Bicol University
College of Science

Fluid Convection Experiment

BY:

Zenit, Augustus Alejandro
Miranda, John Rick
Marfil, Justine Jay
Nerbes, Arjan
Mandapat, Marc Kevin

Submitted to:
Atty. Lidelia Lilibeth Llagas

FLUID CONVECTION EXPERIMENT

OBJECTIVES

1. To be able to demonstrate and explain to the class how convection works;
2. To exhibit real-time demonstration of the fluid convection process;
3. To relate the experiment with the concepts being discussed during class lectures.

CONCEPT

Convection is the movement of molecules within fluids (i.e.liquids, gases) and rheids. It cannot take place in solids, since neither bulk current flows nor significant diffusion can take place in solids.

Convection is one of the major modes of heat transfer and mass transfer. Convective heat and mass transfer take place through both diffusion – the random Brownian motion of individual particles in the fluid – and by advection, in which matter or heat is transported by the larger-scale motion of currents in the fluid. In the context of heat and mass transfer, the term "convection" is used to refer to the sum of advective and diffusive transfer.

The term "convection" may have slightly different but related usages in different contexts. The broader sense is in fluid mechanics, where "convection" refers to the motion of fluid (regardless of cause). However in thermodynamics "convection" often refers specifically to heat transfer by convection.

Convection occurs on a large scale in atmospheres, oceans, and planetary mantles. Fluid movement during convection may be invisibly slow, or it may be obvious and rapid, as in a hurricane. On astronomical scales, convection of gas and dust is thought to occur in the accretion disks of black holes, at speeds which may closely approach that of light.

Natural convection, or free convection, occurs due to temperature differences which affect the density, and thus relative buoyancy, of the fluid. Heavier (more dense) components will fall while lighter (less dense) components rise, leading to bulk fluid movement. Natural convection can only occur, therefore, in a gravitational field. A common example of natural convection is a pot of boiling water in which the hot and less-dense water on the bottom layer moves upwards in plumes, and the cool and more dense water near the top of the pot likewise sinks.

Natural convection will be more likely and/or more rapid with a greater variation in density between the two fluids, a larger acceleration due to gravity that drives the convection, and/or a larger distance through the convecting medium. Convection will be less likely and/or less rapid with more rapid diffusion (thereby diffusing away the gradient that is causing the convection) and/or a more viscous (sticky) fluid.

The onset of natural convection can be determined by the Rayleigh number (Ra).

Note that differences in buoyancy within a fluid can arise for reasons other than temperature variations, in which case the fluid motion is called gravitational convection

PROCEDURES

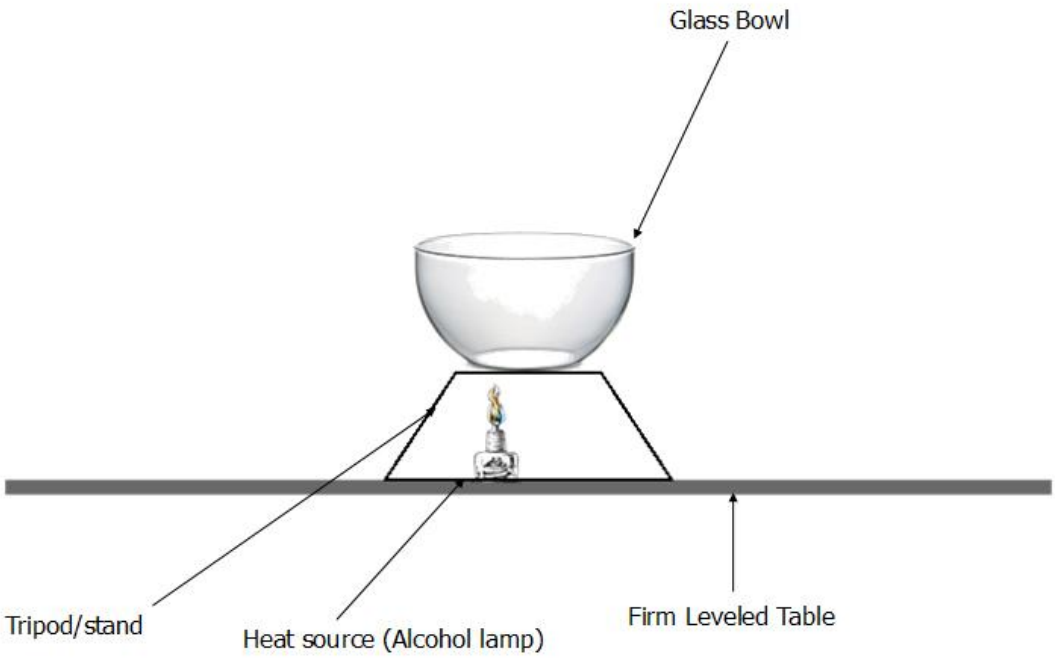
Materials needed:

- Glass Bowl
- Water
- Heat Source (Alcohol lamp, Bunsen burner, etc.)
- Strong Water Soluble dye (food color)
- Syringe (at least 10mL)
- Syringe needle

Experiment proper:

1. Gather and prepare all material to be used for the whole duration of the experiment.
2. Before everything else, set up the materials as shown in Fig. 1.

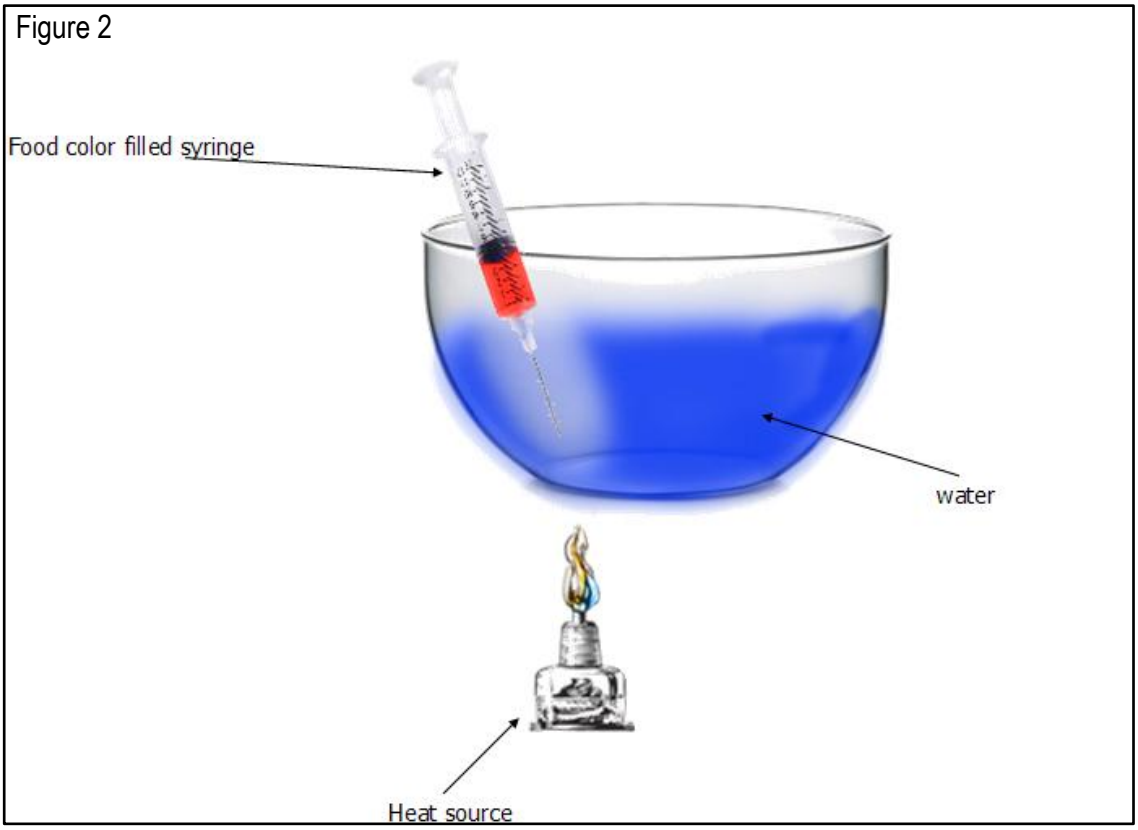
Figure 1



Note: the heat source must be placed under the left corner of the bowl.

3. Before turning on the heat source, put enough water to fill the bow ¾.
4. Now, turn on the alcohol lamp and let it burn for 3 minutes. This will be enough to heat the water a little bit.
5. To observe convection happening on the bowl, put the tip of the syringe needle on the part of the water on the bowl where the flame is nearest. This is shown on Figure 2.

Figure 2



6. Slowly add pressure to the syringe plunger. Do not add pressure very rapidly for this will cause disturbance in the water that will probably fail the experiment, which is to observe fluid convection.
7. After adding 1mL of food coloring, remove the syringe very slowly from the water. Cause as little disturbance as possible.
8. Observe what happens after a few seconds.
9. Take documentations.

DISCUSSIONS

Observations:

After putting 1 mL of dye into the water, it started going up. Then, when it was on the top, the color went from top left area to the top right area until it went down again, restarting the cycle.

Explanation:

Natural convection occurs when a fluid such as air or water moves because of its change in temperature and density caused by absorption of heat from another object. During the day, for example, air near the earth's surface is warmed by its contact with the earth. As it warms, its volume increases. The air becomes less dense and rise, allowing cooler, denser air from above to come down and replace the warm air. The air movement is a natural convection current. In a room in a house, air that is warmed near the radiator rises, and cool air near the ceiling falls. This natural convection current causes the room to become uniformly heated.

To relate it to the experiment; the alcohol lamp starts to heat the left-most bottom corner of the bowl, therefore, heating the water molecules on the area. As this happens, the hotter water becomes a lot lesser in density, thus, making it rise up. Simultaneously, the colder water, having a greater density compared to the hotter water, sinks down and replaces the previous water molecules on the heated area. This cycle will continue until all of the water is heated to the boiling point. However, the cycle may continue for long hours if the rate of heating under is balanced with the rate of cooling of the water on the surface. This is shown on Figure 3.

Figure 3