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TEAM
PROJECT 1

CRAZY MILK

Flow Visualization – Spring 2011

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I. Procedure

The purpose of our first team project was to show what happens when a surfactant (a product that changes the properties of the surface of a liquid) is added to a liquid with food coloring. It appears that funny reactions take place when these three components are added together.

The set-up of the experiment was to add food dyes in various amounts, combinations, and configurations to the surface of milk and/or various amounts of olive oil, and to drop liquid glycerin, soap, acetone, Windex, and bleach into it. This was to explore which surfactants would have the most interesting effects on subject liquids. After many trials with varying levels of success, it was determined that the milk, dish soap, and food dyes were most effective in producing an interesting and noteworthy outcome. Additionally, variations in the amount of time that the food coloring was given to diffuse into the milk on its own were experimented with.



Laboratory set-up

Since the phenomenon is unpredictable, you can carry out this experiment as many times as you want, you will never see the same reactions, that is why many pictures have been taken, each of them being different. The reaction when the drop of soap hits the surface of the milk is quick and spreads in funny ways, so we tried to make a time-lapse of this reaction. Since I was not really satisfied about what we have, I decided to make a video of the experiment, to show how the reaction expands and how the components keep reacting even few minutes after the drop hit the milk.

II. Explanation

The phenomenon occurring in this experiment is mainly a matter of surface tension. As any liquid, the milk has a surface tension. This force makes the surface layer behave like an elastic sheet. When the surfactant, the soap, hits the surface, it breaks the milk surface tension. The surrounded areas, which still “have” their surface tension, tend to attract the weak surface, spreading out the milk. It is like when you stretch a rubber band between your hands, if somebody comes and cut it in the middle, each part will quickly go to your hands.

Since the food coloring is less dense than the milk, it stays at the surface, so adding food coloring allows seeing this areas hit by the milk being spread out. The food coloring is taken away with the milk from the soapy area, creating those beautiful effects occurring as soon as the drop hits the milk.

Another phenomenon then occurs. The milk contains fat molecules. The dishwashing soap purpose is to “attack” these molecules. Indeed, the soap molecules will stick themselves to the fat molecules. So as the soap diffuses in the milk, it reacts with fat molecules, creating he swirls and twists you can see on the video. When the soap is fully dispersed into the milk the reaction stops. Then, the milk surface tension returns to its initial strength. You can actually see this phenomenon at the end of the reaction, as the milk seems to contract: if the reaction created circles for instance, you can see these circles being smoothly reduced for a short moment, and then everything stops. If you then add another droplet of soap, the reaction will start again, since the soap will again break the milk surface tension, and so forth until all the fat molecules being surrounded by milk. The milk will be then “saturated” with soap, and so soap will remain at the surface of the milk, stopping the effects created by the surface tension.

III. About the experiment

As said before, the reaction is unpredictable, so every time you carry out the experiment, you have something different. The issue is then to choose which picture is the best. Since I think that the whole experiment is interesting, I have chosen to present a video, so all the reaction can be shown.

The main issue with the pictures was the focus. Like another project made on a droplet falling in water, it is hard to focus the camera on the liquid. To do so, we took a pen, held close to the surface of the milk, and we focused on this rather than on the liquid itself. In my case, for the video, I had also some troubles with focusing. I took the video with my camera, and often as the liquid was moving with the reaction, the focus changed, creating some blur that was not really pretty to see. I did not really succeed in going through this issue, but I realized that holding the camera close to the container without zooming prevented the focus from changing too much.

I edited the video with the software Sony Vegas Pro 10, software similar to Adobe Premiere. I did not have a fish eye for my camera, so I added it to the video, in order to show only the phenomenon. At the end of the reaction, we realized that dragging a thin object into the mixture gave beautiful effects. You can actually see the whirl in the object's wake, thanks to the food coloring. I decided to add a picture of that at the end of the video, because the effects and the colors were really beautiful.

This experiment is quite easy to implement, but it however is interesting since you can see every day products reacting strangely together. The physics taking place in this phenomenon is also very curious. And of course, above all, the reaction is surprising and beautiful. Indeed, all the ingredients are put together for an interesting flow visualization.