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MCEN 4151, Flow Visualization

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Team First Image: Milk Curdle

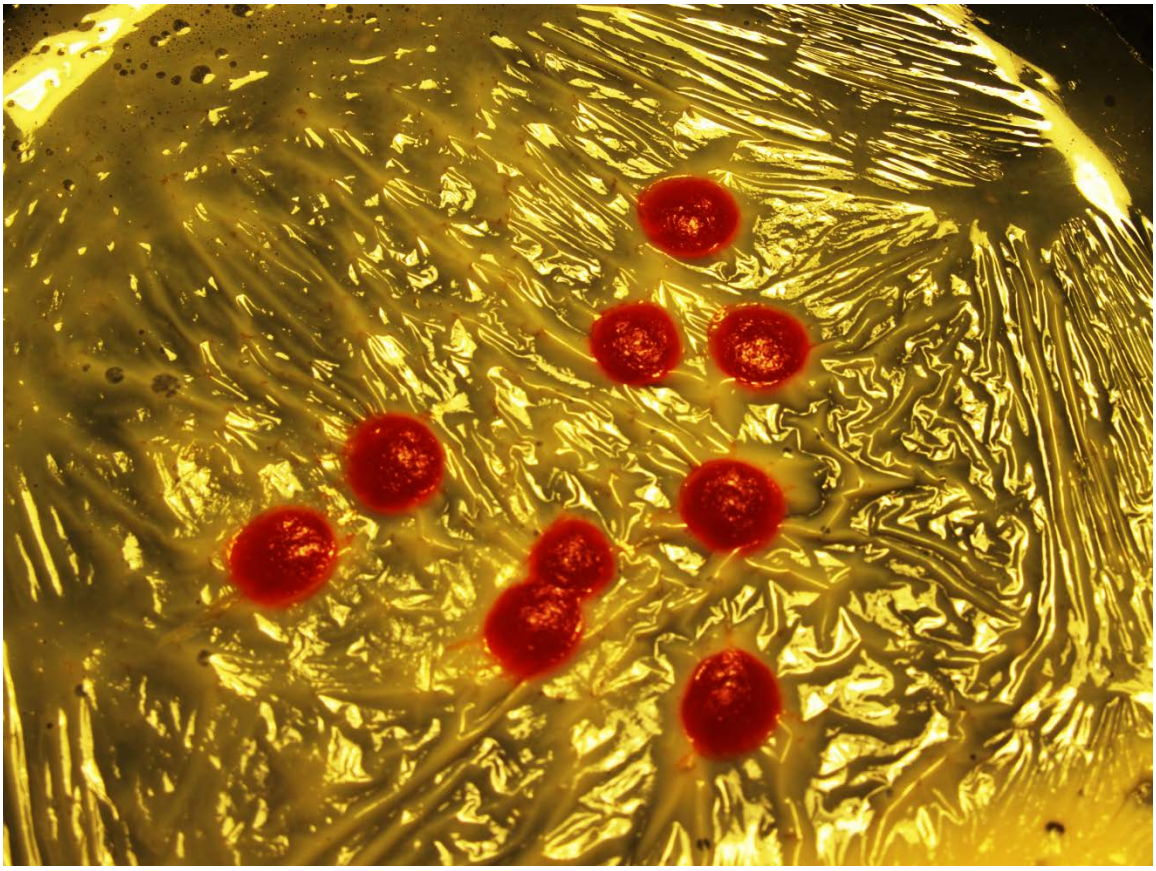

Figure 1: Milk Curdle image

Introduction:

The purpose of this image assignment is to collaboratively work on fluid experiments and flow visualization setups with an assigned team from the course. In this instance, the team did many setups, including the high speed recording of smoke vortex rings as well as a single layer of non-Newtonian fluid with food coloring. The goal of this specific setup was to capture the forming of milk curdle layer, which was obtained by overheating the milk and then draining the liquid milk in order to better see the curd. The red drops are added simply to enhance the contrast of the image as well as to increase the aesthetics of the image.

Flow Description:

Milk is a fluid that belongs to the category of colloids. A colloid is formed when a microscopic substance is dispersed in a solid, liquid or gas. [http://science.howstuffworks.com/dictionary/chemistry-terms/colloid-info.htm]. In the case of milk, the colloid is a dispersion protein and fat molecules on a water-based solution. When this liquid is heated above room temperature, the protein and fat dispersion will tend to intertwine and bond to other molecules like themselves, forming this curdle layer. The curdling can be avoided by keeping the milk well mixed and stirred during heating. For the purposes of this image, the milk was heated such that all the water in the solution would boil away, leaving the protein and fat dispersion free to bond and create the curd. Figure 2 shows the setup of the experiment. The wavy patterns in the layer are most likely caused by stress given by the air pockets that are left under the layer. Since the fluid is static, the Reynolds number of this fluid is zero (velocity is zero).

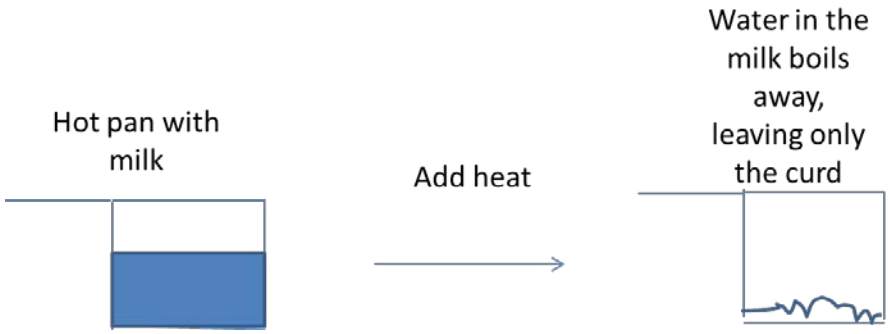

Figure 2: Flow Setup chart

Flow Visualization Technique:

The image was captured in the kitchen of one of the team member's house in order to capture the curd layer immediately after draining the milk. Two of desk lamps were focused on the stove top in order to add additional to the setup (using the camera flash yielded poor results). The field of view that is captured is that of the diameter of the pan (about 14 cm), and the depth

of view is approximately 5 cm. This can give us an approximate size of the “stress pockets” in the image, which range from approximately 1mm to about 3mm in width.

Photographic Technique:

The image was taken with an Olympus camera, series E-500. Manual mode was used with settings F11, shutter speed 1/25s, ISO 100, and zoom @42mm. A high zoom was chosen to focus on the fluid and eliminate most of the pan walls. Manual focus was also used, and the ISO, shutter speed and F-stop were chosen in combination for having provided the most aesthetically pleasing image. The original image was taken as an ORF (Olympus Raw File) and processed through Olympus Viewer 2, then saved as a TIFF file. Olympus Viewer was used as the picture editing software, in which the color contrast curve was adjusted to an S-shaped curve, as learned through the Flow Visualization class during the basic picture editing lecture. A small amount of cropping was done to eliminate the rest of the pan walls and to better show the fluid phenomenon being shown. No exposure compensation was used because appropriate lighting was used. The final image size is 3264x2448 with a resolution of 214.

Conclusions:

The image very strongly resembles the texture of saran wrap, due to the stress ripples that formed in the protein and fat layer. This image was chosen not for pure beauty characteristics, but rather for its strange texture and single-layer like characteristics. The red drops were added to enhance the color and to provide an additional strange-feel to the image, and this effect was realized, but it could be improved by using a color dye that is less viscous and that propagates through the layer better. The lighting techniques were used appropriately, as no exposure compensation was needed.