

This image shows a handful of structural foam bits swirling around in a vortex. The idea was built off the very well known method of creating vortices in 2 liter plastic bottles. However, we assumed that the addition of structural foam bits would make the vortex more interesting. Instead of adding food coloring or shampoo for a more uniform liquid, we figured that the addition of large cubes would add a noticeable contrast between solid and liquid states in the vortex. This was definitely a more feasible idea than dropping milk droplets into engine oil with hopes of photographing the crown of impact.

Flow apparatus:

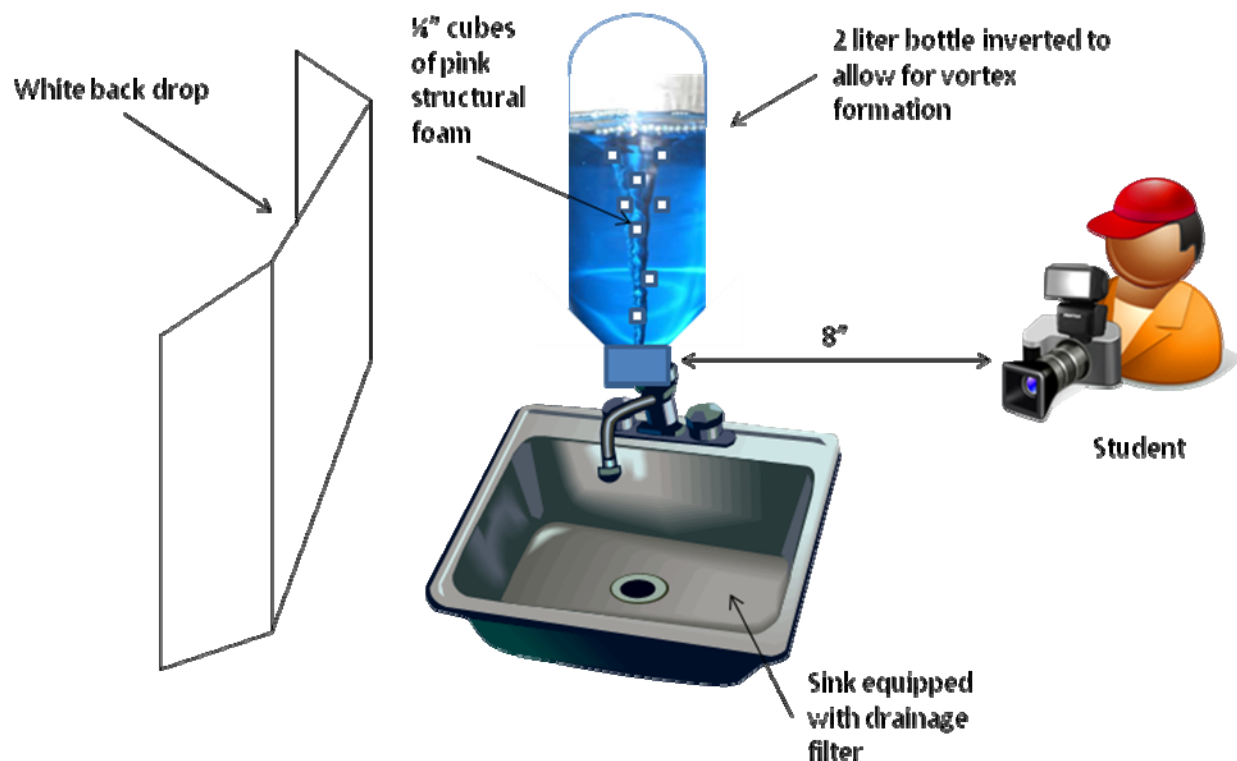


Figure 1.

The setup consisted of filling up a used 2-liter bottle with a small hole drilled in the bottom. Then small bits of pink structural foam were dropped in the bottle. The small hole will allow for fast drainage, but not fast enough to destroy the formation of the vortex. The photographer would stand about 8" away from the bottle to get close enough to take a high resolution image. The bottle was then rotated imparting angular momentum to the fluid and the structural foam pieces.

The type of vortex formed in the bottle is known as a free vortex. Free vortices do not make floating object spin about their own axis while spinning in the fluid. See figure 2.

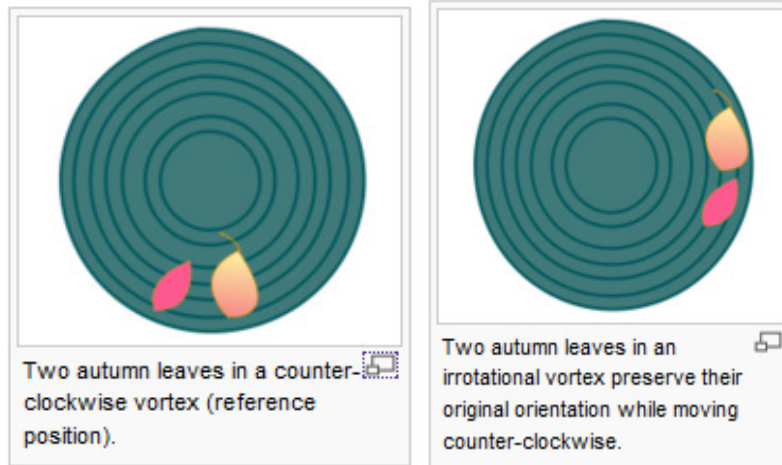


Figure 2. The above shows how two leaves retain their orientation while spinning in a free vortex. <http://en.wikipedia.org/wiki/Vortex>

The tangent velocity of the spinning structural foam pieces can be described as

$$v_{\theta} = \frac{\Gamma}{2\pi r} \quad (1)$$

Where Γ is the circulation, the circulation can be found with vectorized calculus and integrating the line force around the circumference of the path.

r is the radius from the vortex center the piece of foam is.

To attain an acceptable contrast between the flow and the cubes a white background was used. The white back ground has an advantage over a black one because it will allow the camera to discern the ridges in the vortex flow. The first few shots we found that the photographs were too dark, so we used a flash. However we did not want to overexpose the vortex so we used the flash on the upper portion of the 2L bottle where nothing important was going on anyway. The light also illuminated the lower portion were the vortex was but in a less intense way that still brought out the detail in the spinning foam vortex. The get the entire bottles width within the shot a FOV (field of view) of about 8" x 8" was used. For more detailed information on what camera settings were used please refer to figure 3.

Camera Data 1	
Make:	OLYMPUS IMAGING CORP.
Model:	E-410
Date Time:	4/26/2009 – 7:51:31 PM
Shutter Speed:	1/180 sec
Exposure Program:	Shutter priority
F-Stop:	f/4.8
Aperture Value:	
Max Aperture Value:	f/3.4
ISO Speed Ratings:	100
Focal Length:	26 mm
Lens:	
Flash:	Fired
	No strobe return detection (0)
	Compulsory flash firing (1)
	Flash function present
	No red-eye reduction
Metering Mode:	Center weighted average

Camera Data 2			
Pixel Dimension X:	3648	Y:	2736
Orientation:	Normal		
Resolution X:	314	Y:	314
Resolution Unit:	Inch		
Compressed Bits per Pixel:			
Color Space:	sRGB		
Light Source:	Unknown		
File Source:	DSC		

Figure 3. Camera settings

If I were to recreate this image I would do two things differently. One I would use shampoo in the water to add a shimmering effect to whirling liquid. I think it would make an excellent accent to the spinning cubes. I would also attach another 2L bottle to the other end of the bottle we used to reduce the time between shots, plus it would of made clean up much much easier.