Get Wet: Heated Water Drops

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Introduction:

Before coming to my final image, I was intrigued by the effect of heat transfer on a fluid. I came to the conclusion of my experiment by putting droplets of water in a hot pan. I wanted to see how the large temperature difference between the pan and the water would impact how the water reacts. In the very center of the pan, the water would form almost rounded coins in the pan and would move sporadically. On the outer edges of the pan, the water would bubble up and looked like foam. The final image resulted in water droplets with well defined curvature.

Fluid Physics:

The captured image represents a variation of the Leidenfrost Effect. The Leidenfrost Effect is when a surface is significantly hotter than the fluid in contact with it. In this experiment, the fluid is regular tap water, while the surface is a hot non-stick pan. When the fluid makes contact, a layer of vapor is formed. As soon as contact is made with the hot surface, the fluid vaporizes extremely quickly. This vaporization is what creates the vapor layer and suspends the rest of the fluid above the vapor. The layer allows the fluid above to skid around the surface freely. The effect also causes the fluid to evaporate much more slowly. This is because the steam has low thermal conductivity when it makes contact with the hot surface. In my image, the pan was below 212^{o}F, which caused a lesser effect of Leidenfrost. Therefore, my final image resulted in a flatter fluid instead of more bead like.

Experimental Setup:

A kitchen stove top was used with an electric burner. A non-stick pan was heated to medium-high heat. In this experiment, the stove top dial was turned on to a 7 out of 10. A measuring cup with room temperature tap water was filled while the pan was heated. Varying methods of placing the water in the pan was used. I dipped my fingers into the tap water and flicked water into the pan. However, I thought that this method did not allow for enough water to be in the pan. I slowly poured water from the container into the center of the pan, approximately 1.5’ above the pan. Various different lighting sources were also used. The yellow overhead light of the stove was tested in combination with the white light from the kitchen light. However, the best results came from just the white kitchen light. Having the overhead light caused an undesired orange tint in the image.

Photography Techniques:

The camera used to capture the final image was a digital Canon PowerShot SX530HS. A medium shutter speed of 1/20 was used since the water in the pan was not moving as fast as the full Leidenfrost Effect would have done. The lighting in the kitchen was adequate so an aperture of f/5.6 was used along with an ISO of 1000. The camera was set up on a tripod in front of the stove, slightly higher than the pan itself. The lens was approximately 2’ away from the pan so no

equipment would be damaged. Due to this distance, a medium zoom setting was also used. The original image ended up being 4608x3546 pixels. The image was then transferred to GIMP for editing. In editing the image, the “curves” feature was used to accentuate the edges of the water droplets. The original image was also cropped down to focus more on the central part of the pan which had the most interesting water droplets. Finally, the brightness was turned down due to the pan being so reflective in the chosen original image.

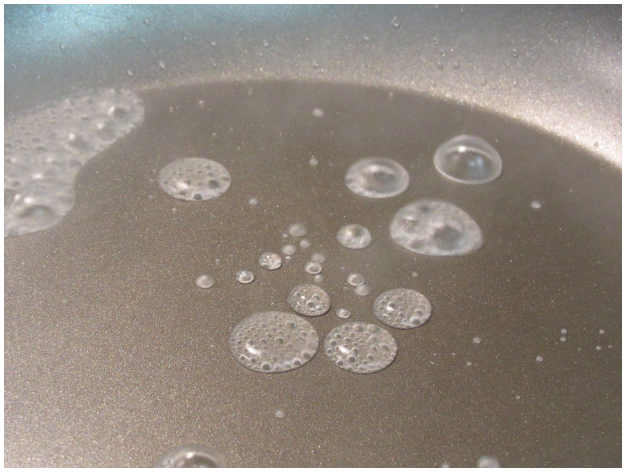

Figure 1. Original Raw Image

Conclusion:

The final image shows the Leidenfrost Effect and how it impacts fluid through heat transfer. I personally like how the image highlights the shape of the water in a way that is not seen too often. I also like the contrast of the dark pan background behind the water droplets. The pan adds a nicely textured background overall. I dislike how some of the smaller water drops are not as defined as the larger ones in the center of the image. I believe that I fulfilled my intent, which was to find out more overall about how heat transfer works on a fluid. I would improve like to improve the image quality by increasing the shutter speed of the camera to have a higher quality end image. In the future, I would like to try different fluids with varying densities and other properties specific to that fluid.