Coupled thermo- aerodynamical problems in design of protection cloth

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ABSTRACT

The paper presents study of coupled aerodynamic and thermodynamic interaction between human body and environment under low temperature and wind conditions. The task can be classified as a typical problem with thermomechanical coupling of fluids (air or water) and structures (human body and clothes).

The body generates the heat within certain organs which is then transferred by the thermal diffusion through the body substance possessing very non uniform properties. A large fraction of the heat generated by internal organs is transported to the body periphery by a complicated net of blood vessels. The heat penetrates through the cloth and is transferred to surrounding medium by natural and forced convections.

Wind causes big areas of the overpressure on the cloth surface which results in deformations and local change of the cloth thickness. In its turn, change of the local thickness leads to an alteration of heat conduction properties of the cloth. This means that the heat exchange between body and air is changed not only by intensification of convective heat transfer but also due to change of thermodynamic properties of cloth caused by wind induced deformations. The second effect which has still not been discussed thoroughly in the literature is in focus of the present paper. Under strong wind conditions the heat transfer from the human body can sufficiently be increased due to change of the thermal conductivity caused by cloth deformation under wind induced pressures. For instance, at 10 m/s the heat increase could be of ten percent.
To keep the human body temperature on the acceptable level, the local heating elements can be embedded into the cloth textile. The power of this heating was calculated using the models of aero-thermodynamic coupled interaction including heat radiation. The results of the work are used for the design of real protection cloth for the work under low temperatures and wind conditions in oil gas industry.