PHYSIOLOGICAL AND SUBJECTIVE RESPONSES TO WORK IN ASBESTOS PROTECTIVE SUITS

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INTRODUCTION

Work with asbestos products on site is rather heavy and performed in tiresome working postures, often in narrow and warm spaces. Since the work has to be done in full personal protective equipment; i.e. overall and ventilation mask, there is a great risk that the thermal balance can not be maintained [3, 5]. In a previous study [4] the physiological and thermal strain was monitored during asbestos work in the field. The present study was undertaken as a complement with an aim to determine, during controlled climate and working conditions, the effect of different types of protective suits on the heat balance and to calculate their permeability. This paper, however, only gives a summarized view of some physiological and subjective data.

METHOD

Subjects

Four healthy males volunteered for the study after their informed consent had been obtained. All subjects where familiarized with the measurement procedures before entering the experiments. The subjects had an (Mean±SD) age of 36±8 years, a weight of 70±7 kg and a height of 1.76M.07 m.

Clothing

The subjects were dressed in shorts, socks, and sneakers for one condition (No PS) and in combination with each of the suits for the other conditions. The suits were made of Gore-Tex® (GT), Molnlycke polypropylene (PP) and Tyvek® (TYV). Every suit except the GT was taken new to each experiment, and was taped close to the leg down at the ankles.

Climate

Three types of protective suits for asbestos removal work were tested in climatic chamber experiments at two ambient temperature conditions, 24.9±0.6 and 35.7±0.7 °C. The relative humidity and air velocity were 50±12, 26±3 % and 0.3±0.1 m/s.

Measurements

The subjects performed each experiment at the same time of the day to avoid circadian variations in body temperature. The preparation of the subjects did take about 20 minutes and was done in a antechamber with an air temperature of 22°C and a relative humidity of 40%. Thermistors for skin temperame measurements (Fenwall, UUA32J3) were taped on 8 locations. Core temperature was measured with a thermistor (YSI 401) inserted 8 cm beyond the anal spincter. Four humidity sensors were used (Two Vaisala HMP-I 13Y and two General Eastern 850) placed on the right thigh, trunk, back and right arm to measure the relative humidity near the skin. The heart rate was measured with a chest electrode belt and a recording unit (Sport Tester PE3000). Potentiometers were used to set subjective ratings (work, temperahue, sweating and comfort). The total weight loss due to evaporation was measured with a scale (Mettler KC240) under the ergometer (Siemens 380B).

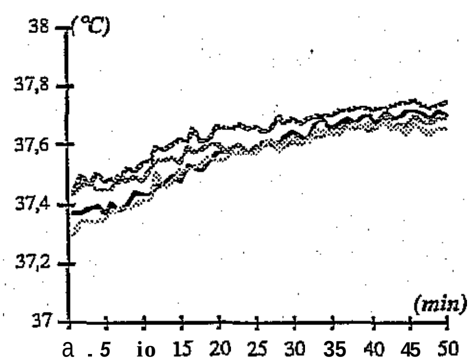
Procedures

Four subjects performed 50 min of bicycle exercise at 90 W. All temperatures, humidities, heart rate, subjective ratings and weight loss were collected by a computer (IBM AT) every minute during the experiment and stored for analysis. Each piece of clothing was weighed (Sartorius 1403MP) before and immediately after the experiment when removed from the subject. The only dripping possible, from the face, was wiped of with a towel stored in a bag and the weight difference was calculated. Oxygen uptake (VO^2, RQ) was measured, between minute 20 and 30, with an oxygen uptake system (Ametek OCM-1); calibration was checked before each experiment The subjects worked without a breathing apparatus in order to facilitate oxygen uptake measurements and sensor placement.

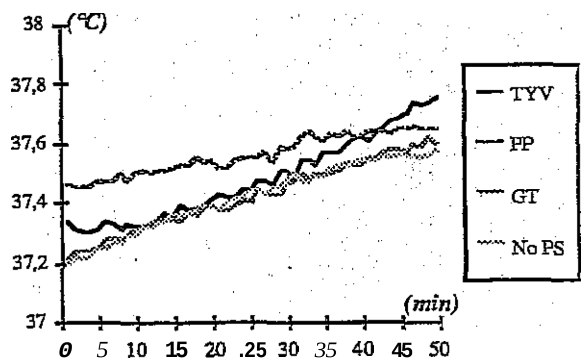
RESULTS

In the 25°C experiments the subjects reached thermal balance after approximately 35 minutes and the rectal temperature showed only marginal differences *between* the different suits (see diagram below). In 35°C, on the other hand, the subjects were not able to reach and maintain steady state, and the rectal temperature curves had a steeper gradient, especially at the end of the experiment.

Rectal temperature, 25 °C

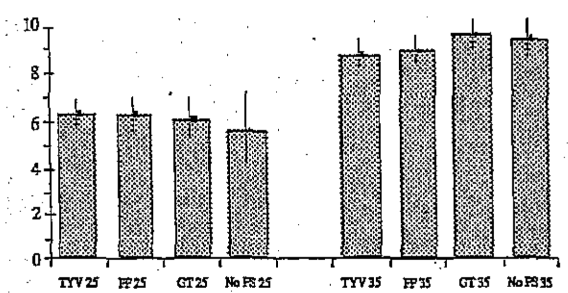


Rectal temperature, 35 °C

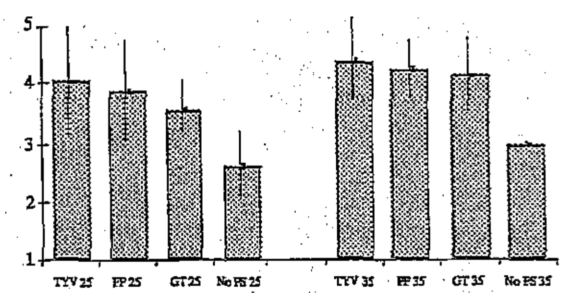


As shown in the diagram below the weightloss due to evaporation was fairly constant between the suits within the two conditions. Apparently sufficient amount of sweat evaporated and passed through the suits in all conditions, despite differences in permeability of fabrics. However the evaporative part of the heat exchange could be maintained only at the cost of a higher water vapour pressure (wettedness) inside the less permeable suits.

Weightloss minute 32-50 (g/min)



Subjective ratings sweatting



The subjective ratings of sweat sensation were reported on a 5-point scale [1] (How does your skin feel? (1) Dry, (2) Sweat onset, (3) Damp, (4) Wet, (5) Soaking wet). The diagram above show that the subjects *also* experienced the increase in skin wettedness. The subjective ratings were clearly correlated (r^2=0,952) with the variation in skin wettedness.

CONCLUSIONS

At *25* °C responses differed very little between suits. At 35 °C TYV resulted in higher physiological strain than for PP and GT, caused by a greater impedance to vapour permeation. *The* results indicate differences between the suits, that may be of little importance at normal mom temperature, but becomes significant under conditions of heat stress, especially under longer working periods and at higher workloads. The use of a breathing apparatus could also in some cases further increase the physiological strain and the personal discomfort

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