CU Boulder

Flow Visualization

Group 3 Report

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Purpose

The purpose of this image is to capture a striking image of opaque fluid formation. This image is a collaboration with Andriy Wybaczynsky, William Vennard, and myself. Originally, the group had decided to pursue the formation of rain clouds indoors in the same vein as the work of artist Berndnaut Smilde. A location was scouted and equipment acquired, but when it came to the photoshoot day wind conditions outside were too severe for the cloud to stay in one spot. It was also determined that the fog machine used has a flow rate out too low. If this experiment were to be successfully performed a cold indoor environment with limited draft and a much larger fog machine. Nevertheless, this required a plan B.

The group decided to study the fog machine. We explored areas for angles that would produce nice photographs of the fog around the Discover Learning Center at CU-Boulder campus.

Description of Flow Physics

This experiment is rather simple to set up. All that is required is a spray bottle of water, a light, and a fog machine. The key to this experiment is finding interesting locations to photograph fog.

The term fog machine is a common term for a few different mechanisms. The machine used to produce this cloud is a glycol/water mix vaporizer. A reservoir this mixture is connected to a heating element, with particularly small input and output tubing, which superheats the mixture to produce a vapor. This vapor is then pushed out using a small fan and through a nozzle on the front face of the fog machine. Below is a diagram of the internals of a fog machine.

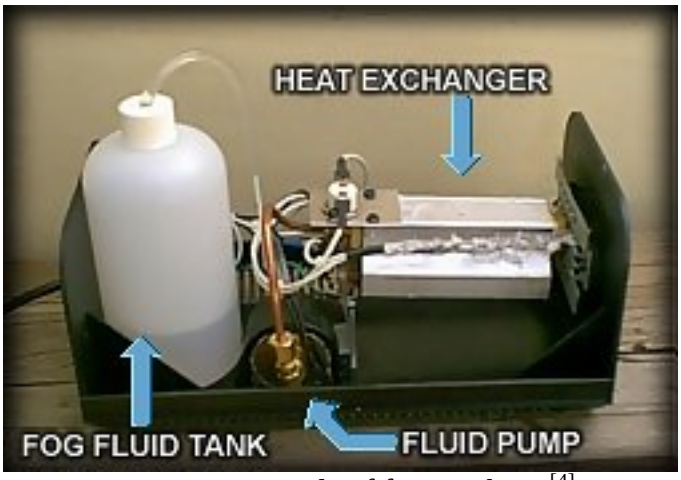

Figure 1. Internals of fog machine [4]

The particular fog machine used is rated for 400 Watts. This is on the low end of consumer fog machines, which typically range from 400 to 700 watt power supplies. Theoretically, the higher the heater wattage, the more fog the machine can produce. Also, the less time between re-heat cycles the machine can achieve, which limits the dissipation of expelled fog. [4]

General mixture of commercial “fog juice” is glycol/water mixture, or even a mineral oil/glycol/water mix. The density of the fog is heavily dependent on the glycol content as this is the main element being vaporized. While the exact recipe of the mixture used is unknown, given the quick dissipation characteristics, I would expect it to be more water than glycol, possibly a 60/40 water/glycol mixture. [2]

Photographic Technique

The photograph is taken on a Nikion D3000 digital SLR camera. The lens used has a focal length of about 18 mm. The specific picture used a f-number of 4 and a shutter speed of 1/20 seconds. The ISO used was set automatically by the camera and is found to be 200. The resulting image has a size of 2592 x 3872 pixels. The struggle behind this image was capturing a subject in motion in a low light setting. The idea behind using these settings was to preserve the detail in the fog cloud as much as possible while using very limited low light sources without too much motion blur. The light source was a 13 W bulb. The main cloud was about a foot and a half in length and a foot wide. Below is the original image captured.

Figure 2: Original image

Post processing was performed on the image using Photoshop Elements. The image was cropped to provide better artistic framing. The contrast was increased heavily and the brightness also increased. The white balance was also tweaked, but mildly.

Figure 3: Image after post processing

Conclusion

While the group was unable to capture its original planned image due to environmental factors, we are pleased with the way the fog pictures turned out. If this experiment had to be done again some minor changes would be made, mostly in the realm of planning equipment, location, and researching the glycol mixture a little more. First off, the planned outside location, while visually stunning, was not well equipped with outlets or blocks from the wind. Second, the fog machine used is on the lower end of consumer fog machines, and one with higher wattage would be able to produce more fog. Thirdly, the glycol mix dissipated far too quickly, even in the indoor locations. A mixture of almost entirely glycol would allow the fog to hang in one place for a prolonged period of time, which was the hope with the cloud experiment. On the photography side of things, a higher wattage light, and even multiply lights were be nice since this particular photo, personally, has too much motion blur. A higher shutter speed would prevent this, and more lighting would allow this.

Reference:

[1] "The Physics of Clouds." *The UCSB Current*. Web. 14 Dec. 2015. <http://www.news.ucsb.edu/2015/015076/physics-clouds>.

[2] "How Smoke Machines Work." *About.com Education*. Web. 14 Dec. 2015. <http://chemistry.about.com/od/howthingswork/a/smokemachines_3.htm>.

[3] "Clouds and Cloud Formation." UCAR. Web. 14 Dec. 2015. <http://www.ucar.edu/communications/gcip/m8clclchange/m8pdfc1.pdf>.

[4] "Fog Machines - Your Guide to Using Fog Machines for Halloween." *Fog Machines - Your Guide to Using Fog Machines for Halloween*. Got Fog? Web. 14 Dec. 2015. <http://www.gotfog.com/fog_machine_how.html>.