AN EVACUATION OF THERMAL ENVIRONMENTS ALSO FOR NON-SPECIALISTS

Gaetano Alfano, Francesca R. d'Ambrosio and Giuseppe Riccio
D.E.TE.C. - Dipartimento di Energetica, Termofluidodinamica Applicata, Condizionamenti Ambientali - University of Naples - Italy

INTRODUCTION

In the planning of life and work environment it is becoming more and more important to calculate conditions which ensure thermal comfort, in case of moderate thermal environments, or avoid thermal stress, in case of extreme thermal environments, to the exposed people. In this connection, so many advances have been made in the last thirty years in the field of thermal environment, that now indoor climate Standards are specified in greater detail than they used to be and the evaluation of an environment from the thermal point of view needs the intervention of a specialist.

This evaluation is generally done using some indices which are generally also reported or are used in the ISO and ASHRAE Standards:

- for moderate thermal environments PMV (ISO 7730, [1]) and ET* (ASHRAE 55-81, [2]);
- for extreme bot environments WBGT (ISO 7243 [3]) and SW_{req} (ISO 7933 [4]);
- for extreme cold environments IREQ (ISO/CD 11079 TR [5]).

Generally, each of the reported indices can be used only for a specific kind of environment; this can create confusion at the moment of the evaluation, especially in those people who aren't experts on the matter. For this reason we decided the following computer program, which constitutes an instrument to solve the problem. The first time this program was presented at the I.E.A. Congress in 1991 [6]. Now it is at the second edition.

DESCRIPTION OF THE COMPUTER PROGRAM

The computer program uses as input data the classic parameters, parameters linked to the person (clothing, that is thermal resistance, I_{cl}, and clothing vapour permeability, i_{cl} or i_w, metabolic rate M) and environmental parameters (air temperature, t_a, air velocity, v_a, relative humidity, ϕ, mean radiant temperature, t_r).

It is also possible to have as input data:
as alternative to t_a: the globe temperature, t_g, or the six plane radiant temperature, t_{pr};
as alternative to ϕ: the wet bulb temperature, t_w, or the natural wet bulb temperature, t_{wn}, or the partial pressure of water vapour in the air, p_a, or the dew point temperature, t_{dew}.

However, at the end of the first part, the computer program always knows either t_r and ϕ either t_g and t_{nw}. The last two values are necessary to evaluate the WBGT index To change from classic environmental parameters to t_g and t_{nw} and vice versa, the computer program uses the equations by Sullivan and Gorton [7], corrected for free convection.

The program makes use of the PMV index to indicate the different kind of thermal environments. If the value of this index is in the range (+1,-1) the thermal environment is considered moderate. In this case the program calculates also the indices PPD, ET*, and DISC [8,9] and evaluate the presence of local thermal discomfort. If the value of PMV is less that -1, the environment is considered extreme cold. In this case the program calculates the global index, IREQ, and the WCI index Similarly, if the value of PMV is more than +1, the environment is considered extreme hot and the program calculates the WBGT, the SW_{req} and the DISC indices.

The range of PMV values (+1,-I), which is used to distinguish the kind of environment, could seem too small. Anyway, it should be considered that the PMV index gives good results in the range of parameters

over which it has been validated by experimental data and does not depend on the type of clothing vapour permeability: in case of clothings whose vapour permeability values are very different from the usual ones, condition of thermal stress can occur also with PMV very close to ±1. For instance, for M=1.2 met, I_{cl}=.60 clo, $t_a=t_r=27°C$, $v_a<.10$ ms^{-1}, $\phi=.80$, the PMV index is nearly +1 but, for $i_{cl}=.10$ the DISC index is nearly 4.

MAIN CHARACTERISTICS OF THE COMPUTER PROGRAM

The computer program synthetically presented before is interactive and is very easy to use also by people who have a general knowledge of thermal environment problems, but are not a specialist in this field. Among other things, this computer program:

- reminds the user of the reference values of the standards in force, and compares these with the analyzed environment values;
- helps the user to evaluate parameters, in case they are not known or experimentally evaluated (e.g. it reports lists of metabolic rate and clothing thermal insulation values).

REFERENCES

1 ISO, 1984, ISO standard 7730, "Moderate thermal environments - Determination of the PMV and PPD indices and specification of the conditions for thermal comfort"., Modified draft, August 1990, Geneva: I.S.O.

2 ASHRAE, 1981, ANSI/ASHRAE standard 55-81, "Thermal environmental conditions for human occupancy". Revised draft standard 55-81, sept. 1991. Atlanta A.S.H.R.A.E.

3 ISO, 1989, ISO standard 7243, "Hot environments - Estimation of heat stress on working man, based on the WBGT index, Geneva: I.S.O.

4 ISO, 1989, ISO standard 7933, "Warm environments - Analytical determination and interpretation of thermal stress using calculation of required sweat rate". Geneva: I.S.O.

5 ISO, 1990, ISO/CD 11079 (TR), "Cold environments - Determination of required dothing insulation (IREQ). Geneva: I.S.O.

6 Alfano, G. Cesarano, A. and d'Ambrosio, F.R., 1991, A computer program for thermal environment evaluation, in: "Designing for everyone" (Taylor and Francis, London), 924-926.

7 Sullivan, C.D. and Gorton, R.L., 1976, A method for calculation of WBGT from environmental factors. ASHRAE! Transactions, Vol. 82, pt. 2, pp.279-292.

8 Gagge, A.P., Fobelets, A.P., and Berglund L.G., 1986, A standard predictive index of human response to the thermal environment, ASHRAE Transactions, Vol. 92, pt.2b, pp. 709-731.

9 Alfano, G., Cicolecchia, S. and d'Ambrosio, F.R., 1989, The influence of the vapour permeability of clothing on thermal discomfort. ASHRAE transactions, vol. 95, pt.2, pp. 309-315.