Bryan Wong
Image-Video Report 3
MCEN 4151
11/23/20

Image-Video 3 Report: Spoon under Laminar Flow

This image was taken to demonstrate the effects of laminar flow as it falls onto a spoon held underneath. The laminar flow is from a kitchen sink and the spoon is held underneath using my hand. By maintaining a constant mass flow rate in the kitchen sink, a laminar flow is achieved. When the laminar flow hits the face of the spoon, an interesting flow pattern is created and was captured in my image.

The flow from the kitchen sink flowed at a steady velocity with very little deviation in mass flow rate. When the flow velocity is low, this creates a laminar flow that is then used to impact the concave side of a metal spoon. In doing so, as the flow impacts the face of he spoon, a unique flow pattern is formed that can be described to be in the shape of a donut.

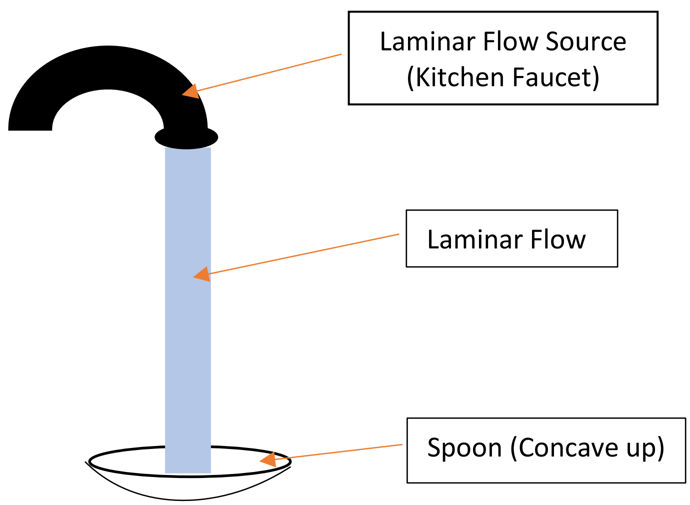


Figure 1: A sketch of the experiment apparatus. Includes the laminar flow source, the laminar flow, and the spoon.

In this experiment, the main flow phenomena that can be examined is the laminar flow as it hits a surface. However, other flow phenomena such as free fall effects on a laminar flow can also be observed through this experiment. In this experiment a laminar jet falls vertically onto a concave surface and spread out radially across the face of the spoon. As the jet leaves the outlet of the faucet the diameter of the flow decreases as it travels further downward. This effect can be explained through continuity. With this example, we can use the equation:

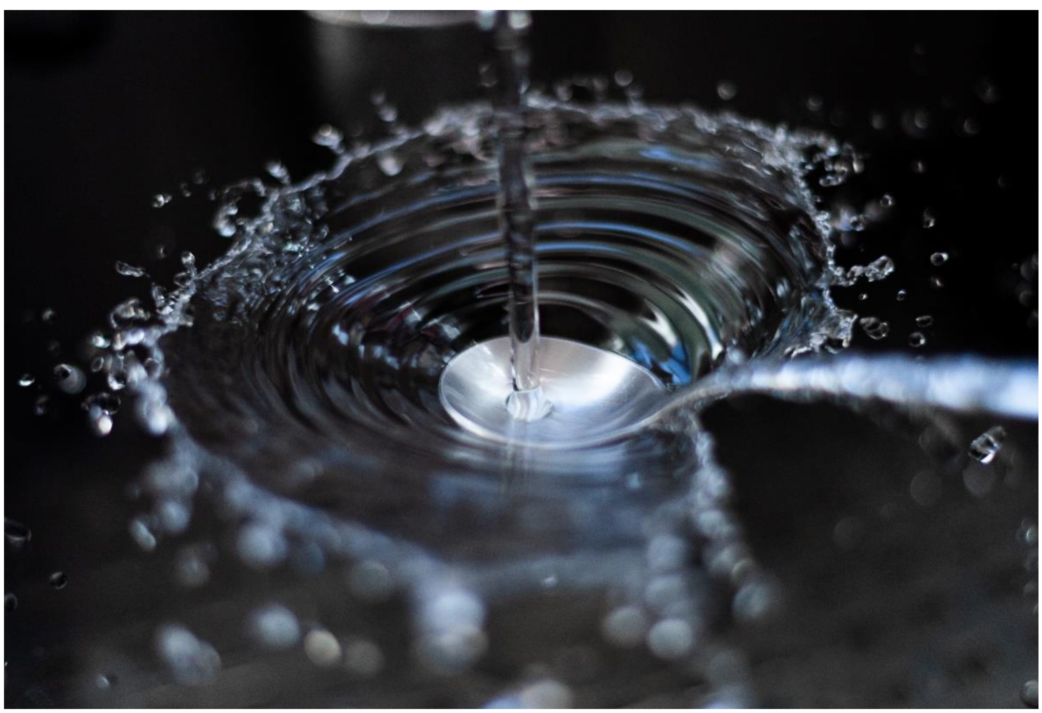
$$A_1V_1 = A_2V_2$$

Where A_1 is the initial cross-sectional area of the flow as it exits the faucet, V_1 is the initial velocity of the flow as it exits the faucet, A_2 is the final cross-sectional area of the flow, and V_2 is the final velocity of the flow. Using basic physics knowledge, since the flow is in free fall, it is ultimately affected by gravity. Due to gravity the flow will accelerate downwards thus, increases it's velocity. From the equation above, if V_2 increases, A_2 will need to decrease to keep the equation balanced on both sides. This equation explains why the laminar flow's cross-sectional area decreases as it travels further for the faucet outlet. When the flow hits the surface of the spoon, it spreads out across the surface. This flow phenomena can be described when examining the stagnation point. When a fluid flow is in the immediate neighborhood of a solid surface, the fluid divides into different streams or a counterflowing fluid stream [1]. This phenomena can be further detailed using studies conducted by Hiemenz and Homann. When the laminar flow hits the surface of the spoon, it creates a stagnation point which causes the flow to spread out radially across the spoon thus creating the unique flow pattern of a thin layer of water flowing off the edges of the spoon. However, this observation can only be made when using a laminar flow. If the flow was turbulent, the velocity of the flow hitting the spoon would be too great and result in the water just splashing across the spoon surface in a random fashion.

To visualize the phenomena described above, water was used. More specially, water from a faucet was used in this experiment. The experiment was performed in a controlled environment eliminating the possibility of wind or other external interferences. The only light source used for the image was natural light shining through the kitchen windows. The natural light was sufficient enough to light the experiment to capture a sharp image. This experiment was conducted during mid-day so the natural light provided by the sun was at its brightest.

This image was captured using a Nikon D810 with a 50mm f/1.4 prime lens. Using this lens allowed the image to be captured with an extremely shallow depth of field. The shallow depth of field then allows for the foreground and background of the image to be blurred out highlighting the details of the flow. The lens was setup on a tripod to ensure stability in the image to avoid any motion blur. The lens was positioned about one foot away from the flow. The shutter speed used to take the image was set to 1/2000th of a second to make sure the details in the flow were sharp. As mentioned previously, a focal length of f/1.4 was used to create a shallow depth of field. To compensate for the lack of artificial lighting necessary, the ISO was set to 200. This allows the image to be taken at a more proper exposure while not introducing too much noise. The final image was cropped to dimensions of 5619 x 3796 pixels.

Original Image



Edited Image

For post-production, Adobe Lightroom was used to make adjustments to the image so the details in the flow could be highlighted. The original image was cropped to center the spoon. Then the exposure of the original image was increased. Contrast was also added to better distinguish the highlights and the shadows within the image and to give the image more depth and detail. Finally, minor edits were made to change the hue and saturation of the blues in the image to make the image more interesting and visually appealing. This also gives the overall image a cooler tone which is what I believe to be the most interesting and pleasing color palette.

To me, this image highlights the beauty in everyday flow phenomena most people experience. This simple experiment can be recreated by anyone with just the use of a faucet and a spoon, yet the results, if captured properly, can be mesmerizing. In my image, I like how the focus is on the spoon while the background is sufficiently blurred out. It makes the subject of the image stand out and gives the image more depth. In future iterations of this experiment, I would like to add more sources of lighting. The original image was very underexposed and adjustments to the camera settings to compensate for the lack of lighting would only hurt the quality of the image. I may also consider using different shapes of surface to observe the differences between them. This may prove to create interesting results such as the differences in the flow after hitting a square surface or even a more concave surface. Despite these adjustments for future iterations, I believe the physics and flow phenomena examined are perfectly depicted in the image.

References:

[1] Wikipedia contributors. (2020, October 14). Stagnation point flow. In *Wikipedia, The Free Encyclopedia*. Retrieved 7:58, November 23, 2020, from https://en.wikipedia.org/w/index.php?title=Stagnation_point_flow&oldid=983401867

[2] Hathcox, Marsch, Ward. "Why does a stream of water from a faucet become small at it falls?" June 2001. https://www.uu.edu/dept/physics/scienceguys/2001June.cfm