Get Wet Assignment:

Drip

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MCEN 4151: Flow Visualization

The image *Drip* was produced by Samuel Verplanck for the course Flow Visualization at the University of Colorado. The purpose of this course is to explore art and science of fluid flow. This assignment was the first assignment of the Spring 2014 semester and the purpose was to have students "get their feet wet" with taking images of fluid flow.

Drip was taken on the February 2, 2014 around 11 AM. The temperature was 20^{o} F in Boulder, CO (courtesy of weatherspark.com), and the icicle was located on the south side of a house. Due to a clear day, the solar radiation and a warm house caused water to melt off the roof and rapidly drip down the icicle. The icicle was located at the base of a gutter. The picture was taken at such an angle that the background was only blue sky.

The following camera settings were used to produce *Drip*:

Camera: Nikon D40

ISO: 200

F-stop: 5.6

Exposure time: 1/1600 sec

Flash: no flash

Focus: Manual

The icicle had formed over the past few days of freezing temperatures and snow. An icicle like this one forms when a warm house and solar radiation cause snow on the roof to melt. This melted snow ran down the roof and dripped off a gutter full of leaves. Once the drip has left the warm roof it is in contact with a freezing air temperature and freezes to the gutter. As more water drips down the roof, the icicle continues to grow. Since the air temperature was below freezing, the icicle was likely in a stage of growth.

Notice the ridges on the icicle. These ridges have roughly the same wavelength, no matter the size of icicle[1]. Experts are uncertain of why these ridges happen but recent research shows that small concentrations of salt are necessary to produce the waves. When icicle experiments are run with heavily distilled water, the ripples do not form. *Drip* clearly shows ripples so there are certainly impurities in the water.

A valuable calculation can be the mass of the larger droplet. Assuming the droplet is a sphere with a radius of .25 cm (.0025 m) the mass is calculated below.

$$m = \rho V = \rho \frac{4\pi r^3}{3} = \left(9999 \frac{kg}{m^3}\right) * \frac{4\pi (0.0025\ m)^3}{3} = 6.5 * 10^{-4}\ kg$$

Note, the density (ρ) of water is 9999 kg/m^3 and the volume is denoted by *V*.

The velocity (*u*) can be calculated based on an estimation of the distance (*d*) fallen of 3 cm (.03 m) and acceleration due to gravity, *g*, of 9.8 m/s.

$$u = \sqrt{2gd} = \sqrt{2\left(9.81\ \frac{m}{s^2}\right)(0.03\ m)} = 0.8\ m/s$$

Another point of interest of *Drip* is the image an upside down house within the droplet. This is produced because the droplet of water acts as a lens and inverts any light coming through the drop. The drop is held together by surface tension. This surface tension is created due to the hydrogen bonding between water molecules.

The image was post processed using Gimp. A simple crop assure there was only blue sky in the background. Then the contrast was increased, accentuating the blue background and detail within the icicle.

Works cited:

1. Kim, Meeri. "Icicles: A Symbol of Winter and a Scientific Mystery." *Washington Post*. The Washington Post, 07 Feb. 2014. Web. 12 Feb. 2014.