National Institute of Technology Rourkela

Departmental Seminar

Seminar Title	: Numerical simulation of heat and moisture transfer in protective clothing under extreme environmental conditions: Effect of fabric properties
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Venue	: ME Seminar Hall (ME-001)
Date and Time	: 06 Aug 2025 (10:00 AM)
Abstract	: Personal cooling through fabric-based thermal management is essential for workers operating in hot and humid environments. This study presents a numerical simulation to evaluate the thermo-physiological performance of five natural fabrics (linen, ramie, bamboo, tencel, and hemp) under extreme environmental conditions. A one-dimensional coupled heat and moisture transfer model was developed to capture transient interactions between the human skin, fabric layers, and ambient environment. Each fabric was modeled as a porous medium, and simulations incorporated variable ambient temperatures (20–40 °C), high relative humidity (90–95%), and wind speeds ranging from 0.01 to 10 m/s. Key thermal and moisture-related parameters such as skin surface temperature, heat flux, evaporative flux, water retention, and thermal resistance were assessed to understand fabric behavior in extreme conditions. Results revealed that linen outperformed other materials by maintaining lower skin temperatures, higher evaporative and conductive heat loss, and efficient moisture transport. Ramie and bamboo demonstrated moderate performance, while hemp and tencel retained more moisture and exhibited slower cooling responses. The study also analyzed the influence of airflow, showing that higher wind velocities significantly enhanced heat and vapor removal, especially in porous fabrics like linen. The findings emphasize the critical role of fabric selection and airflow dynamics in designing garments for thermal protection. This work provides a practical framework for the virtual evaluation of natural fabrics in extreme conditions, aiding the development of sustainable, high-performance clothing for occupational and outdoor applications. Keywords: Protective clothing, Heat and moisture transfer, Natural fabrics, Thermal comfort, Extreme environments, Moisture management.