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Gao, Chuansi; Kuklane, Kalev; Holmér, Ingvar

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Chuansi Gao, Kalev Kuklane, Ingvar Holmér
The Thermal Environment Laboratory, Division of Ergonomics and Aerosol Technology, Department of Design Sciences, Faculty of Engineering (LTH), Lund University, Sweden

Contact person: Chuansi.Gao@design.lth.se

Phase change material (PCM) vests can be used to cool the microclimate around human body in the heat, e.g., firefighting. The temperature gradient (T_{gr}) between skin temperature and PCM melting temperature (T_m) might have been the factor accountable for insufficient cooling effects in some earlier studies. The objective of this study was to physically quantify the relationship between temperature gradient and PCM cooling rate.

Three cooling vests tested with PCMs (inorganic salts) at three melting temperatures 24, 28, and 32 °C, had the same design, surface area, and mass. Before and after the tests, the vests were kept at 20 °C overnight for solidifying and preparing for re-use. Clothing worn on the manikin was Swedish RB90 fire fighting ensembles. These include T-shirt, briefs, RB90 underwear and outerwear, socks, and gloves. The PCM cooling vest was worn between T-shirt and RB90 underwear. Thermal insulation without the vest was 2.78 clo (0.431 m^2 ºC/W).

Thermal manikin Tore with 17 individually controlled zones with manikin surface temperature at 38 °C was used in order to assess the cooling rate in heat stress conditions. The vests were loaded with PCM packs (24, 28 and 32 °C), accordingly the resulting temperature gradients were at 6, 10, and 14 °C. Climatic chamber air temperature was kept the same as manikin surface temperature (isothermal condition), so that there was theoretically no heat loss from the manikin to the environment. As the cooling vest covered only torso part of the manikin, therefore chest, abdomen, upper and lower back zones were included in calculations for determining the cooling effects on the torso.

The results showed that among the torso heat losses of the thermal manikin at 38 °C in isothermal conditions, PCM24 has the highest cooling rate due to a greater temperature gradient (14 °C) even though the total latent heat is the smallest. The cooling rate/slope (-0.2949 W/m^2.min) was the steepest. On the contrary, the cooling rate was the smallest for PCM32 (slope: -0.0354 W/m^2.min). Obviously the duration of the cooling effect is shorter for PCM24, lasted about 2.5 hours due to the highest cooling rate. PCM32 has the smallest cooling rate and longest cooling duration (lasted more than six hours). The cooling rate of the PCM vests tested is positively correlated with the temperature gradient.