A solution for footwear active cooling

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Footwear products should help the body maintain thermal balance [1, 2]. However, since footwear are relatively closed "systems", the temperature and humidity of the air trapped inside footwear can escalate over time due to sweat and heat released by the body. In this situation, user comfort is at stake and the conditions can favour the growth of bacteria and fungi. As a possible solution for this problem, a cooling solution based on enhanced convection inside footwear was studied numerically. For this purpose, a FEM-based approach [3] was used to simulate numerically the fluid flow and heat and mass transfer near the skin. This allowed the study of the effect of different parameters over the cooling potential of the envisaged solution, such as the air flow rate and the number and position of air inlets. Furthermore, it allowed the study of the temperature and relative humidity distributions along the footwear skin, as well as the analysis of the systems' energy requirements and associated weight, as a function of the characteristics of the electronics used to impose air motion and power the system.

Despite evidence of sub-optimal positioning of air inlets (i.e. at the footwear front edge and at the midway between toes and ankle), which resulted in zones with negligible evaporative and dry heat cooling (see Fig. 1), interesting overall cooling potential was obtained. Further research is needed to identify the optimal characteristics of the system, e.g. air inlet positioning, air flow rates and system's operating point.

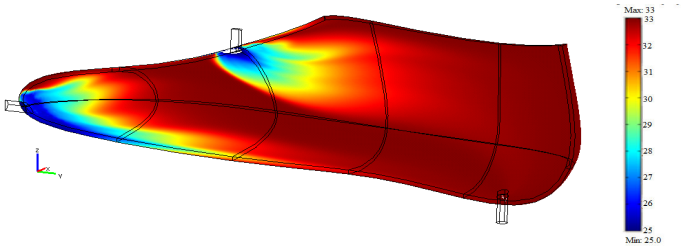

Figure 1 – Temperature distribution (ºC) inside footwear, for a solution with 2 air inlets

References

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