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48 Clothing surface area as related to body volume and clothing microenvironment volume
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The evaluation of clothing surface area becomes important in analyses of heat exchange between the clothed body and its environment. The evidence accumulated in the studies of radiation area (Bedford, 1935; Guibert and Taylar, 1952; Nielsen and Pederson, 1952; Fanger, 1972) has led to the conclusion that the ratio of clothing surface area to body surface area (f_{cl}) may be defined as a function of clothing Insulation. However, there has been disregard of the effects of clothing fit, despite of the observations of McCullough et. al. (1984) that f_{ci} does not correlate strongly with clothing insulation alone.

Radiation area factors were derived with a photographic method (Horikoshi and Kobayashi, 1982) for five subjects wearing four different helicopter pilot suits. While sitting on a seat suspended in the center of a box shaped frame, photographs were taken of the subjects with a fish-eye lens at 00 equidistant points on the six sides of the frame. The derived factors of 0.7 f 0.18 (mean SD) for the unclothed case closely agreed with that reported by Fanger (1972). while it scattered in a relatively wide range for a given suit.

The present study proposes a new approach for predicting f_{cl} as related to the body volume and the clothing microenvironment volume, and defines f_{cl} as:

$$1)\ f_{cl} = \left(1 - V\mu / \sum_{i=1,\ i\neq m}^{N} Vi\right)^{0.5}$$

where, $V\mu$ = volume of clothing microenvironment (m^3)
Vi = volume of i-th body mmponent (m^3)
m = exposed body components (e.g. head, feeet and hands)

Assuming that volume of the head is 7% of the total body volume (Vb, m^3), equation 1 can be rewrittenas:

$$2)\ f_{cl} = (1 + 0.93 \cdot V\mu / Vb)^{0.5}$$

Since all the suits tested enclosed the entire body surface with the exception of the head, equation 2 can be compared with the observations. The body volume and the clothing microenvironment volume of each subject were determined using the water displacement method and the method suggested by Sullivan et al. (1985), respectively. The predictions showed a good correlation with the values derived from the photographic method. It is therefore suggested that improvement in the prediction of f_{cl} has been achieved by incorporating clothing fit.

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