



Density

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Calibration, Certification & Repair from every angle

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Dense Thought

Imagine if our bodies were much more dense and compact than they are currently. Life would surely be different. We would have trouble floating in our pools, running would be an arduous task, but we would almost certainly have more strength as a result. Anything that contains matter, including the air you breathe has a density. And although you can follow the idea I just explained to you may not understand the basis of what density is and why it's important.

Indivisible

You may have seen a trick at some point in your high school career where a teacher took a container full of oil and water, then proceeded to shake it up violently. What you then would have witnessed would have been the oil and the water separating. Why did this happen? And what did the oil always do?

Those of you playing along probably said that the oil rose to the top and the water stayed on the bottom. The reason they separate after a violent mixing actually has more to do with the chemical makeup of each liquid, but one stays on top and the other stays on the bottom because of their relative densities. Oil is less dense than water so it sits on top. Even if you have the same amount of each fluid, the oil will always sit on top. The mass of the liquid or object is what gives it its density. If you have a liter of water and a liter of oil, the water will weigh more and as such will sink below the oil. Makes sense, right? Typically density is described as mass per volume (g/l , g/cm^3 , etc.) In the metrology world, dimensionless units are commonly used such as specific gravity (sg) and relative density (rd). The specific gravity scale is based on distilled water at 4°C . It breaks liquids into groups that are lighter and heavier than water.

Temperature Effects

The general answer to the question 'how does temperature affect density' is to say that the hotter something gets, the less dense it becomes. If we take a liquid at room temperature as an example, we can see that a gallon of that liquid takes up a certain amount of space (volume) and weighs a certain amount. Now let's say we boil that liquid in a closed pot. What happens? If we leave the pot closed, pressure will build up inside because the molecules of the liquid will be moving around rapidly and they create space between them when they do that. Did the mass of the water change? The law of the conservation of mass tells us there is still the same amount of mass inside the pot. However, as is fairly obvious, the liquid has become much less dense. It can also be generically said that when mass increases its volume it decreases its density.

What about Water?

The most unique liquid to use as reference when describing density and its components is distilled water. Although it's the easiest to visualize since everyone is familiar with the three physical states of water: solid (ice), liquid, gas (steam), it is unlike any other liquids known to man. As I previously have mentioned, when a mass cools it becomes denser, and as such, will have less volume. With water however, when it becomes a solid as it freezes, it actually becomes less dense. There are only a couple of known substances that do this such as germanium and silicon. Water is also unique in that it can decrease in density by about 4%

from when it is liquid to its boiling point and can decrease in density by about 9% from when it is a liquid to its freezing point!

The relationship of temperature to density of water is not a linear relationship. It becomes even less so when you add salt to it, which is what the majority of water on the Earth is. Will an egg float in salt water? The answer is yes, at some point the density of the saltwater would equal the density of the egg and it would actually float. The salinity of the ocean is not enough to float one, but it can be done and is done in science classes all the time.

Hydrometers

Tangent Labs has the ability to calibrate hydrometers which measure specific gravity, % salt, and many other density units.

Hydrometers are used in manufacturing of food products and also can be found in plants where hydraulic fluids and oils are either used in the manufacturing of a part or used to lubricate machines I think we're all glad that soda companies test their batches of cola for the proper amount of sugar and glad that milk producers check for creaminess, both of which are density measurements and both of which are usually done with a hydrometer. And believe it or not, hydrometers have been around since about the 5th century! They really haven't changed a whole lot in 2000 years either, which is pretty incredible.

If you're a winemaker or a home-brewer of beer, then more than likely you have a hydrometer in your possession. If you're in the petroleum industry, you probably have hydrometers all over the facility. They are an integral part of ensuring proper density of a multitude of fluids. And most don't know this, but they are also used in the density analysis of various clays and silts. Shows you how important proper density can be!