Iron Sparks over Water

MCEN 5151-Group 9, Image #2

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This picture was taken for the second group image in the Flow Visualization class at the University of Colorado. It was captured with the aide of Lotem Sella, Kelsey Spur, Paul Sweazey, and Aaron Porras. The intent of the image was to capture the reflections of sparks over a body of water. A mirror was also used to reflect the light, adding further complexity. There was minimal processing done to the photo, only basic adjustments to the contrast.

The setup (shown in Figure 1) for this image was relatively straightforward. A piece of steel was placed in a vice. An angle grinder was used to generate the sparks and aim them towards the mirror, which was being held above a tank of water.

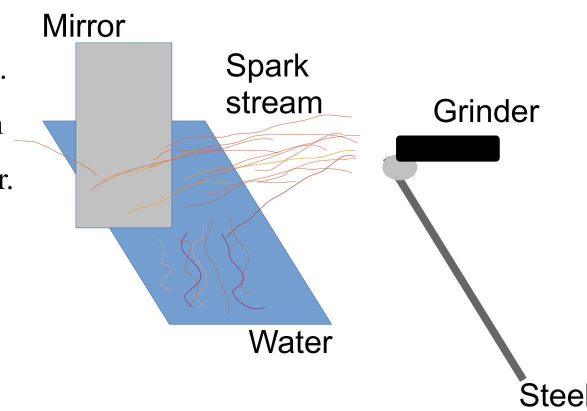

Figure 1: A simple setup was used to capture the sparks and their reflections.

A long exposure was used to capture the trails of the sparks. Unfortunately, the exposure is long enough that the trails extend throughout the entire image. Had a shorter exposure been used and the sparks only extended through a portion of the frame, it would be possible to estimate their speed. Some information could possibly be gleaned from the trajectory of the sparks, but a better method of estimating their position would be necessary. This image can, however, provide some insight into the type of steel that is used.

Spark testing is a technique that can be used to identify certain steel alloys. When an abrasive wheel is used to grind the metal, friction and oxidation cause the particles of steel to be heated[1]. The shape and color of the sparks can be used to help determine what elements the test piece is made of. Different materials will cause the light radiated by the sparks to have different intensities at different wavelengths[2]. Materials with a higher melting point will cause the sparks to be cooler, making them appear red. As the melting point of the alloying elements decreases, the spark temperature increases, causing them to emit light at shorter wavelengths and appear brighter[3]. The concentration of the alloying element also plays a role in the color shift.

In addition to color, the shape of the sparks can be helpful in identifying the alloy. As the particles heat, CO_2 and CO form on the surface due to oxidation. This causes a skin to form on the surface of the particle which flakes off easily. Hot gases escape as the skin cracks, causing the bursts seen in the spark stream[1]. Alloying elements will cause the number of bursts, their location in the stream, and other characteristics to change[2].

A Casio Ex-ZR100 high-speed digital camera was used to capture the image. The ISO was set to 100 with a 1/50 s shutter speed. The focal length was 4.2 mm with an aperture of F/3. No flash was used. The original image was 3,648 x 2,736 pixels, cropped to 1,808 x 920 in the edited image. Minimal editing was done for the photo, only small adjustments made to the red contrast curve to enhance the difference between the sparks and their reflections.

Artistically, this image achieves what was intended: a visually appealing interaction between the sparks and their reflections. A shorter exposure worked well also, giving more detail to the individual sparks, but the reflections were subdued and barely noticeable. With regards to the information that can be gleaned from the image, an experienced spark tester may be able to make some determination of what type of alloy was used.

References

[1] R. W. Buzzard, *The utility of the spark test as applied to commercial steels*, J. Res. Nat. Bur. Stand. 11, 527 – 540, (1933).

[2] R. D. Brown, JR, W. D. Riley and D. M. Soboroff, *Sorting techniques for mixed metal scrap*, Conservation & Recycling, 9, 73-86 (1986).

[3] J. Hunger and 0. Werner, *The influence of structure on plain carbon and alloy steels upon the spark stream in spark testing*, Arch. Eisenhuettenwes. 23, 277 - 286 (1952).