

May, 5 2010

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## [SMOKE RISIN']

This is the second fluid flow photo of the Flow Visualization class at the University of Colorado, Boulder

In this photo, my main objective was to show very clearly how smoke transitioned from laminar flow to turbulent flow. In the process, I found that smoke didn't always transfer to turbulent flow immediately or linearly. The photo above shows one such phenomenon where the flow is neither completely laminar nor turbulent. In taking the photograph I found that if the surrounding air was as still as possible, the smoke would create vortex like shapes that would continue to 'roll' upward as the wick kept lit. Disregarding the lack of focus, the photo below shows the continuous 'rolling' and expanding of these vortex shapes.



I believe that the reason the smoke behaves this way is the same reason that a mushroom cloud forms after a nuclear explosion. The smoke is simply microscopic particles from the burning wick rising due to its heat. The smoke is a far denser fluid than the air is and as it is force upwards, two things happen; there is heat transfer into the air around the smoke, and there is a small amount of friction between the boundary of the air and the smoke. The latter of the two things happening has less of an effect on the smoke as the former. The heat transfer is not uniform, so the smoke closer to the boundary cools faster

than the smoke in the center of the plume. This causes the smoke at the boundary to slow down while the smoke in the center retains its speed, thus creating a sort of vortex ring. Also as the smoke rises, the temperature and speed in the smoke plume cross section becomes more uniform. The smoke below it then goes through the same process.

The setup for this picture was fairly simple. I took the photo in my bathroom, as it is the darkest room in the house, and has a vent in the ceiling. There is a blanket hanging from the shower curtain in order to get a black background, thus the best contrast. The camera uses its flash; however, I put a piece of paper in front of it in order to soften the flash. Without the paper the flash illuminates the entire room too harshly, and picks up too many highlights, as shown below.



The source of the smoke is a wick from stamp wax. The composition of the stamp wax yielded fantastic smoke density, as opposed to a generic house candle or cigarette. Finally, after taking nearly 50 photos, I got a photo with just the right exposure and content to do minimal photo editing. I found that with this type of composure, adjusting contrast and color levels tends to make the photo worse than better.

Below are a few specifics of the photo:

<b>Date and Time of Photo</b>	<b>March 29, 2010 @ 9:17 am</b>
<b>Location</b>	Boulder Colorado
<b>ISO</b>	100
<b>Shutter speed</b>	1/3 s
<b>Aperture</b>	f/4
<b>Focal Length</b>	5.9 mm
<b>Flash</b>	Yes
<b>Camera Make and Model</b>	Fujifilm FinePix s1000fd