

HEAT TRANSFER PROPERTIES OF CHEMICAL PROTECTIVE OVERGARMENTS  
 WITH VARIABLE PERMEATION PROPERTIES

C.A. Levell and R.R. Gonzalez

United States Army Research Institute of Environmental Medicine

Address for reprints:  
 US Army Research Institute of Environmental Medicine  
 Biophysics Branch, Military Ergonomics Division  
 Kansas St.  
 Natick, MA, 01760-5007 USA

The human ergonomic and biophysical potential of prototype chemical protective (CP) overgarments (OG) with variable permeation properties and/or easily attached or removable hoods is a desirable option during extended work covering wide environmental temperatures. Several CP, OG options were studied to determine differences in insulation (clo) and vapor permeability ( $i_m$ ). Each OG was evaluated alone on a copper manikin with mask, gloves and boots ( $T_a=27^\circ\text{C}$ , rh 50%,  $V=0.5\text{m}\cdot\text{s}^{-1}$ ). Table 1 gives this data along with a US attached permeable hood (70-mil) integrated hood with standard OG and two vapor permeable rainsuits (polytetrafluoroethylene [PTFE] laminate) calculated with ASTM moisture vapor transmission rates (MVT) of 700 and 450  $\text{g}\cdot\text{m}^{-2}\cdot 24\text{h}^{-1}$ .

Table 1. CP overgarment properties

Items	clo	$i_m$	$i_m/\text{clo}$
<u>1. NATO</u>			
a. French integrated hood - closed	2.57	.33	.13
b. UK integrated hood - closed	2.27	.32	.14
c. Netherlands integrated hood - closed	2.49	.27	.11
d. US standard without hood - open	2.24	.35	.16
US standard - closed	2.55	.28	.11
<u>2. US Permeable Hood</u>			
a. Battle Dress Uniform with Permeable Hood (70-mil)	2.01	.32	.16
b. Standard Battle Dress Uniform with Impermeable Hood (90-mil)	2.01	.27	.13
<u>3. Vapor Permeable</u>			
a. Battle Dress Uniform (standard)	1.49	.39	.26
b. Battle Dress with standard rainsuit	2.00	.22	.11
c. Battle Dress with MVT 450 $\text{g}/\text{m}^2/24\text{hr}$ PTFE rainsuit	1.89	.34	.18
d. Battle Dress with MVT 700 $\text{g}/\text{m}^2/24\text{hr}$ PTFE rainsuit	1.89	.37	.20

The  $i_m/\text{clo}$  of the permeable hood was ~~some~~ 23% larger between U.S. integrated hood garments; but this showed little difference from NATO OG. The minimal difference in heat transfer between hoods probably does not compensate for any reduction in agent protection which is afforded by the impermeable hood. PTFE showed a 40% increase in the  $i_m/\text{clo}$  over the standard impermeable rainsuit. Higher potentials for evaporative cooling may reduce heat strain on the wearer in hot environments but warrant further testing by physiological studies. These data illustrate the protective merits of thermally integrating various clothing materials in structural military clothing.