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Role of Firefighters in Functional Clothing

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I. INTRODUCTION

Firefighters have to face many situations while putting out a fire and they use fire clothing to avoid getting burnt by the fire, they may even die or get hurt due to burning in the fire so use personal protective equipment. Personal Protective Equipment (PPE) and Personal Protective Clothing (PPE) are the materials that provide a barrier between the hazardous environment and firefighters for protection. The performance level of the PPC is the most significant factor, which determines the potential for clothing rescue/injury. The level of performance is dependent on the nature of the fire, the type, design and characteristics of the PPC. The use of protective clothing is essential to protect firefighters from thermal exposures and other life-threatening risks. Generally, the standard protective clothing is a multi-layered construction, which is heavy and voluminous to provide the desired thermal protection. This reduces the capacity of protective clothing to transfer internal heat into the surrounding atmosphere and creates thermal stress for firefighters. It is important to recognize the difference between the need for fire fighting clothing and environmental conditions. The ideal fire protection clothing system should support all of the following:

Protection against radiant and convective heat.

2. Resistant to impact and abrasion.
3. Comfortable in a different weather conditions.
4. Water repellent
5. Easy to clean inside.
6. Resistant to chemicals.
7. Durable and affordable.
8. Resistant to damage from sparks.
9. Adjustable air cooling system.
10. Flame resistance

In an active work situation, the performance of a fireman is synonymous with his comfort characteristics. The primary concern in the garment system is to provide comprehensive protection from heat exposure while dissipating sufficient metabolic heat into the environment.

Protection and firefighters' clothing

Various types of fire fighting include structural fires, wildland fires, aircraft fires and certain other types of fires. The time firefighters spend fighting the fire is only about 5% to 10% of their service time, where they are exposed to extreme heat and flames. That's why he uses fire clothing.

Heat resistance

The equipment used in the protective clothing must not melt. Parts of clothing such as zippers must be kept functional when exposed to an atmosphere of 180 degrees Celsius.

Tensile strength

The external materials of fire protection garments must withstand a breaking load of more than 450 N and the main seams must have a maximum breaking force of more than 225 N.

Components of fire fighter clothing

Under NFPA 1971 and other similar standards in other countries, all participating apparel must have three components: an outer shell, a moisture barrier, and a thermal barrier.

Generally, trousers are fitted with reinforced knees and leather cuffs. The materials used for the three layers in trousers and turnout coats may vary but will very often include a combination of Nomex/Kevlar materials.

For example, the materials used by the Los Angeles City Fire Department, as found in their 2005 recruit handout are as follows:

- Outer shell: Nomex/Kevlar blend in a rip stop weave with water repellent finish.
- Thermal insulator layer:Quilted fabric.
- Moisture barrier: Breathtex material combined with a Nomex/Kevlar laminate.

Heat and moisture barriers are sewn together for cleaning, repair and replacement of the exterior shell. The principal components of most firefighting clothing are Kevlar and Nomex, two fabrics created by the chemical giant DuPont in the 1960s. Many protective clothing companies use a blend of both fabrics, while others focus more on the flameproof Nomex. Nomex is the fabric that gives protective equipment its heat and flame resistance while Kevlar provides flexibility, comfort and breathability.

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Different types of fire fighters fabric

It primarily covers firefighter soldiers and certain industrial costume workers. Glass, carbon, Kevlar, Nomex. These garments have a fire-resistant inner layer composed of a moisture barrier, a thermal barrier and a coating. The outer shell containing fibers such as aramides and PBI supplies flame, thermal and mechanical resistance and strength. Thermal protection includes fire and extreme heat conditions and environments and applies to firemen, welding, foundries, metal and ceramic industries, etc.

Specification for fire-resistant suits

Firefighters are working in extremely high temperatures up to 1000 to 1100°C, such as furnace and oven repair, cooking, slagging, firefighting and rescue work, the use of aluminized fabrics are essential. A combination of "Celanece pbi" fiber (25%) and "Conex" meta aramid fiber (75%). The flameproof outer shell must not rupture or lose its inherent flexibility after being exposed to a 1200°C flame for more than 65 seconds. Intended for use by firefighters of structures that encounter risks of hazardous radioactive pollution and radio-active contamination during firefighting and related rescue operations in "hot work" areas. These suits consist of:

Trousers
Coats
Gloves
Boots
Hoods

A piece of head to toe filled with air to reduce heat and increase comfort. Firefighter clothing should be designed with certain functions in mind, the most important of which is protected against heat and flame. And humidity protection is also important depending on the type of extinction method. Firefighting suits first appeared and were used in the 1930's and were originally made of asbestos cloth. Nowadays, this combination is made of aluminized materials deposited in a vacuum.

There are three basic types of this aluminized suit:

1. Approach suit: ambient heat protection up to 200° F (93°C) and used to work in the general area of high temperature such as steel mills.
2. Proximity suit: kiln ambient heat protection up to 2000° F (1093°C) and used for aircraft rescue and firefighting etc.
3. Entry suit: ambient heat protection up to 2000° F (1093°) and used in the situation in which requiring protection from extreme heat.

Different types of fire fighter suits

- NFPA Turnout Gear.
- Firemen Helmet.
- Balacava.
- Firemen Boot.
- Firemen Hand Gloves.
- Fire Suit.




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Use of Nanotechnology for fire fighters clothing

New technology discovered to reduce the damage causes by fire, which nanotechnology is one. In nanotechnologies, structured starch-based nanocoatings have been introduced to be applied to furniture and textiles to increase their fire resistance and make them almost flame retardant. Clay products like brick and mortar may be modified to adopt a lower thermal conductivity while has gas barrier properties. Nano fiber mats that have applications in building insulation are used instead of foam and have shown to absorb thermal energy of the flames, extinguish fires preventing them from being spread all around to cause damage and give occupants more opportunity to escape a place on fire. In other applications, there are reports on the application of hydrogen to increase the fire resistance in blankets and clothing as well as absorb heat and prevent thermal burns. Nanocomposites made of polyetherimide are capable of increasing the thermal protection of household appliances. They can also be combined with agents that do not release toxic if exposed to flame and fire. There are numerous potential benefits to using nanotechnology to advance fire safety. Smoke detectors and alarms are good for detecting particulates immediately after a fire begins. There are quality of nanocoatings with fire resistance that can increase the resistance of materials and their durability to withstand high thermal energy and heat. To fight fires, a series of fire suppression systems have been introduced that operate on the basis of various chemical mixtures at the nanoscale to deal with fire suppression in such an effective manner. In addition, the vehicles were fitted with fire-resistant nano-coatings on engine components and fuel lines to suppress fires in vehicles.

Defining the application of nanotechnology in fire safety

There are numerous solutions for building materials which act against the effects of fire and are mainly integrated nanotechnologies. Technologies that depend on nano structured materials can find Solutions as the properties of materials can greatly enhance fire resistance quality, fire retardancy and can create environments with higher safety when exposed to fire. Nanotechnologic materials can greatly enhance fire protection and prevention strategies. Fire extinguishers and clothing systems are examples of innovative solutions that take advantage of nanotechnology, mainly to provide comprehensive approaches to firefighting. The combination of various chemicals with nanotechnology can strengthen the quality and process of suppression and improve the efficiency and fighting force. In so doing nanotechnology has to be explored even more to achieve its advantages in developing fire-fighting equipment and clothing as it is possible to achieve durability of fibers in clothing and equipment to resist fires better and have high thermal energy when nano structured materials are involved. By taking advantage of nanostructured materials, firefighters might get fire safety as well as efficiency in the fire stage.

II. CONCLUSION

It has been one of humankind's greatest achievements for exploiting fires with consequent advances in technology. Although fire plays an extremely important role in human life, it is clear to everyone that it is extremely dangerous as well. Such as a person also dies.The outbreak of fires has been a huge problem in almost all countries and have cost injuries with a lot of damage that are in fact preventable if the right materials are chosen in designing and fabrication of products. Studies and results have shown that the incorporation of

nanotechnology has significantly diminished the damage by fires as well as improvements in the resistance of materials and machinery that are exposed to fire.

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