Mechanical Engineering Thesis Defense

Optimization and Implementation of Wind Tunnel Like Capsule for Sweat Evaporation Measurement in Humans

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Abstract

Human thermoregulation is substantially based on sweat evaporation, yet little is known about this process at the microscopic level. Midwave infrared thermography (MWIR) and optical coherence tomography (OCT) can assess the sweat evaporation dynamics from the skin, from the onset of a sweat droplet emergence from the sweat pores to its filmwise stage. In physiological studies, the rate of sweat evaporation is frequently determined using ventilated capsules or technical absorbent pads. The first part of this thesis compares flow fields and water film evaporation rates from a capsule with a sudden expansion transition section, from a round tube to a rectangular evaporation section and one with a transition consisting of a wind tunnel-like diffuser section. The comparative study shows that the ventilated capsule with the diffuser transition section is effective at minimizing the flow disturbances as compared to the chaotic flow occurring with the capsule with a sudden expansion transition section. The second part of this thesis focuses on optimization and implementation of the ventilated capsule with diffuser transition section in pilot human trials. The experimental setup and protocol for pilot human trials are also described. The capsule geometry is altered to increase the imaging field and include calibration or alignment marks on the skin to enable quantitative image analysis. Based on pilot human trials, several additional improvements to the ventilated capsule, including a soft gasket and alternative sapphire window, are proposed to further refine this sweat evaporation measurement and imaging technique.

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Zoom Link: https://asu.zoom.us/j/2282565241

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