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Study on Settling Characteristics of Particles

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1. Introduction

In this paper, it was observed that the settling of particle depends on shape in accordance with its shape factor. The settling of particle also depends on the fluid in which the settling is observed. The experiment was done so as to observe the settling velocity of particles of different shape such as cubical, cuboidal, trapezoidal, triangular and spherical. Different fluids such as water, kerosene and paraffin oil were taken as the medium. It was observed that the settling velocity of particle depends on type of fluid/medium. The settling was observed under two different kinds (viz. hindered settling and non-hindered settling) and it was found that particle settling velocity was different for both cases. The formula of settling velocity under different conditions was used so as to compare the theoretical and experimental values of settling velocities.

2. Theory

Settling is the process by which particulates settle to the bottom of a liquid and form sediment. Particles that experience a force, either due to gravity or due to centrifugal motion will tend to move in a uniform manner in the direction exerted by that force.

The free fall of particles through fluid media is known as free settling. Stokes, transitional and Newtonian settling describes the behavior of a single spherical particle in an infinite fluid, known as free settling.

The total amount of force exerted on a particle can be broken down into four categories.

Acceleration = Gravity Force - Force due to Buoyancy Force - Drag

For a particle, there are two stages when it falls. The acceleration stage and then the stage of constant velocity, also known as the terminal velocity *or* free settling velocity.

Buoyant Force and Drag Force

$$F_G = (\rho_P - \rho) g V_p \quad F_D = \frac{C_D A_P \rho v_s^2}{2}$$

$$v_s = \sqrt{\frac{2(\rho_P - \rho) g V_p)}{C_D A_P \rho}} \qquad C_d = \frac{F_d}{\frac{1}{2}\rho f U^2 A}$$

2.2.2 Hindered settling:-

The interaction of particles within the fluid, or the interaction of the particles with the container walls can modify the settling behaviour. Settling that has these forces in appreciable magnitude is known as hindered settling.

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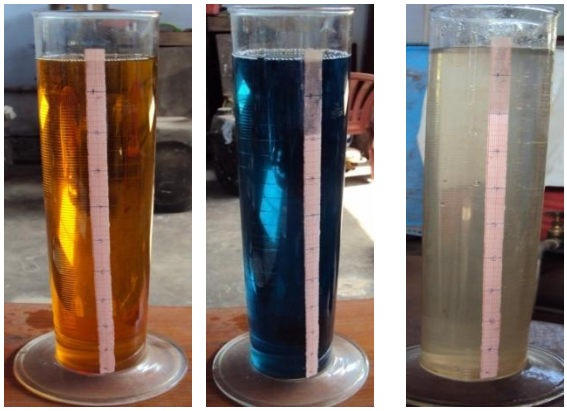
3. Experimental Setup:-



Figure(3.1) Densities of liquids:(a) Paraffine (1 gm/cc), (b) Kerosene (0.8239 gm/cc), (c) Water (0.793 gm/cc)

Figure(3.2) Different shape of glass particles

4. Result and Discussion:-

The terminal velocity and hindered settling velocity of different shape particle was calculated by the known formula. The experimental value of terminal velocity was obtained for different shape particle. Calculated terminal velocity was compared with obtained experimentally. The results were very similar with a very little difference in their experimental and calculated velocities. Hindered settling velocities were obtained for different shape particles..Various parameters like void fraction, porosity etc were calculated for hindered settling velocity of different shape particles. Calculated and experimental velocities were compared during hindered settling. Graph between terminal velocity and shape factor were plotted.

Table(4.1) HINDERED SETTLING FOR WATER

% Settled	Cube	Cuboidal	Triangular	Trapezoidal	Sphere
50%	4.0/10	5.0/10	6.5/10	7.5/10	3.0/10
100%	11.0/10	10.0/10	9.0/10	11.0/10	6.0/10

Table(4.2) HINDERED SETTLING FOR KEROSENE

% Settled	Cube	Cuboidal	Triangular	Trapezoidal	Sphere
50%	6.0/10	4.5/10	5.0/10	4.0/10	2.5/10
100%	9.0/10	8.0/10	8.5/10	6.0/10	5.0/10

Table(4.3) HINDERED SETTLING FOR PARAFFINE

% Settled	Cube	Cuboidal	Triangular	Trapezoidal	Sphere
50%	4.5/10	4.0/10	4.5/10	5.0/10	3.5/10
100%	10/10	8.5/10	10.0/10	7.0/10	7.5/10

Table(4.4) EXPERIMENTAL HINDERED SETTLING VELOCITY

Particles	Water (cm/sec)	Kerosene (cm/sec)	Paraffine (cm/sec)
Cube	27.2727	33.3333	30.0000
Cuboidal	30.0000	37.5000	35.2941
Triangular	33.3333	35.2941	30.0000
Trapezodial	29.2929	50.0000	42.8571
Spherical	50.0000	60.0000	40.0000

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5. Conclusion:-

It was observed that the settling velocity of particle depends on the shape factor of the particle. The settling velocity has different value for different shape factor particle. The settling velocity also comes out to be different with different fluid in which settling was observed. The maximum hindered settling velocity for spherical in kerosene and minimum for cube in water. The settling does not comes out to be linear with time rather it varies with some non linearity with time. Rate of settling also depends on hindered as well as non hindered settling.

6.References

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