Theoretical Justification for Improving the Design of Special Clothing in Order to Optimize Its Design

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ABSTRACT

The development of scientific and technological progress, changes in the sphere of production at modern industrial enterprises, including the task of ensuring the safety of workers in production, including the development of special clothing for their protection, first of all optimally solve the tasks set, the problem of the harmful effects of the production environment puts it in first place. In modern economic conditions, the problem of purposeful improvement of the assortment and quality of special clothes that adequately satisfy the needs of customer organizations is of particular importance. Personal protective equipment (PPE) has a special place in the complex of measures to ensure the safety of workers and prevent occupational diseases. Among the widely used personal protective equipment is special clothing, which is one of the necessary conditions for reducing the impact of dangerous and harmful production factors on a person and maintaining high performance and health.

Keywords: special clothing, industrial enterprises, harmful effects, new technologies, development of costume materials.

Introduction

A person, performing labour operations, makes movements with different speeds, amplitudes and at different rates. At the same time, the size and shape of parts of the human body are constantly changing. As a result, overalls made of various materials with different stiffness, thickness and other properties either move relative to the human body, causing skin irritation or resist movement and put pressure on the body if the possibilities of movement are limited [1-3].

Overalls are subjected to tensile, compressive, abrasion and other influences both from the side of a person and from the side of objects that they come into contact with in the environment. This leads to the appearance of mechanical stresses in it, eventually causing its destruction [4-9].

The purpose of this section is to apply the principles of constructing optimal workwear designs that are ergonomically rational from the point of view of design, i.e., choosing the best solution from a certain set of feasible solutions for a specific production situation.

Product parameters that achieve the best combination between effects and costs, determined from the standpoint of reasonable goals and taking into account reasonable restrictions, the initial state and upcoming changes over time, are called optimal, and the theoretical and experimental procedures for their determination are called optimization [10-17].

Following the variety of optimization conditions and the requirements for the quality of optimization results, a set of various optimization methods has to be used to establish the parameters of overalls.

As it was established in [1], the use of a variety of optimization methods in the design of overalls is due to both objective difficulties inherent in the nature of the design task - ensuring the necessary protective effectiveness of overalls at the lowest physiological stress of the body, and the lack of sufficient information about the operating conditions of overalls during its operation.

Thus, as rightly stated in [1], the task of creating optimal overalls with improved parametric characteristics is a multicriteria one. The solution to such a problem is associated with general optimization i.e. the design solution should be optimized as a whole as a single object with a given purpose, but partial (local) optimization options are possible due to the division of the design process into stages, and the design object into parts according to its individual parameters. In this case, the optimized object can be not only the product as a whole, but only one or another part of it.

When designing optimal overalls, and this means ergonomically rational, it is advisable to use methods of partial optimization, because, as studies have shown [1], [4], it is fundamentally possible to divide the process of ensuring the necessary ergonomic level of quality into separate components: hygienic, anthropometric and psychophysiological.

Anthropometric conformity of overalls to the size and shape of the human body is considered from two positions [1], [5], [6] [7]: static and dynamic conformity. Basically, it is provided due to the rationality of the design parameters of overalls. Since the main purpose of workwear is functional, its ergonomic system also manifests itself in dynamic processes, that is, its dynamic correspondence to the nature of the main labour movements of the worker is of paramount importance for the choice of the principal design scheme of workwear.

It was found [17] that the dynamic correspondence of overalls to the dimensions of the human body can be characterized by two complex indicators (level 3): the degree of restriction of human movements and the tension of the clothing sections. The latter indicator can be determined by the following single indicators: the tensile strain of materials in the details of the product, the tensile force of the material and the seams of the product.

The “man-clothing-environment” system operating in production in dynamics, in accordance with its main target function, allows you to select and justify the necessary and sufficient number of individual ergonomic indicators of dynamic compliance. The system characterizes the ability of the worker to perform specified movements with a maximum range, with the lowest level of clothing pressure on the body surface, minimal deformations of materials in its details and limited movement of individual sections of the product relative to the surface of the worker's body [18-19].

The author [16] for the ergonomic evaluation of overalls uses as criteria such single indicators as the movement of clothing relative to the human body, the deformation of the stretching of the material of clothing parts along the warp and weft, the deformation of the fabric mesh, tension, stretching and pressure of clothing, while the complex criterion of the system " man - clothes - environment ”(MCE) serves as the functional state of the body - its performance. The validity of these provisions, confirmed by numerous experimental data, is beyond doubt, therefore, in our study, they were taken as the basis for solving the problem of optimizing the parameters of overalls for workers in the automotive industry.

Conclusion

As a result of the research, the topography of the damaged areas of the overalls used in the technological process, the matrix values of the areas of the destroyed areas for all types of impact were compiled, and the intensity of the impact of the OVPF was calculated. An analysis of possible ways to optimize the interaction between the components of the “man-clothes-work environment” system for the conditions of the technological process of assembly and body products made it possible to determine that the study of the operational reliability of the system should be carried out based on the development of its mathematical

models. A study of the kinematic interaction of the "man-clothes" system in three-dimensional space was carried out and mathematical dependencies were obtained that make it possible to predict the magnitude of constructive additions to the details of products in the process of optimizing the parameters of workwear.

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