

Lesson: Temperature



In this lesson, you will be introduced to the following topics:

- Definition of density
- Factors that affect density
- Density water properties
- Density current
- The research findings of the seventeenth century scientist named Marsigli about his theory of a surface current and a deep undercurrent

Floating in the ocean is easier than floating in a lake because ocean water is denser than lake water.

Density is defined as mass per unit volume and is measured in grams per cubic centimeter (g/cm³).

Two factors that affect the density of water are salinity and temperature. Salinity, the amount of salt dissolved in water, is measured in parts per thousand (ppt). Temperature, a measure of the average kinetic energy of a substance, is measured in degrees Celsius.

You've probably been to an ocean beach in the summertime and stood neck-deep in the water. While you're standing there you suddenly feel cold water flowing over your lower body. From your feet to your knees the water feels icy cold and from your knees to your head the water feels warm.

You probably wondered what causes this to happen. What you felt were warm surface currents and cold deep currents. Changes in the density set these currents in motion. Some ocean currents are set in motion by the wind. Other ocean currents are created by something you can't see or feel. Differences in the density of water can also cause currents to form and move.

Density is affected by **temperature** and **salinity**. Cold water or water with dissolved salts (higher salinity) is denser than warm water or water without dissolved salts (low or no salinity). For example, at the same temperature (20°C) the density of salt water is 1.025 g/ml and fresh water 0.998 g/ml.

Density Water Properties

More dense (higher density) Cold water, Salt water
Less dense (lower density) Warm water, Fresh water

Less dense substance will always lie above a more dense substance. When you have water of two different densities meeting, the lower density (less dense) water will move on top of the higher density (more dense) water.

The different densities actually cause the water to move, forming a **density current**. In the oceans, the deep, bottom currents are colder and saltier than the surface currents. How did scientists ever figure out that this is how some currents were formed?

A seventeenth century scientist named Marsigli went to Constantinople to settle a dispute between fishermen about a deep current in the Bosphorus. Marsigli observed the Bosphorus and concluded that there was a surface current that flowed into the Mediterranean Sea from the Black Sea.

He designed an experiment to test his idea. He placed a rope deep enough in the water so that both the surface and deep currents touched it. The rope wouldn't stay straight but became tangled as if pulled in two directions. Marsigli's observations led him to believe there was a surface current and a deep undercurrent. The upper or surface current pulled the top of the rope in the direction of the Mediterranean Sea. The lower part of the rope went in the opposite direction towards the Black Sea.

Marsigli determined that the current changed directions about 8 to 12 feet below the surface. He theorized that there were density differences between the two seas causing a countercurrent to develop.

Marsigli set out to prove his density theory by taking water samples of the Mediterranean and Black Seas. Marsigli found that the Black Sea had a lower salinity than the Mediterranean Sea.

Marsigli thought that the lower salinity in the Black Sea was because so many rivers flow into the seas, diluting the salt water with fresh, river water. Marsigli then measured the density of the surface and deep water from the Bosphorus. The surface water had a lower density than the deeper water.

Marsigli performed another experiment to prove his point. He created a box that was divided in half and the divider had two holes in it- one at the top and one near the bottom of the divider. He filled one side of the box with dyed water from the Black Sea. In the other side of the box he placed water from the Mediterranean Sea dyed a different color.

When Marsigli opened the holes in the divider he noted that the water from the Mediterranean flowed through the lower floodgate and that the water from the Black Sea flowed through the top floodgate. The Black Sea water was less dense and had a lower salinity and so it flowed over the saltier, denser Mediterranean water. This caused an upper current and a lower current similar to that of the Bosphorus.