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Application of A New Firefighter Protective Clothing Material in Fire Rescue

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Abstract. Firefighters are usually exposed to high temperatures, smoke and other hazards from the environment when carrying out fire fighting and rescue. Fire fighting clothes are special protective clothes used to protect firefighters from high temperature and fire damage. PPS fabrics can meet the basic requirements of fire service coatings. According to the standard requirements of a pair of firefighters' chemical protective clothing, this topic further coats the surface of PPS fabric to achieve a certain chemical penetration resistance, and does basic research on the application of PPS fibers in the outer layer of chemical protective clothing. It can be used to make exterior material of Fire Fighting Protective clothing. Fabric density affects the warp and weft tear properties, but due to the limited fabric density in this design, the density does not affect much. In addition, it has been found that reducing the latitude and longitude density difference can increase the latitudinal tear strength value. The possibility of multi-stage airbag cushioning type pressure-proof protective clothing captured in actual fire-fighting and rescue work is analyzed, which provides a certain guarantee for the safety of fire-fighters during fire-fighting and rescue operations.

1. Introduction

Because of the different combustion performance of building materials, the fire resistance limit of building components and the fire resistance grade of building structures, the time of collapse accidents caused by component destruction and structural instability after fire is uncertain, which seriously threatens the life safety of fire officers and soldiers who are engaged in personnel search and rescue and fire fighting in fire-fighting buildings [1]. If we can design and develop a kind of personal protective equipment which can resist and eliminate the impact damage of building components and other heavy objects on human body when building collapse, we can ensure the safety of people who are still rescuing in building collapse accidents. According to statistics, nearly half of the fires are caused by textiles [2]. Burns are the fourth most common human injury in the world. Of the burn patients in China each year, 500,000 people need long-term medical care [3]. Although China's firefighter protective clothing has been improved many times, and the development of fire-fighting protective clothing standards is continuing, but there is still a big gap with the international fire-fighting equipment standards. In order to save firefighters' physical strength in firefighting operations, improve the wearing comfort of clothing, and reduce or prevent the occurrence of heatstroke among firefighters, it is necessary to adopt new processing techniques and raw materials to develop light weight, good heat insulation and flame-retardant performance. New insulation material [4].

Among many firefighters' fires protective clothing, combat suits are the most commonly used protective clothing. This study takes the firefighting suits currently used in China as the research



object. Firstly, it conducts a nationwide survey to understand the current situation of the use of combat suits and the subjective evaluation of the war fighters used by firefighters, and analyzes the firefighting suits currently used in China. Major defects [5-6]. The study of flame-retardant fabrics is based on the length of damage, and the existing and only the influence of a single factor on the length of damage is analyzed. In practical applications, flame retardant performance is the result of a combination of factors. This paper considers the influence of several factors on the damage length, and analyses the most influential factors. First-line emergency firefighters need specific firefighting clothing to avoid the environmental threat to human health at the accident site [7]. At the same time, working in the environment with these hazardous chemicals, the concentration of harmful substances sometimes exceeds the standard [8]. Without specific protection, the consequences are unimaginable. The design and development of domestic fire-fighting clothing fabrics can not only give full play to the role of the thermal properties of nylon in the fire-fighting industry, but also complement the gaps in the field of high-performance fire-fighting protective clothing made in China, which is of far-reaching significance.

2. Methodology

Firefighters' fire-fighting protective clothing currently used in China is divided into six categories: fire-fighting protective clothing, fire-fighting clothing, fire-fighting thermal insulation clothing, fire-fighting chemical clothing, combat clothing and command clothing. These protective clothes are developed according to the harm to human body caused by different disaster accidents, and are applied to fire scene and various disaster accident scene. The ply yarn is obtained by single yarn twisting weaving. The strength of the fabric made of the ply yarn is much greater than that made of single yarn with the same linear density. This is due to the reduction of the evenness, strength and twist of the ply yarn due to the combination and re-twisting, which improves the strength utilization of the fibers in the yarn [9]. Chemical protective clothing is a personal protective equipment that firefighters must wear when entering a chemical poison and chemical dangerous goods and corrosives at the fire or accident site to carry out firefighting and anti-terrorism attacks and rescue operations. It can prevent toxic and harmful chemicals from directly damaging human skin. Or the absorption of the skin through the skin is a special protective report. The formation of the collapse is caused by the shorter projection length of the fiber along the yarn axis when the yarn is twisted into a yarn [10]. Excessive collapse not only directly affects the linear density and twist value of the yarn, but also has a serious impact on subsequent weaving of small samples.

Due to the strong electron-withdrawing thiol group on the macromolecular chain, the double bond conjugate of the benzene ring makes the molecular structure more excellent in heat resistance, thermal stability, high temperature dimensional stability than aramid. Resistance to thermal oxidation. The heat source in the experimental device is the original carbon rod heater of the research group. The heater consists of six U-shaped carbon rods with a diameter of 20 mm. The two ends of the carbon rod are buried in the refractory brick and supported by a steel structure shell and It is placed vertically. Under the conditions of high temperature, high humidity and high frequency, it still has high insulation, low dielectric loss and excellent arc resistance. However, antistatic composite materials and products can be prepared by composite modification. Tests show that the twist ratio of FY single yarn is over 55%. As shown in Figure 1, it seriously affects yarn weaving and excludes yarn as the preferred yarn. There is no twist between FY and FO strands. Spunlaced pressure, number of spunlaced channels, aperture of needle board and specifications of spunlaced bracket screen will affect the physical and mechanical properties of spunlaced nonwovens.

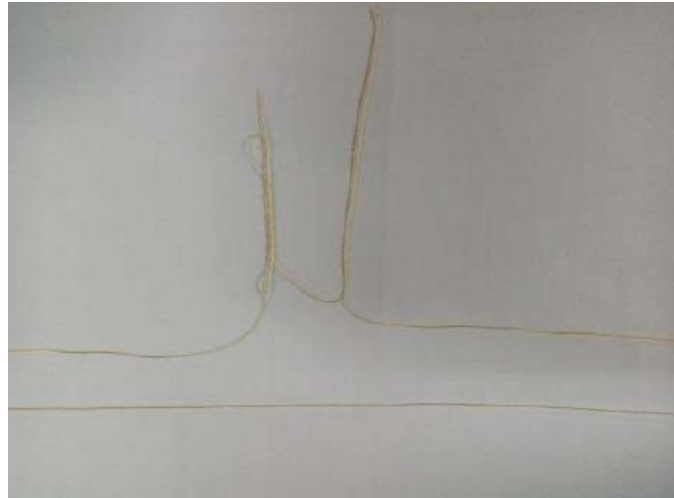


Fig. 1 Twisting schematic diagram of FY single yarn

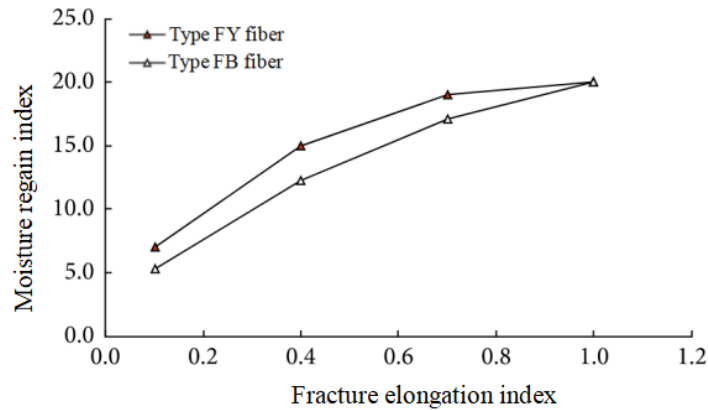
There are many ways of tearing and destruction in the use of various textiles on different occasions. In the experiment, when the heat flow meter on the preheated insulating screen reads to the set value, the preheated insulating screen is pulled out so that the experimental sample is suddenly exposed to a certain radiation intensity. In order to better analyze the properties of polyphenylene sulfide (PPS) fabrics, in this paper, the samples of PPS fabrics should be woven in the design process of the experiment, combined with the existing test conditions. The problems encountered in the weaving process are analyzed and summarized. The hairiness trait is one of the basic structures of the yarn. It not only affects the appearance of the fabric, but also affects the weaving of the yarn. It is customary to call the hairiness of 5mm and above as the critical length or the harmful length. The more harmful the length, the more harmful to the subsequent processes such as weaving. The bigger the more, the more sizing is required. The web containing a large amount of water after hydroentanglement needs to be dried to remove moisture from the web on the one hand, and to heat set the spunlace nonwoven fabric in the high temperature region on the other hand.

3. Result Analysis and Discussion

The main part of the jacket and trousers is divided into air layer: surface layer, pressure layer and contact layer with the body. The anti-pressure protective clothing is made of fire-proof, high temperature resistant and puncture-proof materials. Multistage air bag cushioning pressure protective clothing has two layers of fabric and lining. The fabrics are aluminium foil composite (or coated with aluminium) flame retardant fabrics, and the lining is natural fiber fabrics. The arrangement of the pressure airbag layers of the multi-stage airbag cushioning anti-pressure protective clothing can refer to the arrangement of tortoise shell patterns. In addition, the threaded cuff is connected with the inner liner, which makes it easy for water to enter the cuff through the gap between the inner liner and the outer liner, and the arm lifting is inconvenient, and it will pull the body down. In terms of the structure of the nonwoven fabric, in addition to the high strength, the uniformity of the thickness is also required. Through trial and error, a series of technical difficulties have been solved. The tightness of the fabric is the ratio of the projected area of the yarn in the fabric to the total area of the fabric, indicating the tightness of the fabric. Therefore, in order to achieve the strength and surface density of the fabric to meet the requirements of protective clothing standards, try to choose a smaller tightness, and at the same time consider the increase in the number of interlacings per unit area of the fabric. Fiber testing properties mainly include fiber elongation at break and moisture regain. The test temperature was 30 °C, the humidity was 55%, and the humidity was adjusted for 15 h. The test results are shown in Table 1 and Figure 2 below.

Table. 1 Raw fiber properties

Fiber type	Elongation at break (%)	Moisture regain (%)
Type FY fiber	22	1.8
Type FB fiber	18	1.5

**Fig. 2** Raw fiber properties

The heat transfer process inside the fire service is a complex process of nonlinear dynamics. The internal heat and moisture transfer mechanism of the fire service is the basis for the research of fire service, and it is also a hot issue for scientific and technological workers for decades. The yarn is dyed prior to weaving, using a dispersion dye. Compared to fiber dyeing, yarn dyeing avoids the frictional entanglement of the fibers in the dye and reduces the mechanical properties of the fiber. The back of the hand is a semi-circular wrap-around airbag, the palm is not set; the airbag is placed at the top of the instep, and the bottom is made of hard puncture-proof material. A metal puncture resistant liner is used in the insole. Back; Separate design of protective clothing jacket and underpants can solve the adverse effect of body height on design size. Finally, the optimal design of sleeves. Frequent arm lifting is one of the unavoidable actions of firefighters during operation. Because when the arm is raised, the skin under the armpit and the back near the side of the body will expand upward. The reduction of weight enhances the comfort of firefighter's firefighting and protective clothing, and is conducive to enhancing firefighter's fighting effectiveness of firefighting and rescue.

The design of exterior fabric of firefighting protective clothing is not limited to FY double-stranded yarn used in this subject. With the development and perfection of raw material production technology, the improvement of spinning and weaving technology and the exploration and development of blended yarn, the corresponding fabric design scheme will also change. The basic mechanical properties of fabrics, mainly testing the tensile, tearing and bursting properties of fabrics. The tensile, tearing and bursting properties of fabrics directly affect the durability of fabrics. During the experiment, the burners jointly spray flames to the central dummy, the radiation intensity of the fabric surface can reach 80kWm^{-2} , the surface of the protective clothing is directly in contact with the flame, and the radiant heat received by the surface is measured by a heat flow meter on the surface of the dummy human body. And temperature. Considering the problem of oxygen supply after the use of protective clothing personnel in the high-pressure gas cylinder after the distress, the two exhalation valves are added on the basis of the current exhalation valve. Metal anti-piercing lining is used in the inner sole to meet the requirements of anti-smash, waterproof and anti-skid performance of general fire boots.

4. Summary

With the rapid development of social economy and urban construction, the continuous application of new technologies, new processes, new materials and new products in production, the dangers of various types of fires and sudden disasters have emerged, the nature of accidents and disposal methods

the difficulty is increasing, and the unsafe factors in the fire fighting and rescue process are increasing. Starting from reality, aiming at the development of modern science and technology, using new materials and new techniques, and developing practical protective equipment to face the development of the economy and the progress of society. Generally speaking, Spunlaced pressure has a great influence on the strength and appearance of spunlaced cloth. The bigger the pressure, the better the fiber entanglement, the higher the density and strength of the product. In addition, the blending process improves the tensile properties of yarns, and decreases the twist and evenness of yarns. The material of FB yarn is slightly different from that of FY yarn. The former adds black dye to make the yarn appear black, but the mechanical properties measured are lower than those of FY yarn. Considering that there are air layers between the layers of fabrics, the model agrees well with the experimental results. Using this model, the effect of different air layers on the temperature change of the fabric is studied for the first time.

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