

QUANTITATIVE JUDGEMENT OF WEARING COMFORT OF HAND-FOOT-WEAR USING A HAND-/FOOT-MODEL

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INTRODUCTION

The wearing **comfort** of military clothing directly influences the capacity performance of the soldier. Biophysical **aspects** must, therefore, be considered during the development of clothing systems. Optimization of materials used for clothing with respect to **their** biophysical properties **requires** efficient test methods. In some cases sophisticated models must be employed to receive the desired information.

Because of constructive features of **shoes** and gloves a final judgement of the wearing comfort cannot be achieved by determining the biophysical **parameters** of the applied materials alone. The shoe or glove **has** to be investigated **as** a whole. Up to now suitable testing devices **are** not available. A **so** called hand-/foot-model therefore **has been** developed for **this** purpose.

METHOD

The hand-/foot-model measures the **dry** and humid heat transfer **through** gloves and shoes.

It **consists** of a computer controlled air conditioner, a heated transfer line and exchangeable hand and foot **dummies**, made of fibre reinforced plastic (1,2). The specifically designed **perforation** of the surface **of** the dummies corresponds as closely **as possible** to the distribution of perspiratory glands **on** the human hand and foot (3).

The model **can** be operated in two different ways:

In the fixed value mode a **specified** rh/T-level is set up **inside** the hand (foot) dummy and **the** resulting humidity and temperature values **are** measured by two **sensors**, located in the palmar (medial) region **and** at the thumb (big **toe**) **on** the hand (foot) dummy. This way, prototypes of shoes and gloves **can be** judged with respect to the applied materials and constructive details influencing the heat and moisture exchange.

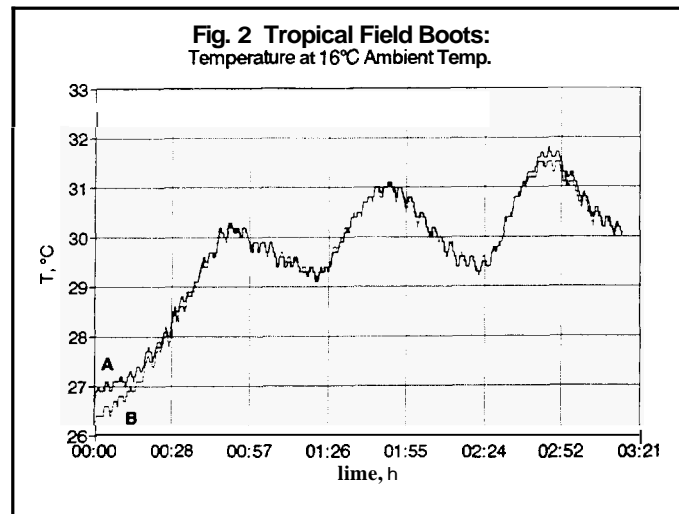
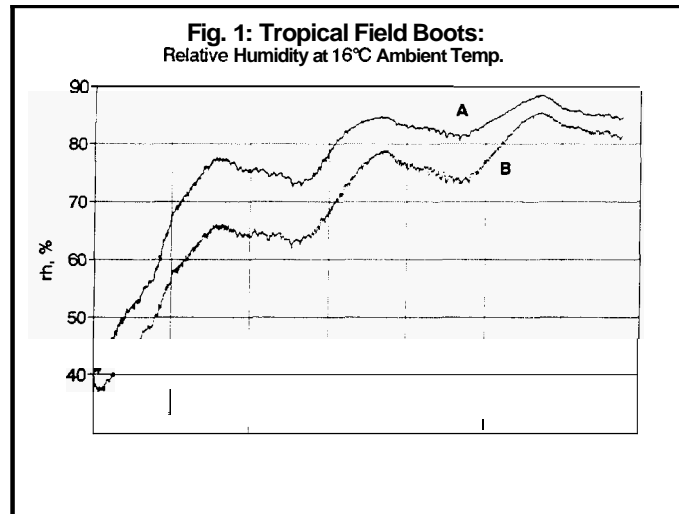
In the dynamic mode a dynamic change of temperature and humidity according to real life microclimatic conditions in hand- **and** footwear **can** be simulated. This mode is mainly used for comparative studies. The database for the dynamic mode results from tests with different (**weak/normal/strong**) sweating **types** of volunteers **walking** on an ergometer at three different levels of tilt in a climatic chamber at -16, **0**, +16 and 32°C. The **three** levels of tilt represent energy conversion **rates** of 209,418 and 627 W (3). The **volunteers** were wearing clothing suited for the corresponding temperatures. During the **tests** temperatures and relative humidities were recorded by means of **rh/T-sensors** mounted in the same places like those attached **to** the dummies.

The dynamic mode allows to follow the change of temperature and humidity levels inside the shoe/glove at **different** energy conversion rates, **i.e.** different **amounts** of heat and humidity created by the dummy. In a reference test with the dummy the rh/T-level **inside** the glove (shoe) is controlled by either the thumb (toe) or **the** palmar (medial) **sensor** according to the rh/T-values **from** the database while recording the resulting control parameters **of** the air conditioner at the same time. In the **target** test the control parameters **are** adjusted according to the reference test and the rh/T-values of the two **sensors** are recorded. A comparison of the rh/T-curves of the reference and the target tests shows the influence of differences in the glove (shoe) design and/or manufacture on the rh/T-level, i.e. the wearing comfort.

RESULTS

Using the hand-/foot model comparative studies have been carried out on different types of military hand- and footwear. The effect of membrane materials used inside gloves and shoes has been evaluated with respect to their cold/wet behaviour.

As an example Figs. 1 and 2 show the results of a comparative test of field boots designed for tropical weather conditions. The test was carried out in the dynamic mode. Microclimatic wearing comfort can be expected, when a boot has good heat and moisture exchange capabilities, i.e. low internal values for relative humidity and temperature. Fig. 1 shows considerably higher rh-values for boot A compared to boot B, whereas the slopes of the temperatures for both boots in Fig. 2 are nearly identical. Therefore, boot B would be the better choice for tropical weather conditions.



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