Team Project 3

Flow Visualization

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This image was the third and final team project, however due to scheduling conflict the group was forced to work individually for the assignment and therefore has a wide range of images. The purpose of the image seen was to explore the physics of granular flow specifically looking at how the flow changes depending on the material it is flowing through.

The apparatus used for the experiment was fairly simple in set-up using a vase filled with tap water, a canister of table salt, and a black backdrop for contrast. The vase was pre-filled with water then placed in front of the black backdrop. The salt canister was held about 2-3 inches above the brim of the vase and tipped slowly until a steady flow began. Below in figure 1 the set-up is shown:

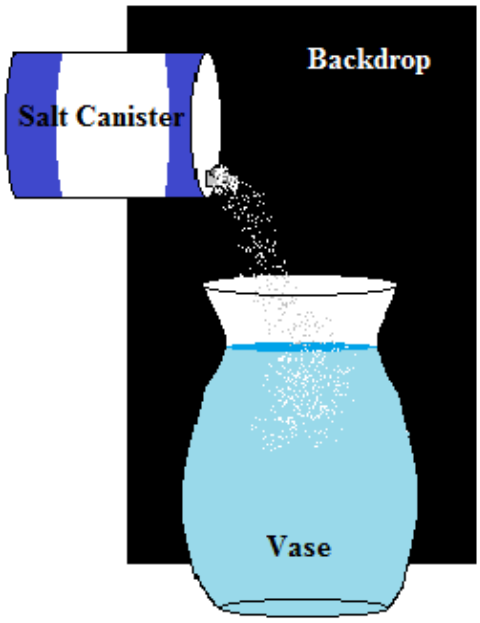

Figure 1: Flow Apparatus

The set-up shown allowed for a steady granular flow to be seen and clearly captured in the image. A granular flow is one in which a solid flows much like a Newtonian fluid and takes on fluid like properties. Normally, a granular material would appear and act as a solid. Granular material physics work in the following way: any stress is distributed throughout the grain in a

“force chain” or arrangement of grains touching one another which results in a non-uniform stress distribution (which differs from a standard solid). However, if the granular material is acted upon by shaking or pouring the grains that were once in contact no longer maintain continuous contact and thus begin to flow resembling a liquid [1] [3]. As the salt canister was tilted the salt inside was acted upon by gravity until the gravitational force was enough to cause the salt to flow out the opening. The salt traveled downward through air until reaching the water within the vase at which point the physics change slightly. While traveling through air the salt is acted upon by gravity, a downward force, and drag, an upward force although due to the minute size of the particles drag is minimal, however when the salt enters the water drag becomes a much greater factor. The viscosity and drag of the water will slow the acceleration of the salt particles and resist gravity, thus slowing the granular flow. Buoyancy in this case will be negligible since the salt particles are denser than the water and will not float [2]. So, when the salt enters the water it begins to disperse in a more erratic fashion then in air due to the fluid viscosity and drag (also in the image the curvature of the vase has an effect on how the salt appears in the water). Eventually the salt reaches the bottom of the vase settling in a thin sheet covering the bottom surface where it regains its solid granular physics [1] [3].

The visual effect captured in the image was created by pouring salt into a vase of water. The salt used was Morton iodized salt from a 26 oz. canister purchased at a local grocery store. The vase was 48 oz. and about 8 inches tall; it was filled with tap water to the neck of the vase and so contained roughly 36 oz. of water during the capturing of the image. The black backdrop was a 17 in. x 10 in. piece of cardboard covered in black plastic. The vase was standing about an inch away from the backdrop and resting on a countertop the salt was held about 2-3 inches above the brim of the vase as it was poured for the image. The lighting for the image was natural ambient light of the room coming in through a window to the left of the flow apparatus and about 3 feet away. The window faces west and had minimal to no direct light coming through since it was about 10:00am. Also, the camera flash which is fixed above the lens of the camera was used while capturing the image.

The image was captured using a Nikon D50 digital camera. The field of view was 2256 x 1496 pixels. The camera was held about 5-7 inches away and at about a 10-20 degree angle with the lens at about the height of the vase. The focal length was 18.0mm with an exposure time of .008s or 1/125 and the aperature set to f/5.6. The original image was cropped and edited using

Picasa 3. The image was cropped down to 668 x 1496 pixels as well as the image was converted to black and white and the shadows and highlights were adjusted to increase the contrast of the flow and allow for a better visual of the images details.

The image was table salt being poured from the canister into a vase filled with water, the reason for pouring the salt into water was to capture how fluids of different densities would affect the granular flow. In the final image I liked the overall effect the image had, the salt canister in the corner pouring and the vase being seen at a slight angle I believe gave a real artistic and dramatic feel to the image. Also, the black and white in my opinion enhanced the image greatly from the original and allowing for more details to standout than the color image. The intent of the image was fulfilled, as I wanted to capture a granular flow through varying densities which was done. However, if I could improve the image I would adjust the lighting slightly to reduce the glare this would also allow for me to further improve my skills. Lastly, to further develop the idea it could be interesting to use varying granular materials and create contrasting flows to visualize how grain size could affect the physics.

References

[1] *Wikipedia*. Web. 02 May 2010. <http://wikipedia.org/wiki/Granular_material>

[2] *Wikipedia*. Web. 04 Apr. 2010. <http://wikipedia.org/wiki/Buoyancy>

[3] "Physics of Granular Materials." Web. 02 May 2010. <http://physics.clarku.edu/~akudrolli/granular.html>.