

# Smoke Balls



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Flow Visualization – Spring 2014

University of Colorado at Boulder

## I. INTRODUCTION

This report will document the flow visualization of smoke bomb fireworks. With the colored smoke it is easy to identify the type of flow from the high velocity smoke. The combustion process of potassium chlorate, a sugar and sodium bicarbonate evaporate the dye and disperse particles into the air. The following report identifies the type of air flow the smoke sees as it leaves the smoke bomb, and the process used to capture the image.

## II. FLOW APPARATUS

## III. VISUALIZATION TECHNIQUE

In order to capture the image a white poster board was set on the table and another white poster board was set up as the background behind the smoke balls. In order to get the smoke balls to light at the same time and have the smoke paths cross the smoke balls were oriented similar to figure below. The fuses were twisted together so that they could be lighted at the same time. The smoke emission lasted for approximately 10 seconds so the time frame to take a picture was very small.

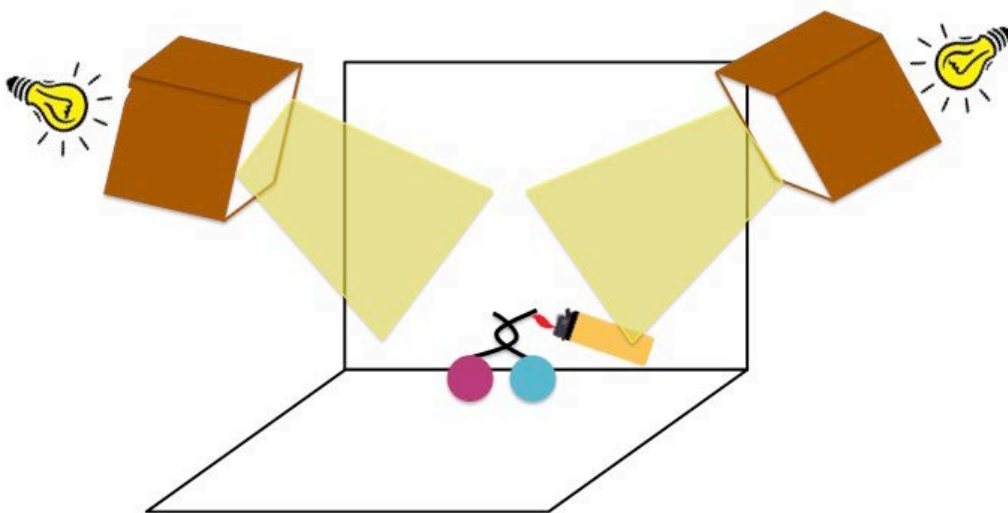


Figure 1: Smoke Ball Set-Up

Make-shift diffuse lighting was used to take the final image. Using cardboard boxes the flaps on one side of the box were removed and covered with a piece of white paper. On the other side of the box the light fixture was inserted and turned on. This created a softer light that reduced the amount of reflections of the white poster board. It would have been better with more light in order to increase shutter speed to reduce the motion blur in the photo, but the light fixtures were too harsh and washed out the photo.

#### IV. PHOTOGRAPHIC TECHNIQUE

Smoke ball image was captured using a Canon EOS Rebel T1i was used with a Canon EF-S 18-55mm f/3.5-5.6 IS lens. This image was captured at f5.6 with a shutter speed of 1/13 of a second. The ISO value was set to 1600 in order to take the image as fast as possible and to try and avoid any motion blur.

The final image processed using iPhoto. The boundary between the poster on the bottom and the poster in the background was blurred together. The colors were contrasted more and the warmer color values were brought out. This ended up making the smoke balls have a more dramatic burnt look to them. Initially, the image field of view was a portion of the poster board, approximately 25.5 inches wide by 22 inches tall. The focal length was set to 55 mm as the camera was a few feet from the smoke balls being imaged. The final image was cropped to a size of 4113 x 3158 pixels.



**Figure 2: Unedited Smoke Ball Image**

## V. IMAGE ANALYSIS

The image reveals the turbulent flow of fast moving air. The smoke particles allow the visualization to become very clear. The image is not ideally focused. The motion blur takes over near the top of the image. It would be interesting to explore slower moving smoke and the effect of obstacles in the way of the smoke. Is the flow laminar or turbulent when it flows over the obstacle.

Image Assessment Form  
Flow Visualization  
Spring 2013

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Assignment: Team photo 1

Date: March 1, 2014

Scale: +, ! = excellent ✓ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Comments
Intent was realized	+	
Effective	+	
Impact	✓	
Interesting	+	
Beautiful	+	
Dramatic	+	
Feel/texture	+	
No distracting elements	+	
Framing/cropping enhances image	✓	

Flow	Your assessment	Comments
Clearly illustrates phenomena	+	
Flow is understandable	✓	
Physics revealed	+	
Details visible	+	
Flow is reproducible	+	
Flow is controlled	✓	
Creative flow or technique	+	
Publishable quality	✓	

Photographic/video technique	Your assessment	Comments
Exposure: highlights detailed	+	
Exposure: shadows detailed	+	
Full contrast range	+	
Focus	+	
Depth of field	+	
Time resolved	N/A	
Spatially resolved	✓	
Photoshop/ post-processing enhances intent	N/A	
Photoshop/ post-processing does not decrease important information	N/A	

Report		Your assessment	Comments
Collaborators acknowledged		+	
Describes intent	Artistic	+	
	Scientific	✓	
Describes fluid phenomena		+	
Estimates appropriate scales	Reynolds number etc.	✓	
Calculation of time resolution etc.	How far did flow move during exposure?	N/A	
References:	Web level	+	
	Refereed journal level	N/A	
Clearly written		+	
Information is organized		+	
Good spelling and grammar		+	
Professional language (publishable)			
Provides information needed for reproducing flow	Fluid data, flow rates	✓	
	geometry	+	
	timing	+	
Provides information needed for reproducing vis technique	Method	+	
	dilution	N/A	
	injection speed	N/A	
	settings	+	
lighting type	(strobe/tungsten, watts, number)	+	
	light position, distance	+	
Provides information for reproducing image	Camera type and model	+	
	Camera-subject distance	+	
	Field of view	+	
	Focal length	+	
	aperture	+	
	shutter speed	+	
	Frame rate, playback rate	N/A	
	ISO setting	+	
	# pixels (width X ht)	+	
	Photoshop and post-processing techniques	N/A	
"before" Photoshop image	N/A		