

Physical Burdens and Restrictions to Wearers of Chemical Protective Coveralls

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Abstract

Chemical protective coveralls (CPC) have been widely used in industrial and military applications. CPC materials are usually heavy, stiff and bulky. Wearing CPC can cause physical burdens and restrictions to the wearer because of added weight, bulkiness, stiffness, inflexibility, friction between fabric layers, improper fit and poor design. It was found in many studies that wearing protective ensembles significantly increases energy consumption and decreases mobility and work efficiency. Many researches have focused on the effects of the weight of protective clothing ensembles on metabolic rate/energy expenditure. Little is known about the relationships between textile mechanical properties and overall physical burdens encountered while working in the CPC. In this study, it was hypothesized that wearing CPC would significantly increase metabolic rate and restrict movements. The Kawabata evaluation system (KES) was used to determine tensile, shearing, bending, compression, surface friction, and surface roughness properties of three selected CPC fabrics. Then exercise sessions involving fifteen participants walking on a treadmill at 3.5 mph, 4% grade for 60 min while wearing CPC garments made from the three KES-tested materials and one control garment were used to measure oxygen consumption, rate of perceived exertion (RPE), heart rate and level of restriction of movement. Analysis of variance results showed that: 1. There were significant differences in material mechanical properties among the three CPC fabric types; 2. There were significant differences in oxygen consumption, RPE and subjective ratings of restrictions to movement among the garments made from the three CPC fabrics. Pearson's correlation test was performed to determine the relationships between material mechanical properties (i.e., tensile linearity, bending rigidity and shearing stiffness) and the physical burden and restrictions associated with wearing the CPC garments (i.e., oxygen consumption, RPE and restriction of arm and leg movement).