# Second Team Report

Rob Drevno

MCEN 4151-001: Flow Visualization

Mechanical Engineering

University of Colorado, Boulder

Date: 11/11/19

Contributors: Faisal Alsumairi, Blake Chin, Matthew Knickerbocker, and Abhishek Kumar

## Introduction

The objective of this assignment is to create an experiment and photograph a fluid's flow. The image will uncover the physics of the flow and result in an aesthetically engaging photo. This experiment uses equal parts cornstarch and water to create a non-Newtonian, shear thickening fluid otherwise known as a dilatant. This fluid was applied to the top of a subwoofer of a speaker and different periodic waves of varying frequencies were played in order to create a dancing motion.

## Background

Dilatants, otherwise known as a shear thickening fluid, are liquids with a viscosity that increases with increasing shear rate. Typical dilatants suspend particles in a liquid. In this experiment, the team used corn starch as the particles in water. If a shear rate, or force, is applied to these particles, the molecules need to reorganize as to decrease the influence of the force. If the applied force is small, the particles have time to reshuffle and disperse in the liquid. If the applied force is large, the particles don't have time to restructure and there is a build up of a shear force. In the case of cornstarch in water, a high force will cause the liquid to turn solid.

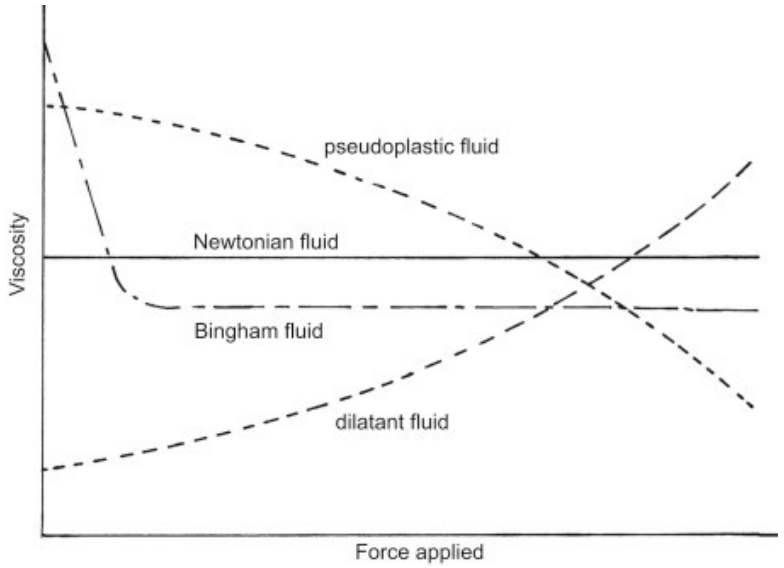


**Figure 1:** The relationship between force applied and viscosity in different fluids. Source: "Dilatant Fluid." *Dilatant Fluid - an Overview | ScienceDirect Topics*, www.sciencedirect.com/topics/engineering/dilatant-fluid.

Sound is a vibration of waves of pressure crossing through a medium such as liquid, solid, or a gas. As particles in this medium are vibrated, the sound propagates throughout the liquid. As the pressure waves travel through the dilatant, the oscillating transverse waves cause the fluid to act as a solid and create areas that are higher in position than others.

**Experiment setup**

The team used 50:50 cornstarch to water ratio to create the dilatant. We first used a large bowl to mix the fluid and played with it to visualize the shear-thickening properties. Next, we poured roughly 1.2 $in^3$ of this mixture onto the subwoofer of a Bluetooth speaker. Following this, we played various frequencies of sound with a frequency generator app on the phone.

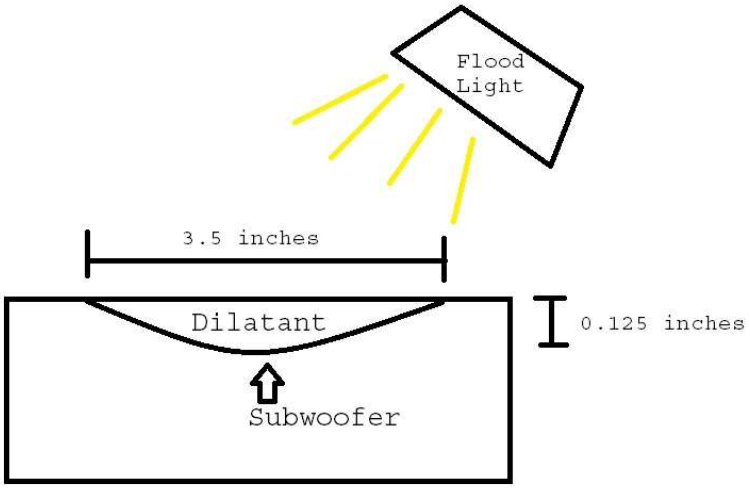


**Figure 2:** Scale and sketch of setup

The images captured were with a 25 Hz square wave. Figures 3 & 4 are two still images captured within this setup.

**Figure 3:** Dilatant being affected by sound waves

**Figure 4:** Dilatant being affected by sound waves

Clearly the two images show the oscillating pattern of the square wave's affect on the cornstarch and water mixture. Figure 3 is the "positive" side and figure 4 is the "negative" side. The positive side has peaks where the negative side has valleys. Each peak and valley were roughly 1/16$^{th}$ of an inch in height.

**Photo Editing**

The field of view of the original image is 4 x 4 in. with a 2 – 3 in. distance from the subwoofer to lens. The original image is 4750 x 3160 pixels. The focal length is 30 mm so I could focus on the center of the dilatant within the subwoofer. I used a 18-55 mm lens on a digital Canon EOS-50D on aperture priority mode. My exposure specifications are 1/2000 second shutter speed, 500 ISO, and f/7.1 aperture. For editing the image into gif format, I used https://giphy.com to piece 4 images together into gif format. The final images look to be out of focus; however, the shear-thickening fluid had very little texture and was extremely smooth in appearance. The edges of the image where the tin-foil is located are in focus which leads me to believe the dilatant is in focus as well.

**Conclusion**

The shear-thickening properties of this fluid can be visualized in the interaction of sound waves and this dilatant fluid. The synergy between the sound waves compression and tension phases are clearly captured in the fluid. The artistic intent and flow visualization of the experiment has clearly been accomplished.

**References**

"Dilatant Fluid." *Dilatant Fluid - an Overview | ScienceDirect Topics*, www.sciencedirect.com/topics/engineering/dilatant-fluid.

Elert, Glenn. "The Nature of Sound." *The Physics Hypertextbook*, physics.info/sound/.