

Pyro Cat

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Flow Visualization MCEN 4151

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Introduction:

I wanted to take more control and focus on the artistic side of flow visualization through this project. I wanted to use the fluid mechanics as a textured paint brush. This idea of using confined black powder to char paper first came about when I was in high school. I wanted to make something that would make people believe in magic, if only for a moment. The final design was a framed blank paper that would create an elaborate image behind glass after lighting a candle. This Pyro Cat is a reproduction of the same set up.

The Set-Up and Physics:

The experiment takes place within a picture frame seen below in figure 1 as yellow. The orange is a plane of wood that had the line elements of the cat routed into the surface. The channel was filled with a slow burning black powder to be ignited with a fuse. The blue is the blank white paper pressed against a pane of glass seen in light blue. I am not listing the black powder recipe or finer details of the process because I do not think un-qualified persons should attempt to repeat this. Special precautions were taken in formulating a black powder that could burn safely while confined behind glass.

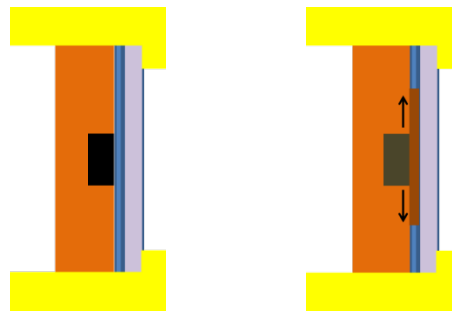


Figure 1: Stack before ignition (Left) and during combustion (Right).

During combustion the black powder generated heat and gas. The elevated temperature chars the paper brown as the pressure from the gas spreads the heat out. The heat is being used to visualize the movement of hot gas flowing quickly through a thin parallel space. The flow looks unstable. The sharp spikes that appear near the path grow into large wisps. Perhaps as the paper burns, space is formed that allows more flow along that path. The initial spikes are equally spaced and get sharper where there was more black powder and pressure. The burnt area is four by five inches and took five seconds to burn. There were visible flames through the glass and a good amount of smoke escaping from the back of the frame.

Visualization Technique:

No special fluid camera techniques were used to get the original images. The automatic camera setting captured sharp enough images. The Photoshop curves feature was used to increase contrast and invert the colors. Then the image was cropped to only contain the charred paper.



Figure 2: Unedited Photo

Date: 3/18/2013
Dim: 1536 x 2048 pixels
Resolution: 300 dpi
Bit depth: 24
Resolution unit: 2

Colors: RGB
Cam: Nikon Coolpix L100
F-stop: f/5
Exposure time: 1/30 sec.

Focal length: 27mm
Aperture: 3.6
Flash: Compulsory
ISO: 320

Commentary:

The image reveals an instability in the movement of corrosive fluid. The fluid opens a larger path where it flows and flows where the path is larger creating a positive feedback and instability. I think this turned out to be a unique way of showing that flow. I like the balance of control and chance artistically, but if I were to repeat this experiment I would try to control the flow even more by seeding the spikes in the wood.

Source:

Saffman, P.G. "Vicous Fingering in Hele-Shaw Cells." *Journal of Fluid Mechanics* 173 (1986): 73-94. Web. 20 Mar. 2012.