GROUP PROJECT 2

Brian Roche
University of Colorado, Boulder
Mechanical Engineering

MCEN 4228, Flow Visualization
08 November, 2007
Jean Hertzberg

Still images of flames are among the more captivating for humans to see. This is perhaps because we never get to see a 'still' flame in real time. For this project, we have explored the physics of flames and attempted to capture their natural beauty. The intent of this image was to capture a violent, quick-burning flame and its reaction with solid media, in this case galvanized steel mesh. An added bonus to the image was the reaction with the galvanizing metal, which sparked and burned bright blue.

To take this photo, a MAPP gas torch was used to introduce a flame through a section of mesh that had been rolled up several times. The diameter of the torch tip is approximately 1.5 cm, and the individual wires on the mesh are approximately 1 mm. The exit velocity of the gas is approximately 2 m/s. If we assume that the viscosity of the flame is close to that of air at 1000 degrees Celsius, we attain a Reynolds number over the mesh of 10.99. This indicates that the flow is laminar. However, this seems like the problem has been oversimplified, which is also evident by the random directions of sparks in the image, indicating possible turbulent flow. A major point of interest in the image is the zinc galvanization burning off. When it does, it produces a bright blue flame, and since it burns violently, it may also cause sparks.

To capture this image, a flame was used in a dark environment (a garage) with a black backdrop. Both the steel mesh and the torch were hand-held. As the zinc burned off, the torch was slowly moved to a 'clean' area of the mesh, to keep fresh zinc burning. The light of the flame, the red-hot metal, and the burning zinc provided all of the necessary lighting in this image.

The camera used was a Nikon D200 digital SLR, with a 60mm f/2.8 Micro Nikkor lens. The image has pixel dimensions of 2683W x 2622H, and was taken with an ISO setting of 800.

The shutter speed was $1/10^{th}$ of a second, and the aperture was f/3.2. The distance from camera to the flame was approximately 2 feet.

The image reveals an interesting variety of fluid flame and solid spark particles. The interaction, or rather lack thereof, of these items is almost as interesting as the fluid flow itself. The solid particles seem to be 'on their own' from the fluid flow, which is counterintuitive to how we understand fluid flow with solid particles. The dominating feature of the image, however, is the contrast of cool and warm tones. The flame starts as a very blue color, quickly warms up to a hot orange-red, and the slowly cools back down to a light blue.

REFERENCE

Simon, W. and Base, Daniel. *Manual of Chemistry.* 11th ed. Philadelphia: Lea and Febiger, 1916.