Tears of Wine

Ben Maples

MCEN 5228 – Flow Visualization

February 8, 2009

Abstract

The Tears of Wine image was taken for the first assignment of the University of Colorado at Boulder Mechanical Engineering course MCEN 5228 – Flow Visualization. The objective of this assignment was to "get our feet wet" in the field of imaging fluid dynamics. The Tears of Wine image was intended to demonstrate the Marangoni effect seen in wines, bourbons, and other high alcohol content beverages commonly referred to as the "legs" or "tears" of the beverage. The image was taken in the hope that with this visualization more individuals will be able to appreciate and understand the complex fluid relations behind this commonly seen phenomenon.

Image Set Up

The image was taken in a well lit room by both natural light coming through windows as well as additional lighting from compact fluorescent light fixtures. The background of the pictures was set up so that the upper half was well lit and bright and the lower half was dark in order to so contrast in the legs from the lensing effect. Additionally, the image was taken at an upward angle towards the flow, as seen in Figure 1, in an attempt to increase the contrast.

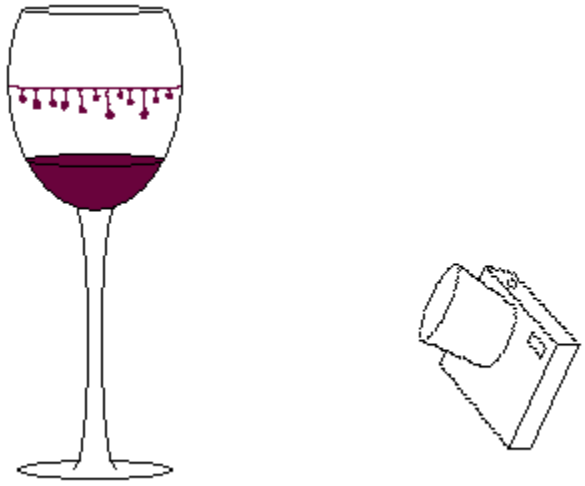

Figure: 1
Set up for Tears of Wine image.

The flow represented in the image was created by filling a standard clean wine glass approximately one third full of Picchetti Winery's 2001 Cabernet Sauvignon (13.5 % alc. by volume) and then swirling the wine so that the liquid would create a thin film on the inside of the glass. Roughly 15 seconds passed between the time the glass was swirled and the time of capturing the image. This was done so that the legs of the wine could develop but not long enough for them to run all the way down the side of the glass.

Phenomenon Explanation

The phenomenon seen in the image is an example of the Marangoni effect which describes the flow of liquid caused by surface tension gradients. This particular effect is due to the fact that wine is mostly a mixture of water and alcohol. Where the wine meets the side of the glass capillary action causes the wine to rise on the side of the glass. At the surface of the film of wine on the side of the glass both water and alcohol are evaporating, but at different rates. Because alcohol has a lower boiling point and higher vapor pressure than water it evaporates faster leaving behind wine with higher water content than before. The lower alcohol content wine has a higher surface tension than the lower wine causing more wine to be drawn up the film. When this additional wine builds up it tries to minimize its surface tension by beading and then falls back down the side of the glass under its own weight, producing the tears or legs that we can see in the image. The beads that are falling down the side of the glass can be seen not only because of the increased volume of the liquid, but more significantly because of the lower refractive index of the alcohol depleted liquid contrasting with the film of high alcohol liquid, glass and air. This phenomenon cannot be seen in just a glass of water or alcohol because they will lack the differential in evaporation rates. Similarly if you seal off a glass of wine or other high alcohol content liquid, the effect will not be seen because the liquid will not be able to evaporate.

Camera Settings

The photo was taken as a digital image with a Nikon D90 set with a focal length of 50mm in order to capture the entire glass so that viewers could automatically recognize what

they were viewing without having to read up on the image. F-Stop of 18, exposure time of 1/60 sec, ISO of 400, size of 2612x2241 pixels, and an aperture value of 1.6 was chosen to capture the clearest image of the fluid flow while at the same time minimizing focus on any distracting background objects. Cropping of the image to center the flow in the frame of view as well as an increase in contrast was used to heighten the observed flow phenomenon.

Conclusions

This image shows the beauty that fluid flows can have and the complex physical phenomena needed to produce these events. Overall the image that was captured came out very well. The photo clearly presented the phenomenon that it attempted to convey and it was done in a visually pleasing way. The lensing effect and contrast in the tears came out better than expected but unfortunately it came at the price of having a reflection off of the glass. In the future, better lighting techniques could be used to eliminate this distraction.

Works Cited

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