Aerospace Engineering Thesis Defense

Direct Convection Correction for Cylindrical Radiometer Measurement

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Abstract

Human exposure to extreme heat is becoming more prevalent due to increasing urbanization and changing climate. In many extreme heat conditions, thermal radiation (from solar to emitted by the surrounding) is a significant contributor to heating the body, among other modes of heat transfer. Therefore, accurately measuring radiative heat flux on a human body is becoming increasingly important for calculating human thermal comfort and safety in extreme conditions. Most often, radiant heat exchange between the human body and surroundings is quantified using mean radiant temperature, T_mrt. This value is commonly measured using globe or cylindrical radiometers. These devices are cost-effective, consisting of only a small sphere or cylinder with a centrally placed temperature sensor. The T_mrt. It is based on radiation absorbed by the surface of the radiometer, which can be calculated from the surface temperature using a surface energy balance. In the energy balance, the convective heat loss from the device surface to the surrounding air needs to be accounted for. Typically, this is accomplished using a traditional heat transfer coefficient correlation with measured wind speed. However, the utilized correlations are based on wind tunnel measurements and do not account for any turbulence present in the air. The latter can even double the heat transfer coefficient, so not accounting for it can introduce major errors in T_mrt. This Thesis focuses on developing and testing a cost-effective heated cylinder to measure the convection heat transfer coefficient in field conditions. The measured value can then be used for accounting convection in measuring T_mrt using a cylindrical radiometer.

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