CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36635

Project Title

Silica-Based Engineering to Solve Thermodynamic Threats to Wildland Firefighters

Abstract

Objectives/Goals

My objective is to extend the time of the current Nomex fire suit#s ability to protect firefighters from permanent damage due to exposure from direct flames and high intensity heat. My goal is that this new fire suit will give firefighters that additional time they need to deploy their fire shelter since it currently takes 30 seconds to deploy but the current fire suit allows only 14 seconds of protection.

Methods/Materials

I combined different fabrics to make a wearable suit that can be worn by firefighters. I built several frames from fire resistant wood composite and hung the various fabrics on the frames. I used a 1400°F+ propane torch to apply heat to one side of the test suit fabrics and on the other side I used a digital laser thermometer to record how much heat penetrated the suit fabrics. I recorded the time and temperature of each suit fabric as well as any physical changes in the fabrics itself. The test was designed to last 5 minutes because an able bodied firefighter can either self-rescue or get into their fire shelter in that time. Independent variable was the different fabrics: Nomex (knitted, magna, twill), silica fiber, cotton, polyester, and fiberglass welder#s tarp. Dependent variable was the time of fire and heat resistance. Controlled variables (constants) included: propane torch, measurement tool (laser digital thermometer), construction materials and time exposed to open flame.

Results

The best fire suit was a combination of fabrics in a specific order to address the different types of heat. The use of two different types of silica was the key to prolonged protection for the user without suffering any long term effects of exposure to direct fire and heat. The suit surpassed the 5 minute goal.

Conclusions/Discussion

Silica has the ability to be an insulator and shield from direct flames without burning. The use of silica in heat and fire behaves as latent heat. Silica not only kept the fabrics from burning but also reduced the heat that it allowed to penetrate, letting the other fabrics# ability to work as insulators without burning. Surprisingly, silica changed in appearance over time in the presence of a constant source of heat energy. As time passed, the silica changed its appearance and its ability to insulate from fire and heat. The data showed silica allowed heat to penetrate in plateaus, and not in a constant heat rise.

Summary Statement

The best fire suit uses silica-based engineering to combat direct flames and conduction heat.

Help Received

Henry Modregon (OSHA trained)-executed all the hard to handle testing procedures. Leslie Perez-proofread graphs and tables. Katteleine Guillaume sewed prototype