Pinned in Fire: The Effects that Thermal Processing Has on the Working Properties of a Steel Bobby Pin

Boudreaux, Kate (School: Bartlesville High School)

The purpose of my project is to see how a steel bobby pin reacts when cooled at different rates and then placed under a load. My hypothesis is if I heat and anneal a bobby pin, then it will have more working strength than a bobby pin that is heated and quenched, because when a metal cools slowly after being heated, the atoms move into a more organized structure that will hold up better under load. To test this hypothesis, I will heat 20 bobby pins quenching them in four materials: water, canola oil, salt, and air. These materials will cool the bobby pins down at different rates, leading to different grain structures in the bobby pins. I will repeat this process 5 times. Next, I will suspend a styrofoam cup on the end of each bobby pin creating a cantilever. I will place pennies in the cup, up to 300 or until the bobby pin breaks, and measure the deflection of the bobby pin. The data supported my hypothesis showing that the slower the bobby pin cooled, the more ductile it became. The more ductile bobby pins were able to bend under the weight of the pennies and hold, but the brittle bobby pins snapped, holding less weight. Cooling the red hot bobby pins quickly freezes the carbon and iron atoms of the steel into a disordered phase with many defects. Due to these defects, atoms cannot move easily and the metal is considered hard to bend and brittle. This project has several thermodynamic real world applications such as: engineering when determining what type of metal to use a in a building, structure, or designed machine; biomedicine when determining materials to utilize in bone replacements; artistic license to determine what media to use to convey an idea; and space exploration when determining the best materials to utilize in highly heated environments.

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