Journal of Fiber Bioengineering and Informatics 15:3 (2022) 185–202

Cite as: M. Sang et al.
doi:10.3993/jfbim00393

Design of the "Hygroscopic Clothing" in Medical Protective Clothing*

Ming-Wei Sang, Ming-Hai Cui*

Beijing Institute of Fashion Technology, Ying Hua Street, Beijing, 100029, China

Abstract

To solve the current lack of thermal and humidity comfort in medical protective clothing for workers in high-risk environments, this paper seeks to adopt moisture-absorbing materials in the design of work clothes for medical staff, thus presenting an innovative design framework for hygroscopic workwear. This paper uses hospital staff in high-risk environment, such as nurses who operate within hospital hot zones and community service personnel, as research subjects. Their activities were recorded and subsequently analyzed Then, the MET values of these actions were discovered and listed. After calculation, the average medium-high-intensity work MET value was ≈5.8, and the medium-low-intensity MET value was ≈2.8, with the corresponding speed of 6.3 km/h and 2.8 km/h, respectively. These two speeds were the references for human motion experiments.

In the human motion experiment, the objects wore medical protective clothing, the ambient temperature was set to 26-28 °n, and the motion status was determined to be 2.8 km/h: 5 min-6.3 km/h: 25 min-2.8 km/h: 10 min. The filtering paper method was employed to measure the regional body sweat. Then, the regional body sweat map was obtained. According to the results, the structural scheme for hygroscopic workwear was proposed to further promote the research process of the hygroscopic workwear.

In the human body wearing verification experiment, the experimental group was the subjects wearing hygroscopic clothes, and the control group was the subjects wearing pure cotton clothing. In the process of exercise, the hygroscopic performance of the work clothes was compared by the changes of internal environment humidity and the feelings of subjects. Through data analysis, compared with pure cotton upper and lower garment, the hygroscopic work clothes can effectively maintain the comfortable balance of internal environment humidity.

Keywords: Thermal and Humidity Comfort; Clothing Structure; Medical Protective Clothing; Work Intensity; Sweating Amounts

*Project supported by the scientific research project of Beijin1g Institute of fashion for the publication as well as the financial support provided by the practical training project (Project No. NHFZ20210022/026) in human experiment and material development.

*Corresponding author.

Email addresses: 2854938114@qq.com (Ming-Wei Sang), fzycmh@bift.edu.cn (Ming-Hai Cui).

1 Introduction

1.1 The Status of Medical Protective Clothing

In 2019-2020, because of COVID-19 pandemic, the medical staff, safety patrol personnel and volunteers, who were required by occupation to interact with potential patients constantly, were at high risk of infection. At the same time, due to the particularity of COVID-19, its infectivity was strong and its propagation speed was fast, which seriously endangered their safety. Medical protective clothing can protect the wearers from germs and viruses, by effectively isolating the wears from dangerous environments and protect their health.

However, although the medical protective clothes protect the safety of staff, they are poor in comfort, difficult to wear, poor recognition, and present low physiological adaptability. As the protective clothing functions as a barrier against liquid and gas, the heat and water vapor inside the protective clothing cannot be discharged, causing the wearers to become deeply uncomfortable. After several hours of high-intensity work, the whole body would have been soaked inswept, rendering it impossible to do high-intensity works for a long time when wearing medical protective clothing [1]. Li Qian [2] and others used surveyed frontline medical staff as the research subjects, and analyzed how their comfort relates to their temperature and humidity within the clothing. The results showed that when the protective clothes were worn for 4-8 h, 55.8% of the users thought that the air and humidity permeability was average, and 43.5% of the users thought that the air and humidity permeability was poor. Medical staff think that the main problem of low work efficiency is due to the poor moisture control. Therefore, for the sake of comfort, it is necessary to develop medical protective clothing with improvements in thermal and humidity control.

At the same time, as the types of medical protective clothing users and their work sites increase, it produces separate factor due to different working hours and safety risks. This context has thus exacerbated the inherent design defects of medical protective clothing with a lack of standardized design that can effectively accommodate everyone's needs. Hou Yu [3] tries to improve the existing disposable medical protective clothing. By considering the general requirements of medical staff based on factors of: comfort, convenience, and protective functions. Yu proposes that the new type of medical protective clothing can be designed with two sets of fabrics: which are internal-using cloths and external-using cloths.

1.2 The Status of Relative value of perspiration

Zhang Wei yuan [4] once explored the distribution of local perspiration of human body. The conclusion shows that the relative amount of sweating of the neck, trunk, forehead and back of hand is more; The relative amount of sweating in arms, legs and other limbs is less. In addition, he explored the relative value of local sweating of the human body, as shown in Table 1.

Through experiments, Verde t [5] concluded that the amount and state of sweating in various parts of the human body are symmetrically distributed, and the axis of symmetry is the central axis of the human body. At present, the commonly used experimental methods to measure the amount of local sweat are: filter paper method, ventilated sweat bag collection method, ethylene bag method, sweat absorbing patch collection method and so on. Zhang Shuo [6] and others used the filter paper method to measure the sweating volume of the sweat concentration part when