# Measurements on falling spheres in viscous medium.

Salman Al-Samiri/student id:2391105

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**Objectives of this lab:**

First step is to establish the relationship that exists between the terminal velocity and radius of a sphere, and to be able to calculate the relation we need to use Stokes’s law. Then to calculate the value for the coefficient of viscosity of glycerol using Stokes’s method. And the final step is to investigate the wall effect using the Ladenberg correction factor.

**Background and introduction for the lab:**

The name of the experiment is the measurements of a falling spheres in a viscous medium. The experiment aims to calculate the difference in terminal velocity of spheres moving through a tube filled with a viscous medium.

To do the experiment we need to calculate:

* the weight of the sphere (weight=mass\*acceleration of gravity)

but in the experiment, we are calculating the weight force and how it relates to the effect of buoyancy force and friction

And if the force of the weight is higher the sphere sinks and if the buoyancy force is bigger than the sphere float, and third possibility that if net force =0 then the sphere does not move at all from it is position.

* the density of the liquid (density=mass/volume),
* the volume of the cylinder we are using (volume=3/4\*πpie\*height\*radius),

* the buoyancy forces

(buoyancy force= volume \*density\*force of gravity),

* the drag force (drag force= ½ \*density\*velocity\*area\*drag coefficient),
* stokes’ law (force= 6\*pieπ\*coefficient of viscosity\*radius \*velocity)
* the terminal velocity (terminal velocity =density of the sphere\*volume\*acceleration of gravity-volume\*density of the fluid\*acceleration of gravity / 6\*pieπ\*coefficient of viscosity\*radius of the sphere)

And to since the volume of the sphere =

The terminal velocity can be found using much simpler steps

First, we extract volume and acceleration of gravity, so we can replace the volume of the sphere part of the equation

Then we divide the pies out of the equation and subtract the power of the radius to be reduced from radius cubed to radius squared

Next, we multiply the denominators together, so it be much simpler to use

The difference in the metallic spheres radius and weight will give different results for the volume, which will be changing the bouncy force, also that show how there will be a list of different results showing the relativity of the volume of metallic spheres to the terminal velocity. The bigger the radius of the metallic sphere the higher the terminal velocity is, and the viscous the medium is the stronger the force of friction is causing the sphere to slow as it sink during it is acceleration within the fluid.

**Experiment procedure:**

First, we will be in need for an object for example a glass tube, then to fill it with a viscous liquid such as corn syrup, food oil or as we used in this experiment a long glass tube filled with glycose.

Second step in the experiment is to prepare the other tools we need for the experiment such as:

* A board marker to draw the lines for the traveling distance of the sphere inside the tube.
* A timer to calculate the time the sphere will take inside the tube between point A and point B.
* Number of different metallic spheres in both size, radius and weight (6 metallic spheres).
* A note book or a board to record the results.

Third step was to take the measurements that we listed above in the background. We write down the numbers of the volume of each metallic sphere, the density of the fluid along with it is viscosity, after that we are done with the other needed measurement such as the length of the tube and the density of glycerol we move to next step.

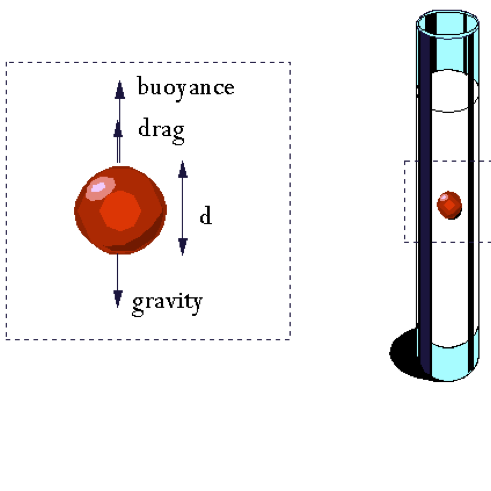
Fourth step is to calculate the different measurement between the six metallic spheres we got, we check on the room temperature, since both density and viscosity get effected by the surroundings temperature.

Final step is to start the experiment by drawing the line on the tube and setting the timer for each of the six metallic spheres we have. This will give us a table of different terminal velocity of each metallic sphere concluding in a graph of the experiment.

A drawing of a cartoon character

Description generated with high confidence

(Allah 2013)



(http://hmf.enseeiht.fr/travaux/bei/beiep/book/export/html/2534 n.d.)

**Results:**

Room temperature

Density of glycerol

Internal Diameter of the tube:

Distance between markers:

Density of sphere

Acceleration due to gravity

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Number of experiment** | **Diameter of the still sphere**  **D/ mm +/- 0.005 mm** | **Radius of the sphere a/m** | **Time of Descent/ s** | ***Mean time*/ s** | **Terminal Velocity (m/s)** | **a^2/m^2** |
| 1 | 11.98 | 0.00599 | 2.61 | 2.650 | 0.205 | 3.588 |
|  |  |  | 2.69 |  |  |  |
| 2 | 6.345 | 0.003173 | 5.89 | 5.815 | 0.093 | 1.006 |
|  |  |  | 5.74 |  |  |  |
| 3 | 4.985 | 0.002493 | 13.77 | 13.560 | 0.040 | 0.621 |
|  |  |  | 13.35 |  |  |  |
| 4 | 2.987 | 0.001494 | 21.82 | 22.003 | 0.025 | 0.223 |
|  |  |  | 22.33 |  |  |  |
|  |  |  | 21.86 |  |  |  |
| 5 | 1.52 | 0.00076 | 79 | 78.000 | 0.007 | 0.058 |
|  |  |  | 77 |  |  |  |

it is in the same form of linear equation.

m =

when m = 6267.3

units:

Pa\*s =

N/ . s =

Kg\*m/. s

=

* The relationship between terminal velocity and radius squared [the wall effect]

**Calculation:**

it is in the same form of linear equation.

m =

when m = 6267.3

units:

Pa\*s =

N/ . s =

Kg\*m/. s

=

* The relationship between terminal velocity and radius squared [the wall effect]

|  |  |  |  |
| --- | --- | --- | --- |
| Mean diameter (mm) | Radius (m) | Vinf (m/s) | Terminal velocity (m/s) |
| 11.98 | 0.00599 | 0.475707758 | 0.20844529 |
| 6.335 | 0.0031675 | 0.148042349 | 0.093379192 |
| 4.985 | 0.0024925 | 0.056444414 | 0.040044248 |
| 2.986 | 0.001493 | 0.029828391 | 0.024637024 |
| 1.52 | 0.000766 | 0.007178108 | 0.006542169 |

# Bibliography

Allah, Wessam E. Abd. 2013. *collecting and storing solar energy: solar pond technology.*

n.d. *http://hmf.enseeiht.fr/travaux/bei/beiep/book/export/html/2534.* Accessed march 13th , 2018. http://hmf.enseeiht.fr/travaux/bei/beiep/book/export/html/2534.