

Clay Fountain

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Flow Visualization MCEN 4151

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Introduction:

If you've looked at my other flow visualization images, you may see a theme. I've been trying to expose interesting fluid mechanics from my every day experiences. Clay Fountain was inspired by my work with slip casting in the ceramics for non-majors class here at CU. While pouring the fluid slip slowly back into the bucket, rings appeared on the surface. I recreated the pour in a more controlled manner and began photographic to better understand what was happening.

The Set-Up and Physics:

The experiment has a simple setup. The fluid is porcelain slip (kaolin, water, sodium citrate). Kaolin is very fine inorganic powder that gives porcelain its white color. The water hydrates the mixture and holds the particles together making the clay workable. The sodium citrate is a deflocculant that acts to increase the repulsive force between the suspended particles to make the clay less viscous (David Walker). The slip was poured from a valve and reservoir to get a consistent stream. A deep bucket was used for storing and catching the slip. A camera resting on the rim of the bucket caught the image with a flash.

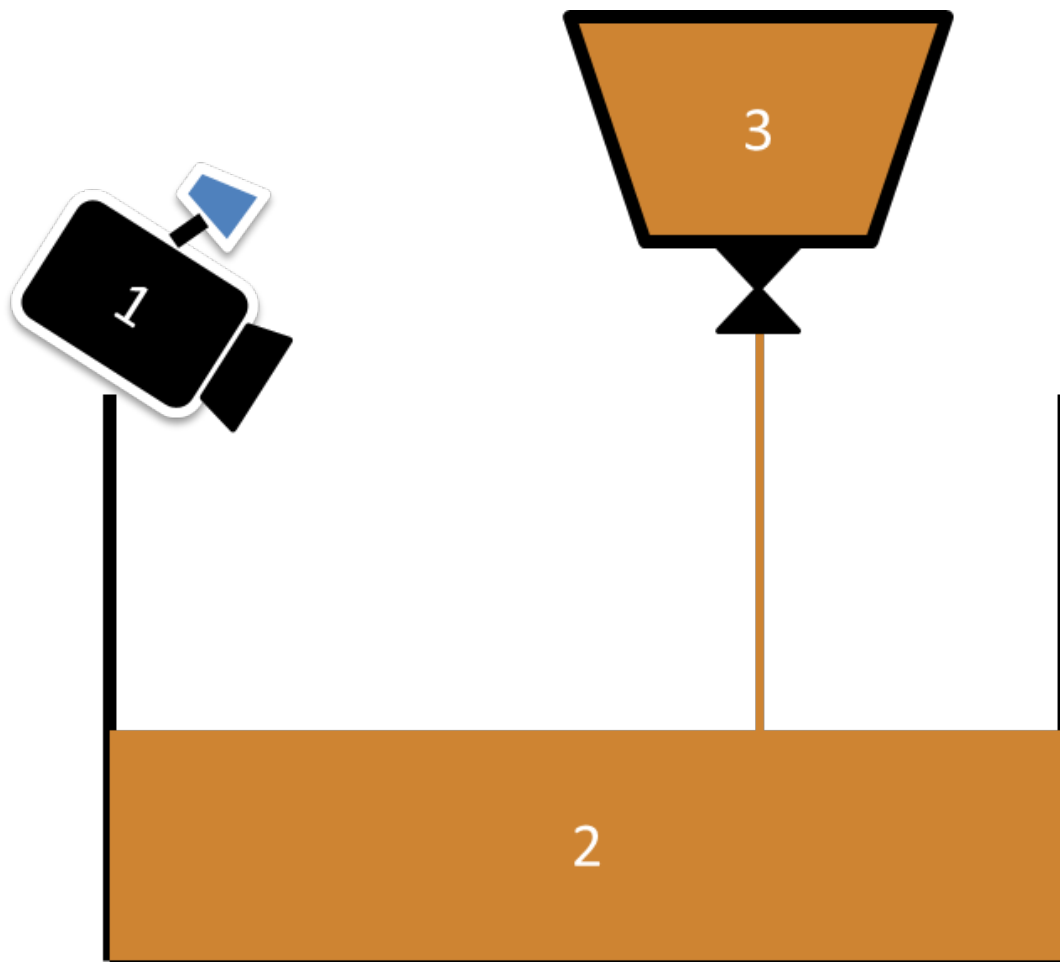


Figure 1: Experimental setup. 1 camera. 2 slip. 3 valve.

Where the clay hits the surface there are some tight coils. This is a shear thickening display. The fluid is forced to change direction and experiences higher shear stress. This causes the clay to stiffen and hold its shape better. The deflocculant must play a part in this because its purpose is to change the viscosity as well, however, the influence is from the kaolin. The clay particles are rough little platelets lubricated by water to slide past each other. Under stress the particles rub more and resist the motion. In this way, porcelain slip is a non-Newtonian fluid. The rings seem to form at the creases formed by the coils. The surface is not a well-mixed system. The rings are a result of different compositions of clay interfering with a thin film. The surface in equilibrium is brighter than the clay body.

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. Then the image was cropped to only contain the rings.



Figure 2: Unedited Photo

Date: 4/20/2013
Dim: 3648 x 2736 pixels

Resolution: 300 dpi
Bit depth: 24

Resolution unit: 2
Colors: RGB

Cam: Nikon Coolpix L100

F-stop: f/7

Exposure time: 1/26 sec.

Focal length: 5mm

Aperture: 3.6

Flash: Compulsory

ISO: 320

Commentary:

The image reveals a beautiful instability and stretching rings where they would normally go unnoticed. This is the exact intent of this image. I really like the subtlety of the image. There is some interaction from the bucket's wall making the ring more egg shaped. The surface is shiny and liquid, but the rings are well defined.

Source:

David Walker, "Casting Slip preparation and recipes." *Walker Ceramics*. Ozclay, 08 Dec 2010. Web. 30 Apr 2013.