University of Anbar

College of Engineering

Chemical & Petrochemical Engineering

Oil properties Laboratory, 3rd stage 2023-2024

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Experiment No. 3:

Density and Specific Gravity (Hydrometer)

INTRODUCTION

Accurate determination of the density or specific gravity of petroleum and its products for the conversion of measure volumes at the standard temperature of 15°C, 20°C or 60°C and also volume to mass and vice versa. The hydrometer method is most suitable method for determining the density or relative density (specific gravity) of mobile transparent liquids. It can also be used for viscous oils by allowing sufficient time for the hydrometer to reach equilibrium or for opaque oils by employing a suitable meniscus correction. Hydrometer readings are obtained at convenient temperatures, reading of density being reduced to 15°C or 20°C. Specific gravity is the ratio of mass of a volume of a liquid at 60°F to the mass of an equal volume of pure water at the same temperature, i.e. the ratio of the density

of the liquid at 60°F to the density of water at 60°F. When reporting results of specific gravity, it is specific gravity 60° / 60°F.

The aim of this experiment

The objective of this exp. is to measure and study density and specific gravity of different liquids by using hydrometer. Moreover, it will provide sufficient information about light and heavy crude oils.

Theory

Hydrometer: is considered the simplest and the fastest method in determination of density and specific gravity of a liquid. The operation of the hydrometer is based on the Archimedes principle that a solid suspended in a fluid will be buoyed up by a force equal to the weight of the fluid displaced. Thus, the lighter the liquid (that is, the less its specific gravity), the deeper the body sinks because a greater amount of liquid is required to equal the body's weight. A hydrometer is usually made of glass and consists of a cylindrical stem and a bulb weighted with mercury or lead shot to make it float upright. The liquid to be tested is emptied into a tall container, often a graduated cylinder. The hydrometer is gently lowered into the liquid until it floats freely. The point at which the surface of the liquid touches the stem of the hydrometer is noted. Hydrometers usually contain a scale inside the stem, so that the specific gravity can be read directly.

Density of a liquid: is its mass per unit volume at a given temperature. Specific gravity of liquid (Sp. gr.): is the ratio of density of a substance (Liquid) compared

$$\rho = \frac{M}{V} = \frac{kg}{m^3} = \frac{lb}{ft^3} \qquad Sp.\ gr = \frac{\rho_{substance}}{\rho_{water}}$$

to the density of fresh water. The specific gravity of crude oil and its products are as follows:

	Specific gravity
Crude oil	0.80-0.97
Jet fuels	0.70-0.78
Gasoline	0.78-0.79
Kerosene	0.78-0.84
Gas oil	0.82-0.90
Diesel oil	0.82-0.92
Lubricating oils	0.85-0.95
Fuel oils	0.92-0.99
asphalts	1.00-1.10

The American Petroleum Institute gravity or API gravity: is a measure of how heavy or light petroleum liquid is compared to water. If its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks.

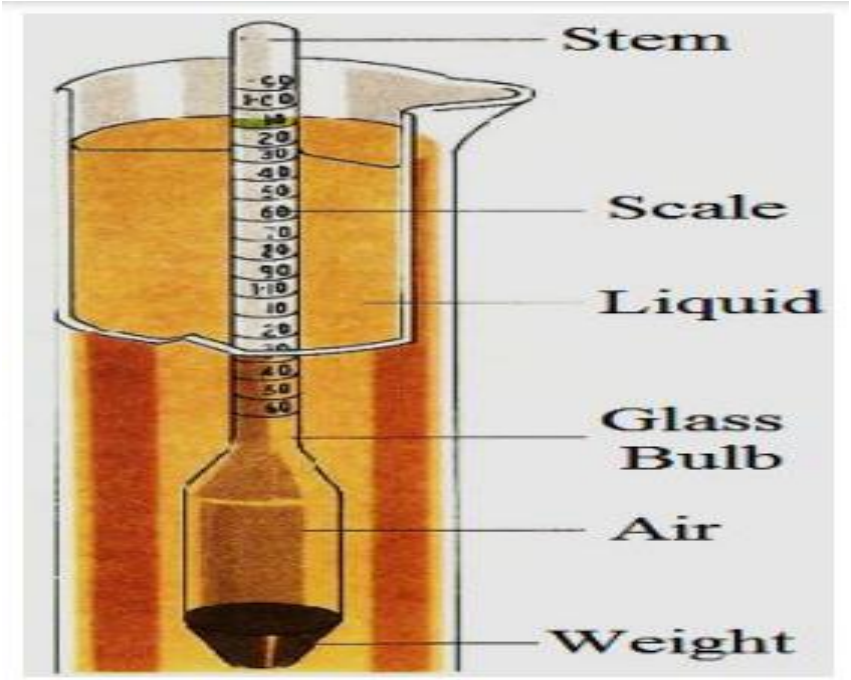
Thus:

Petroleum is lighter than water and floats: API gravity > 10

Petroleum is heavier than water and sinks: API gravity < 10

$$\mathbf{API} = \frac{\mathbf{141.5}}{\mathbf{sp.gr}\left(\frac{\mathbf{60}}{\mathbf{60}}\mathbf{F}\right)} - \mathbf{131.5}$$

A crude oil will typically have an API between 15 and 45 degrees. Higher API indicates a lighter (lower density) crude. Lower API indicates a heavier (denser) crude. Generally, lighter (high API) crudes are more valuable because they yield more high-value light products when they run through a refinery.

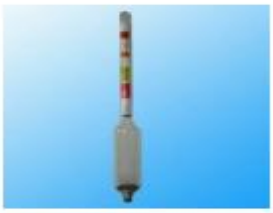


Hydrometer

1- liquid (Sample)

2- Thermometer

3- Graduated cylinder (bottle)



4- Hydrometer

5- Water Bath

Experimental Procedures:

a) Fill the cylinder with the test liquid.

b) Read the temperature of the liquid by the thermometer T actual

c) Down the hydrometer into the sample slowly and carefully

d) Keep the hydrometer floating in center of the cylinder and from the wall.

e) After stabilization of the hydrometer, note the point where the surface of the liquid touches the stem.

Calculations:

1- Calculate the sp.gr for crude oil.
2- Correct the sp.gr of crude oil to be at 15 C.
3- Calculate API for crude oil.

Discussion:

1- What is the significance of density and sp gr. test in oil industry field?
2- Define “HYDROMETER”?
3- What are the differences between density and relative density?
4- What are the differences between density and specific gravity?
5- What is the significant of API? Show the range for different petroleum product.
6- Discuss your results and observations. You should also write a brief summary of your work and results.