Flow Visualization 4151-003: Team Second

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The second team project was done solo, and the photo above is a screenshot from a video taken at a research facility in Golden, Colorado. This is a vibrating bed called a Sweco with a mesh screen at the bottom used for filtering particle sizes. This is a rare phenomenon that occurs when the screen mesh of the Sweco is blinded, and water cannot properly pass through. This causes the water poured onto the vibrating bed to be jetted upwards.

Because of the chaotic nature of this phenomenon, it is extremely difficult to quantify any useful Reynold's numbers or other intuitive descriptions of the flow. In essence, the Sweco is a mesh bed that vibrates in a circular motion at about 20 rotations per second. The Sweco shown above is about 4 feet 10 inches across. The nature of its vibration also causes some minor vertical vibrating about the circumference of the Sweco. These vibrations all cause the water to jet upwards at random locations. Although difficult to describe this behavior, the mesh can be described with Darcy's law; an equation that describes fluid flow through a porous medium [1]. The equation used is $k = cR^2$. In this equation, k is the permeability of the medium, c is a constant for the equation, and R is an estimation of the pore radius. As the radius decreases, the permeability also decreases. Since permeability describes the resistance of fluid flowing through the medium, a smaller radius due to a clogged (blinded) screen means that less water will be able to pass through.

Another possible fluid behavior that can be seen is a standing wave phenomenon. A standing wave is a wave that or behavior that changes with some disturbance (in this case, the vibrating bed) but

does not move in space [2]. In this instance, the water has found some vibrational frequency with the Sweco and has created a series of upward jets. As previously stated, because this phenomenon is so complicated and chaotic, it is difficult to quantify any values that would provide a useful explanation for what's being seen.

For the setup, no dye was used. I was unable to tamper with the incoming water in any way as it was plumbed out of the building's water supply. It was plumbed into the Sweco via 2 locations, a large PVC pipe (which normally holds whatever product is being processed) and a pipe to rinse the product that is typically being separated inside of the Sweco. For lighting, there were several overhead white fluorescent lights about 35 feet up that evenly lit the facility.

Given the spontaneous nature of this phenomenon, an iPhone 13 Camera was used. With this being said, *NO* exposure settings, ISO, shutter, or aperture settings are available. However, the video came out to be 1920x1080p with the final frame being the same size after editing. The only manipulations done to the video were brightness, contrast, and color corrections for aesthetics.

This image shows a fascinating phenomenon of water jetting directly upwards on the vibrating particle separator. Though nearly impossible to quantify, the standing wave phenomenon and Darcy's law are applicable here. Although, the standing wave phenomenon is a bit difficult to see or confirm. Next time, I would like to get a high speed camera on the bed to see more easily what is actually happening when the water is "dancing" about.

References

[1] https://en.wikipedia.org/wiki/Darcy%27s_law

[2] https://en.wikipedia.org/wiki/Standing_wave