

Physiological Strains in Hot-humid Conditions While Wearing  
**Disposable Protective** Clothing Commonly Used by the Asbestos  
Abatement Industry

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## INTRODUCTION

Because of the asbestos exposure risk, the workers of asbestos abatement industry were advised to wear protective clothing. The utility of protective clothing is primarily determined by its efficiency and provided the extra physiological strain: especially the thermal stress on the wearer due to the clothing. The purpose of this study was to investigate workers' responses to work in the hot conditions while wearing the protective clothing commonly used by the asbestos abatement industry, and to evaluate the effects of resting in the cool environment between their work in the heat on physiological strains.

## METHOD

Subjects were seven healthy male students, aged from 18 to 20 years. The protective clothing commonly used by the asbestos abatement industry - light, disposable coveralls with hoods and shoes covers (Tyvek 1422, Polyolefin) - were worn over shorts. Protective air masks were also worn.

Thermal conditions adopted in this study were as follows: (a) 35°C/85%RH (hot conditions), (b) 20°C/85%RH (cool conditions), and (c) worked in hot conditions and took a rest in cool conditions (hot/cool conditions). These hot conditions were adopted as simulated working environments for asbestos abatement industry in the summer season (1). Work was performed on a bicycle ergometer at a constant work level of 70 Watts. This work rate was also chosen to be the work load of the actual asbestos abatement work (1).

All testing sessions took place within the climate chambers. Each test continued for up to 100 min, with repeated work/rest intervals. The subjects rested for 11 minutes, and then took a ergometer work for 18 minutes. After that, they sat on a chair for 12 minutes. This work/rest schedule was repeated 3 times under the 3 environments. Under hot/cool conditions, the subjects took a rest in the next climate chamber which was set up at 20°C air temperature. The order of exposure to three thermal conditions was randomized for each of the subjects. Experiments were carried out during May.

Rectal temperature ( $T_{re}$ ), skin temperatures at 5 sites were recorded by means of thermistors. Heart rate (HR) was obtained continuously from the electrocardiogram using chest leads. Total sweat production (SR) was estimated as the change in nude body weight, measured before and after the experiments. Discomfort sensation (5 points scale), thermal sensation (11 points scale), and rated perceived exertion (Borg's scale) were voted at before, during and after the exercises.

## RESULTS

Under the hot conditions, two tests were terminated because of higher heart rate and higher rectal temperature over the critical values. Means of SR in hot and hot/cool conditions were 1252 and 1100 g, respectively, which were more than 4 times greater than in cool conditions (248 g).

Mean  $T_{re}$  responses were presented in Figure 1. The mean  $T_{re}$  under cool

conditions did not change significantly through the experiments. Tre elevated gradually after the first work under both hot and hot/cool conditions. At the end of experiments, Tre increased, on average, by 1.2°C (range:0.95 - 1.63°C) under hot conditions. Although Tre increased in hot/cool conditions by 0.7°C (0.41 - 0.93°C), it was almost half of that in hot conditions.

Mean HR responses were presented in Figure 2. HR during work in hot conditions did not approach steady state levels in contrast to those in cool conditions. During 12-min rest periods, HR in hot conditions did not recover to near resting levels and remained high than those in cool conditions. Therefore, the increases in HR during work and in recovery with time were observed in hot conditions. Although HR during work in hot/cool conditions were higher than those in cool conditions, HR at pre-work was almost the same as that in cool conditions because of rapid recovery during rest periods.

Although, the degrees of discomfort sensations, thermal sensation, and perceived exertion became higher with time in both hot and hot/cool conditions, these were improved by resting in cool conditions. Especially the improvement of them were observed later in the experiment.

### CONCLUSION

The great thermal stress was linked to work in protective clothing in hot environments. However, the physiological and psychological functions such as Tre, HR, SW, discomfort sensation and perceived exertion, etc., were dramatically improved by resting in the cool conditions between work in the heat. We propose the cooling space in the workplace of asbestos abatement industry to decrease thermal stress.

### REFERENCE

- 1) Tochiara, Y., Ohnaka, T., Watanabe, Y. and Muramatsu, T. : A survey on physiological strains of asbestos abatement work wearing protective clothing in summer. In Report of the physiological study of protective clothing, edited by K. Yoshida), Tokyo, 1990. pp.17-22.

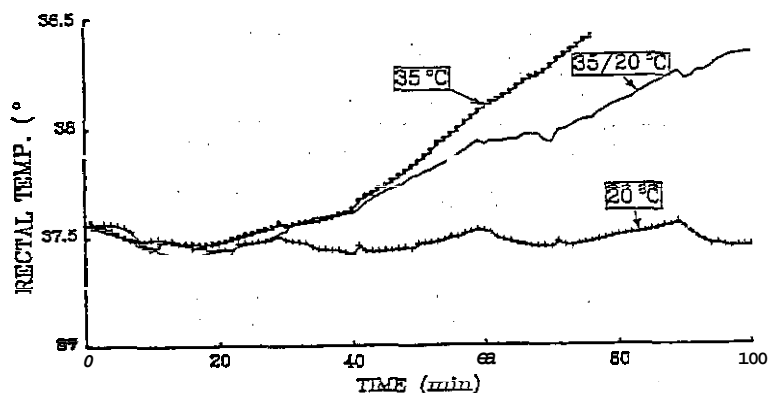


Fig.1 Changes in rectal temperature.

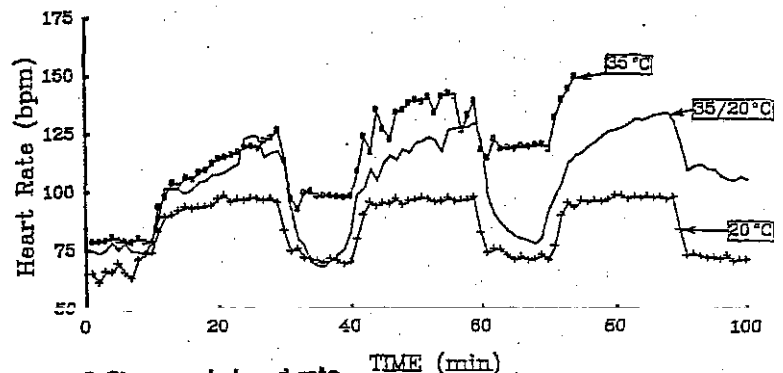


Fig.2 Changes in heart rate.