

Team Second Report – Flow In a Flume



Purpose of the image

When looking for subjects to shoot in this assignment, our team decided on the photographing of fluid flow in a flume. In this video I found that I was able to capture interesting flow phenomena best represented in video by the swirling motion of the flow, which is altered by the flow speed of the flume. In combination with the placement of the background light and use of a blue dye shade that accurately represents flow on the ridge shape, I felt that I was able to accurately portray the interaction of the water and an obstruction, changes in flow due to jet velocity, and how quickly the dye diffuses through the water.

Flow demonstrated

In this video, we can see the effects of vortices, Kelvin-Helmholtz instability, and the effects of a jet in a crossflow due to the upward velocity of the jet. Firstly, vortices can be seen at points in the video (such as 0:36) where two layers of water with different velocities causes a shear effect in the areas of water displayed by the dye. Such vortex points in the flow can best be described as irrotational vortices, whose tangential particle motion is dictated by the equation

$$u_{\theta} = \frac{\Gamma}{2\pi r}, \text{ where } \Gamma \text{ represents the circulation of contours that enclose the vortex axis once.}^1$$

¹ "Vortex." Wikipedia, Wikimedia Foundation, 9 Apr. 2018, en.wikipedia.org/wiki/Vortex

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FILM 4200

In this video, the flume apparatus is flowing at a rate of 1.09 liters/second, giving a horizontal velocity of approximately 4 cm/sec. The difference between this overall velocity and fluid velocity closer to the plastic wedge differ enough to cause the aforementioned Kelvin-Helmholtz instability, while also causing pooling of low-velocity flow in the depression of the plastic wedge.

Materials Used

The materials used consist primarily of a Blackmagic Pocket Cinema Camera with a Lumix G Vario 12-35mm lens used to shoot the flow visualization, an open channel flume apparatus with a 40 liter volumetric tank capacity, a set of Husky work lights for backlighting, white poster board, and blue watercolor dye with a viscosity similar to that of water. Our group experimented with changing the position of the lighting setup, lighting the apparatus from above but eventually settling on diffuse lighting from the side. The process of shooting the image required filling the flume to maximum capacity and running it at a consistent flow rate, then injecting blue watercolor dye into the mixture. We underwent the process of emptying the flume apparatus and refilling with clean water once.

Photo technique

By using the strong backlighting of the diffuse worklight, our group could make use of the white background to then experiment with exposure and capture a flow that was well-lit from all angles. Use of shallow depth of field was another intentional element, shooting at an f-stop of f5.4, a framerate of 30 and a shutter speed of 1/60. In conjunction with an ISO setting of 1600, the exposure of the image made for a satisfactory result. Finally, I color graded and edited the footage in Blackmagic Resolve.

Honorable mention videos:

