

Design criteria for assessment of vehicle climate systems

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Abstract

The combined thermal effects of convection, radiation and conduction in a vehicle compartment need special measuring equipment accounting for spatial and temporal variations in the driver space. The most sophisticated equipment measures local heat fluxes at defined spots or areas of a man-shaped manikin. By calibration of segment heat fluxes with thermal sensation votes of panel of subjects, manikin data can be used as a design tool for evaluation of the quality of the thermal environment.

Introduction

The combined thermal effects of convection, radiation and conduction in a vehicle cabin is complex and assessment of its performance needs more measuring equipment accounting for spatial as well as temporal variations (Holmér et al., 1995; Madsen et al., 1986; Wyon et al., 1989). A recent EU research project (EQUIV) investigated and evaluated different physical methods for the evaluation of the vehicle climate (Bohm et al., 1999). It is proposed that the “equivalent temperature- t_{eq} ” best serves the purpose of describing the thermal interface of the driver as a relatively simple, single climate index. The most sophisticated equipment to determine t_{eq} measures local heat fluxes at defined spots or areas of a man-shaped manikin.

Equivalent temperature

Equivalent temperature is defined (SAE, 1993) as “the uniform temperature of the imaginary enclosure with air velocity equal to zero in which a person will exchange the same dry heat by radiation, convection and conduction as in the actual non-uniform environment”

The mathematical definition is given by the following formula:

$$Q_{cal} = h_{cal} \cdot (t_s - t_{eq}) = h_c \cdot (t_s - t_a) + h_r \cdot (t_s - \bar{t}_r) + h_k \cdot (t_s - t_k)$$

where Q_{cal} is the manikin segment heat loss, h_{cal} is the combined heat transfer coefficient for the homogenous conditions, h_c , h_r and h_k are the coefficients for convective, radiative and conductive heat exchange, respectively, in the real