PROTECH TYPE TECHNICAL TEXTILES – REQUIREMENTS, FUNCTIONS AND QUALITY CHARACTERISTICS

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REZUMAT. Făcând parte din domeniul "Ingineria materialelor flexibile", textilele tehnice se disting prin performanţele lor e mecanice, termice, electrice şi nu numai, prin proprietăţile funcţionale şi de disponibilitate care răspund exigenţelor tehnico-calitative şi se pot adapta la o multitudine de destinaţii. Textilele tehnice fac parte dintr-un domeniu de cercetare permanent, care implică modificări deosebite făcute asupra produselor textile (fibre, fire, ţesături, tricoturi, produse confecţionate), combinări inteligente de materiale, aplicarea unor tehnologii inovatoare de obţinere şi finisare, realizarea produselor inteligente etc.. Lucrarea are drept scop prezentarea și caracterizarea celor mai importante produse tehnice tip Protech.

Cuvinte cheie: textile, tehnică, protecție, caracteristici

ABSTRACT. Being part of the "Flexible Materials Engineering" field, technical textiles are distinguished by their mechanical, thermal, electrical and more performances, by their functional and availability properties that meet the technical-qualitative requirements and can adapt to a multitude of destinations. Technical textiles are part of a permanent research field, involving special changes made to textiles (fibers, yarns, weft, knitted and manufactured products), intelligent combinations of materials, the application of innovative technologies for design and perfecting, etc. The paper aims to present and characterize the most important Protech technical products.

Keywords: textiles, technique, protection, characteristics.

1. INTRODUCTION

The diversification of products, for different fields of activity in the textile industry, has seen a remarkable momentum in recent years due to the most important discoveries in science and technology. These led to:

- obtaining light, flexible and durable alternative products;
- expanding top range technical textiles with multifunctional destinations: industry, agriculture, army, transport, medicine, ecology, sports, etc;
- using new flexible, continuous, versatile technologies;
- creating multifunctional components that are reliable and cost-effective;
- establishing extensive technological user-oriented systems and solutions.

Technical textiles are defined as "products primarily made for their technical performance and functional properties" which meet high technical and quality requirements (mechanical performances, thermal, electrical, durability, etc.) and can be adapted to a technical function [1, 2]. They are part of an ample field, dubbed by David Rigsby as "Flexible Materials Engineering". In the European Union, technical textiles account for 35% of all textiles and are growing at an annual rate of 5% [3].

Technical textiles performances are of mechanical type: traction resistance (cords, seat belts, etc.); reinforcement of material (ski, shockproof materials, rifle pipes, etc.); joint tension (bandages, stockings, knee-braces); elasticity (automobile); protection (ballistics, impact, explosion, side arms, etc.).

These performances allow the functions of: **air filtering exchange**(air conditioning for automobiles, airplanes, etc.), in the food, chemical and mining industries waste and industrial effluents treatment; **isolation, conduction, absorption** (hygiene, etc.); **draining** (geo-textile, agro-textile, hygiene, filtration); **protection against micro-organisms** (microbes, mites, algae), for indoor clothing used in hospitals (operating fields, caps, gowns, sheets, etc.), bio-resorbabile textiles allowing the reconstitution of

living tissues; **thermal protection** (constructions, industrial furnaces, aeronautical equipment, space applications), fire clothing; **chemical, electrical, NBC risk protection** (nuclear, bacteriological and chemical), high visibility, electromagnetic radiation, etc.. According to Techtextil (the main organizer of technical textile exhibitions since 1980), we can differentiate 12 fields of activity for technical textiles (Figure 1).

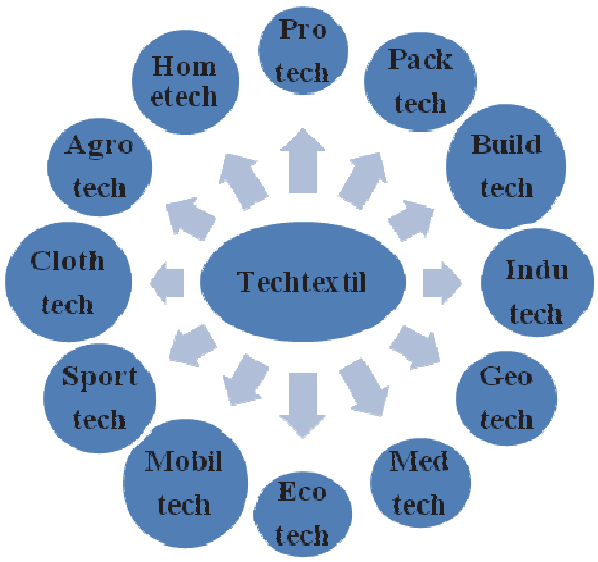

Fig. 1. Applications of technical textiles.

Technical textiles are a permanent field of research that involves special changes made to fibers, yarns, wefts, knitted and other surfaces, intelligent combinations of materials, the discovery of innovative technologies for design and perfecting, researching high value added products , intelligent, interactive or adaptable products (textiles with information sensors, etc.).

In all activity domains of technical textiles, knitted design and fabrication is an essential part, due to the many **advantages** of their use:

- ❖ great diversity of presentation forms;
- ❖ reduced specific mass compared to other types of materials;
- ❖ use of efficient knitting technologies;
- ❖ creating knitted structures combining the characteristics of wefts (resistance to mechanical stress, reduced extensibility) with those knitted specific (spatial moulding capacity, voluminousness, extended diversification possibilities, pleasant touch, high economic efficiency);
- ❖ possibility of directing the specific characteristics;
- ❖ use of an extended range of yarns with superior characteristics;
- ❖ use of innovative finishing technologies;
- ❖ low costs.

2. PROTECH TYPE TECHINCAL TEXTILES – QUALITY REQUIREMENTS

In order for a textile product to be considered as protection, it must comply with certain requirements and regulations established by international organizations such as ASTM (American Society for Testing and Materials) and ISO (International Standardization Organization). This fact enforces an obligation for enterprises to use quality products, safe and healthy, that preserve the environment, in accordance with EU SHE directives (Security, Health, Environment).

Protech type textiles are used in order to improve safety at work, reducing the risk factors that may be of a thermal, chemical, biological, mechanical, physical or electrical nature. These factors have direct influences on the health and life of the individual performing a certain type of activity.

Regardless of the destination of protection products and equipment, several basic requirements must be considered in their design:

A. **ensuring constant body temperature** (avoidance of hypothermia or hyperthermia);

B. ensuring comfort and ergonomics;

C. **keeping mood and ability to work** (avoiding stress and fatigue caused by intense physical, psychological and physiological stress);

D. preserving the environment.

The creation and completion of personal protective equipment (PPE [3]) involves the following steps:

- ✓ identification of hazards;
- ✓ risk evaluation;
- ✓ establishing the necessary measures to prevent the risks.

3. CLASIFICATION AND CHARACTERIZATION OF THE PROTECH TYPE TECHNICAL TEXTILES

Protecting the people engaging in risky activities can be done by using, as appropriate, the following types of protective equipment: clothing, footwear, gloves, helmets, glasses, visors, etc.

Protective equipment's can be classified according to several criteria, shown in Figure 2.

Fig. 2. Classification criteria of protective equipment.

A. The first classification criterion "**nature of the risk factors**" is derived from **the functions of the protective equipment and the type of protection provided**. For this purpose, Protech technical textiles are classified into:

1. ***Protection equipment against mechanical actions*** *(*cutting, piercing, tearing, snagging, friction, etc.). Via the nature of the provided protection, these equipment are characterized by a special resistance to all types of mechanical action, very good adherence and reduced deformation. They are made of weft, knitted, neoprene, or other durable materials, covered or not with rubber or rigid or semi-rigid carcasses, lined or not.

Examples: gloves, knee pads, elbow pads, belts, helmets, special footwear, overalls, etc. (Figure 3).

Fig. 3. Examples of protection equipment against mechanical actions.

2. ***Electrical shocks protection equipment (electroshock)*** (for interventions to electrical installations). These equipment must be made of electrically insulating materials (tire mixtures or special polymers), which constitute a shield between the operator and the live power supply. Examples: gloves, insulating shoes (Figure 4).

Fig. 4. Electric insulating gloves and boots.

3. ***Equipment for protection against extreme temperatures*** (very high temperature, thermal radiation, ignition risk, or very low temperatures).

In the case of high temperatures or the risk of ignition (fire, incandescent drops, sparks), the protective equipment must be: insulating, non-flammable and reflective. Generally, such equipment's are multilayer types, the exterior layer being waterproof and non-flammable. Insured protection can be for:

- **Head** - respiratory system (protect the body from inhalation of harmful substances, smoke, toxic gases, vapors);
- **Eyes, face** (against UV radiation, infrared, sparks, etc.);
- **Upper and lower limbs** (against direct contact with substances, materials, hot liquids, as well as against slipping, falling);
- **Body**.

In case of low temperatures, thick protective equipment is used, consisting of several thermo-insulating layers, the outer layer being waterproof and resistant to rain, snow, wind, UV radiation. Examples: overalls, combination suits, gloves, helmets, visors, glasses, aprons, welding masks, cloaks, protective footwear, elbow pads for welding, multilayer suits, hats etc. (Figures 5, 6, 7).

Fig. 5. Example of fireman protection equipment.

Fig. 6. Aluminized fire retardant costume

Fig. 7. Jackets and protection costumes for very low temperatures.

4. ***Equipment for protection against chemical substances (acids, bases)***. They must provide effective protection if there is a risk of splashing, spraying or dripping of chemical substances. Hydrophobic and waterproof materials are used. Examples: overalls or waterproof combination suits, gloves, visors, glasses, interchangeable filter masks, special footwear, etc. (Figure 8).

5. ***Equipment that provides antistatic protection***, in enclosed spaces, when there is a risk of an explosion, or to prevent disturbance to electronic devices. Examples: Costumes, gowns, gloves that incorporate carbon fibers in their structure, or metallic threads that allow electrostatic charges to discharge into the ground (Figure 8).

Fig. 8. Antistatic chemical suit

6. ***Equipment providing visual and / or phonic protection.*** Examples: glasses, visors, headphones, internal or external hearing blockers (Figures 9, 10). Equipments with **phonic protection and/or sound-absorbing** cancel or eliminate wave propagation. The materials used are porous and air-permeable, having the ability to absorb noise. This prevents disturbance, fatigue, attention loss and decreases in the performer's work capacity.

Fig. 9. Helmet and visor for visual and phonic protection.

Fig. 10. Helmet and soundproof headphones for phonic protection.

7. ***Equipment providing ballistic protection*** (against bullets, projectiles). Examples: bullet proof vests, anti-stabbing vests, etc. (Figure 11), realized of resilient (Kevlar type) materials with superior mechanical properties that allow the capture and deformation of a bullet, diffusing its impact force into the vest. Vests provide ballistic protection in the user's critical (exposed) areas (neck, shoulders, chest, abdomen and groin).

Fig. 11. Bulletproof vests.

8. ***Equipment providing medical protection*** (sterile environment) ***and / or sports***. Examples for medical field: gowns, gloves, bonnets, glasses, protective footwear. They may be disposable or not and require special maintenance by sterilization or decontamination (Figure 12). Sports examples: ankle braces, elbow pads, knee pads, puttees, belts that protect the spine or abdomen, orthotics, prostheses, etc.

Fig. 12. Protection equipments in the medical field.

9. ***Equipment providing protection in special areas*** (forestry, alpine, marine, aviation, height work, etc.), which also require special properties depending on the destination.

Examples:

Forestry equipment (Figure 13) **and height work** (Figure 14 a) must ensure protection for the body from external factors (sun, rain, wind) and from possible snags, hits with natural environment elements, or working utensils. They are generally multilayer type, resilient, lined, with multiple pockets and reflective elements.

In the case of **protective and sea intervention equipment** (swimming suits and lifeguard suits, diving suits - Figure 14 b, life jackets, etc.), the main features are: strength, elasticity and extensibility, impermeability, thermal comfort, movement capacity, insulating capability so that the body is not affected by the aquatic environment.

Fig. 13. Suits for woodcutters

a. b.

Fig. 14. a. Protection equipment for high altitude work; b. diver suit.

10. ***NBC protection equipment (nuclear, bacteriological, chemical)***. Examples: combination suits, overalls, gloves, masks, appropriate footwear (Figure 15).

Fig. 15. Antinuclear protection costume.

B. The second criterion **"risk grade"** divides protective equipment into:

1. Protective equipment for **low-risk activities** (gowns, overalls, bonnets, etc.);
2. Protective equipment for **medium-risk activities** (used in construction, installations, etc.: helmets, gloves, boots, multilayer overalls etc.);
3. Protective equipment for **activities with maximum risk**:

a. provide protection against extreme temperatures (very high or very low);

b. provide protection in special activities or interventions (forestry, alpine, naval, aviation, work at height);

c. provide ballistic protection in military activities;

d. Provide protection against chemical, nuclear, bacteriological factors.

C. "Equipment type" classification criterion refers to which area of the body is protected. These are:

1. Head and neck protection equipment (helmets, hoods, bonnets, hats, masks, etc.);
2. Equipment for limb protection (gloves, stockings, puttees, footwear, etc.);
3. Equipment for the protection of the trunk or entire body (vests, overalls, gowns, combination suits etc.).

D. Criterion **"The Physical Principle of Protection".** From this point of view, protective equipment can be based on:

1. **Insulation**. In this case, the protective equipment ensures a comfortable insulation of the user against the action of environmental factors (liquids, gases, suspensions, etc.);
2. **Filtration / absorption.** Protective equipment provides a selective transfer of substances from the

environment to the body or vice versa. Filtering textile fabrics can neutralize or retain agents that represent risk factors.

3. **Reflection**. The protective equipment can retransmit a light, electromagnetic or thermal flux to the radiant source. The equipment is for the protection of the trunk, or the whole body (vests, overalls, gowns, combination suits, etc.).

4. **Attenuation / amortization** (of noise, light, power, shock intensity, etc.).

E. "Duration of use" criterion classifies protective equipment in:

1. Disposable equipment mainly used in sterile environment (bonnets, masks, gowns, soles, etc.);

2. Frequently used equipment (can be washed, cleaned, decontaminated).

F. Depending on the **"type of activity carried out"**, protective equipment is divided into:

1. Equipment with frequent use in low or medium risk activities;

2. Intervention equipment (for fire fighters, divers, climbers, SMURD crews, anti-terrorist teams, etc.).

G. The latest classification criterion, **"deployment environment"**, differentiates protective equipment into:

1. Equipment used in open spaces (construction, agriculture, army, roads, maritime platforms, oil operations, forestry);

2. Equipment used in enclosed spaces (precincts) (buildings, work halls, hospitals, mines, etc.)

4. CONCLUSIONS

Protech type textiles are used to improve safety at work, by reducing the risk factors that may be of a thermal, chemical, biological, mechanical, physical or electrical nature. These factors have direct influences on the health and life of the person carrying out a certain type of activity.

Based on the main requirements expressed by the beneficiaries of the protective equipment (ensuring constant body temperature, avoidance of hypothermia or hyperthermia, assurance of comfort and ergonomics, preservation of mood and working capacity), the paper presents in a systematized manner the main functions and quality characteristics of various types of equipment that provide protection for the body and the life of the users.

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