Enhanced Cooling of Firefighter Helmets using Phase Change Materials

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Successful regulation of heat-induced stress is one of the challenging aspects of firefighting science. During firefighting activities, the firefighters experience increased heat buildup in their bodies as a result of increased metabolism. This increase in metabolism causes a rise in the core body temperature. The rise in core body temperature if unchecked can lead to various ailments such as heat stroke, brain damage, and impaired thermal regulation. Firefighters can also experience unconsciousness or cardiac arrest. The above mentioned reactions or a combination of the same could prove fatal to the lives of the firefighters. The proposed project will strive to determine the safe duration of exposure during firefighting activities and the external cooling rate required for firefighters to regulate their brain temperature. The hypothesis of this research is that with the aid of external cooling, it will be possible to extend the safe working period for firefighters during firefighting activities. The project would involve the use of computational software, using which a predictive Whole Body Model will be used to compute the thermal response of individual firefighters to firefighting activities.

The proposed research is divided into two parts. First, the time taken for the human brain to reach the critical temperature of 40 ˚C during firefighting activities will be ascertained. Secondly, by accurately quantifying the required cooling rate for individual firefighters, it will be possible to regulate the core brain temperature around 37.2 ˚C using heat exchangers and phase change materials to transfer and store the heat generated by the brain. We propose that the accurate estimation of the thermal response of the human body will help in devising better cooling techniques. This will permit in limiting the heat-induced stress and avoid cooling shock to the body. The computational model can also be utilized to analyze new cooling technologies. This will be an attractive economic option over costly and exhaustive field trials. Most importantly, by helping to remove the excess heat generated during firefighting activities from the human body, it will help shield the firefighters from the harmful effects of heat-induced stress and save their lives.

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