimum area of a thinker

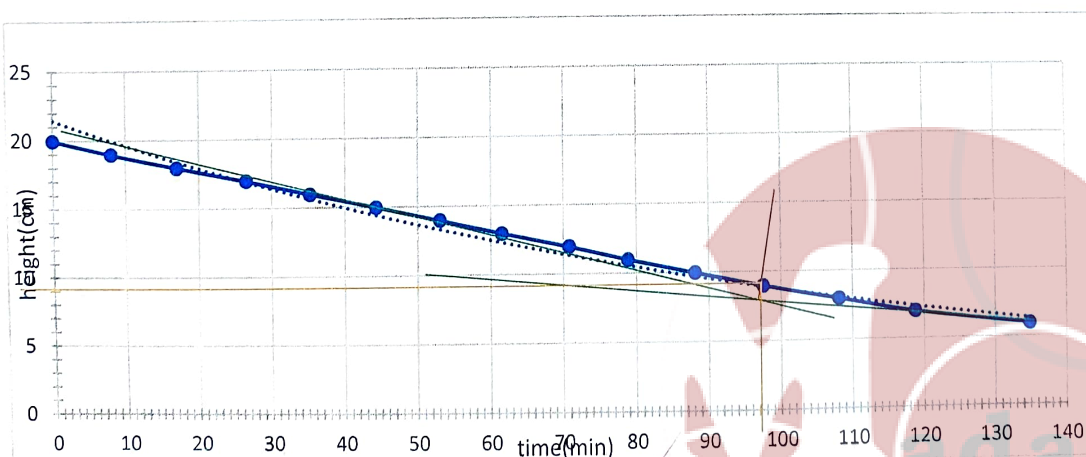
Volumetric rate per unit area at which thickened suspension is withdraw (Uc)	cm/min	0.0948
The volumetric concentration of solids in feed (Co)	g/L	200
The volumetric concentration of solids in the thickened sludge (Cu)	g/L	700
The volumetric critical concentration of solids (Cc)	g/L	173.0769
The volumetric feed rate of suspension (Qo)	L/day	$3.785*10^6$
	L/min	2628.472
Minimum Area (A_{min})	cm^2	24119.77
	m^2	2.4419



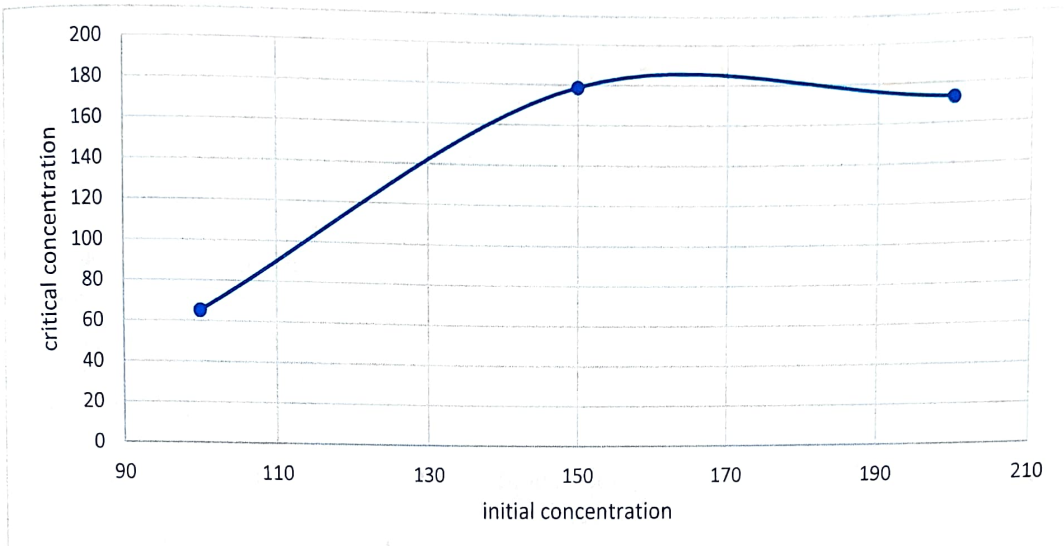
Figure(1):Interface profile of 100g/L concentration sample



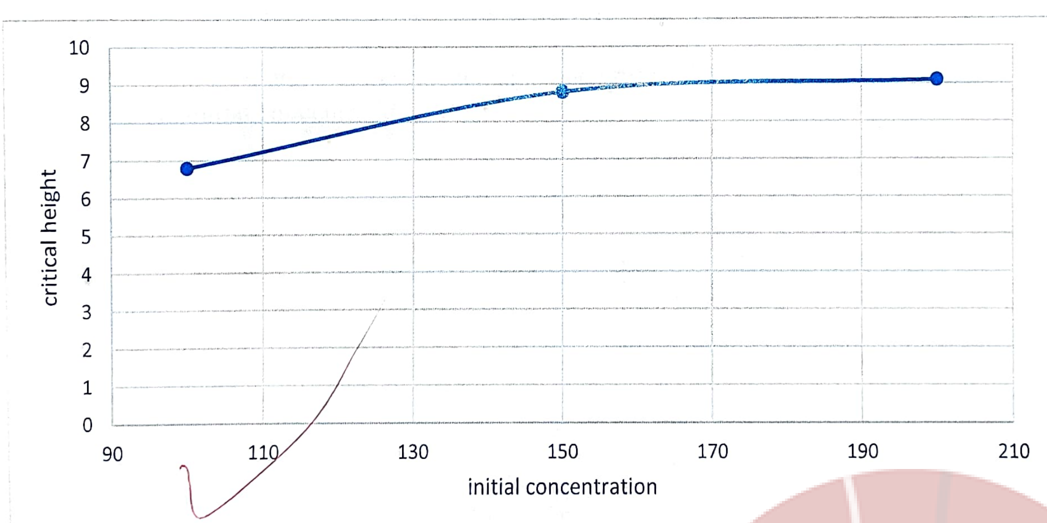
Figure(2): Interface profile of 150g/L concentration sample



Figure(3): Interface profile of 200g/L concentration sample



Figure(4) : Initial concentration vs critical concentration



Figure(5) : Initial concentration vs critical height

Discussion:

The Sedimentation describes the motion of particles in suspensions in response to an external force that is gravity in this experiment, and that results to a clear fluid and slurry of higher solids content is called sedimentation.

In the sedimentation process four layers can be observed , A is clear liquid, B is suspension of the original concentration, C is a layer through which the concentration gradually increases, and D is sediment.

When the particles are dropping into a column of fluid an interface between the clear liquid and the suspension appears ,and it starts immediately to accelerate to some velocity and continues falling through the fluid at that velocity, as a layer of sediment builds up at the bottom of the container. The slope of the steady interface subsidence rate represents zone settling velocity.

The velocity of the interface changed with time as compression begins, and as the interface was getting closer to the sediment layer the particles were getting closer to each other that they were colliding and pushing each other and make it harder for the fluid to move upward as the particles layer was settling. The settling velocity decrease until this interface approaches the layer of sediment, thus, the "critical settling point" is reached when a direct interface is formed between the sediment and the clear liquid.

In this experiment the only factor effecting the settling velocity is the initial suspended solids concentration, the higher the suspended solids concentration the more difficult it is to pass water through the pore spaces in the settling matrix.

As shown if figure 4 and 5 both critical height and critical concentration increases by increasing the initial concentration

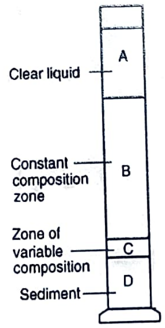


Figure (6): Sedimentation layers

Conclusion

- Settling time was increase at first, then slowly decline, reaching a constant value. This was due to the particles that grouped together, causing slower particle settling rates.
- Higher concentration suspensions needed more time to settle
- The sedimentation is used to get rid of large impurities, its not effective in removing small particles (colloids).
- The sedimentation process could be used to determined the height and the area of the thickener /clarifies unit

References

1.Coulson and Richardson's (2002) ,Chemical Engineering Volume 2"Particle Technology and Separation Processes ",5th Edition, by Butterworth Heinemann Inc

2.McCabe and Smith,(1993)." Unit Operations of Chemical Engineering ", international 5th edition. by The McGraw-Hill Inc.

Appendix

sample (1)

initial values

$Co = 100\ g/L$

$Zo = 22.5\ cm$

From figure to determining critical values (time& height) using kynch method:

$Critical\ time\ (tc) = 21.65 min$

$Critical\ height\ (Zc) = 6.8\ cm$

$$Critical\ velocity\ (Uc) = \frac{Critical\ height\ (Zc)}{Critical\ time\ (tc)} = \frac{Zi - Zc}{tc} = 0.3141\ cm/min$$

$Zi = ZC + UC * tc$

$Zi = 6.8 + 0.3141 * 21.65 = 13.6\ cm$

$Critical\ concentration\ (Cc) = (Co * Zo)/Zi$

$Cc = (100 * 22.5)/13.6 = 165.4418\ g/L$

$Z\ min = Zo - Zi = 22.5 - 13.6 = 8.9cm$

Calculations for the minimum area of a thinker

The volumetric feed rate of suspension (Qo)= $3.785*10^6\ \frac{L}{day}$

$$Qo = 3.785 * 10^6 \left(\frac{L}{day}\right) * \frac{day}{24\ h} * \frac{h}{60\ min} = 2628.472 \frac{L}{min}$$

The volumetric concentration of solids in feed $(Co) = 200 \frac{g}{L}$

The volumetric concentration of solids in the thickened sludge (Cu)= $700 \frac{g}{L}$

The volumetric critical concentration of solids (Cc)= $173.0769 \frac{g}{L}$

Volumetric rate per unit area at which thickened suspension is withdraw $(Uc) = 0.0948 \frac{cm^2}{min}$

Minimum Area (A_{min})= $\frac{Q0\ C0}{Uc}\left(\frac{1}{Cc} - \frac{1}{Cu}\right) = \frac{2628.472 * 200}{0.0948}\left(\frac{1}{173.0769} - \frac{1}{700}\right) = 24119.77 cm^2 = 2.4119\ m^2$

شدة نور سحر ليلى تالين

gravity Sedimentation Data Sheet

height	conc = 100 g/L	conc = 150 g/L	conc = 200 g/L
−1	0:02:45	00:04:05	00:08:00
−1	00:03:40	00:07:56	00:17:00
(1 cm drop)	00:04:40	00:11:39	00:26:30
	00:06:00	00:15:12	00:35:11
	00:07:10	00:19:05	00:44:15
	00:08:00	00:22:30	00:53:00
	00:09:10	00:26:22	01:01:30
	00:10:26	00:30:19	01:10:44
	00:11:34	00:35:11	01:18:50
	00:12:45	00:39:01	01:28:07
	00:14:05	00:45:58	01:37:30
	00:15:10	00:53:42	01:48:06
	00:16:35	1:00:30	01:58:45
	00:18:10	1:07:30	02:14:50
	00:19:50	1:15:20	
	00:22:21	1:24:45	
	00:26:20	1:43:28	
	00:31:20		
	00:45:10		

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