

Study of Fire Protective Clothing

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ABSTRACT

Fire protective clothing have an increasing demand all over the world due to the increasing number of fire-related accidents. The article covers a brief history of the protective clothing along with study of the conventional fire resistant textiles and their drawbacks. The main focus then is to empirically suggest an unprecedented solution in order to increase the efficacy of the materials while simultaneously reducing manufacturing costs.

1. The need for fire resistive textile

The current scenario in our economy does not allow extravagant expenditure for Emergency Response Teams like Police or Fire emergencies. The bulk of the government expenditure is spent on Major Economical Hurdles of the 21st

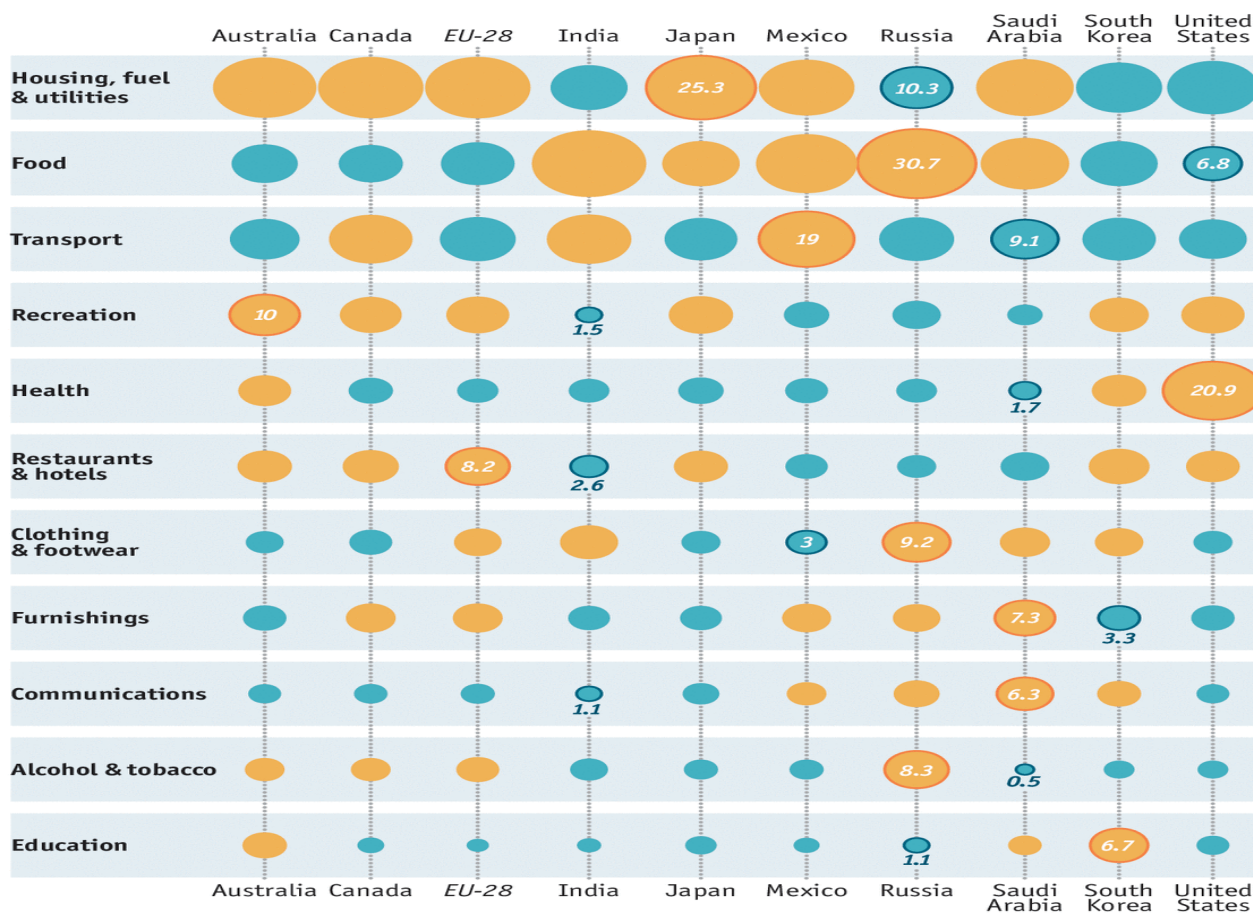
Century be it income inequality, Unemployment or Medical care for the underprivileged.

Due to this the emergency response teams are heavily under-funded and lack the latest technological innovations which are a common occurrence in the more developed economies of the west.

How they spend it

Household spending*, % of total, 2013 or latest, includes taxes

Within category ● highest spend ● above average ● below average ● lowest spend



Source: Eurostat
Economist.com

*Categories exclude miscellaneous spending

Annual Spending by countries on fire protective

Our aim, is to come up with a economical solution to these sectors of emergency respondents so that they are better equipped to handle Fire Related emergencies whilst maintaining operational integrity and keeping costs low to finance such innovations.

Building and understanding from conventional approach.



*Evolution of protective textiles.
Source:- Google*

3. The problems with Fire Proximity Suits

Asbestos was woven or embedded into the line of the fabric material, every time a firefighter used this equipment, his skin would rub against the asbestos resulting in abrasion of skin and can potentially be carcinogenic.

This required a need for removal of asbestos form the fabric, and replace it with a more human friendly material.

2. History

Fire proximity suits first appeared during the 1930s, and were originally made of asbestos fabric. Today they are manufactured from vacuum-deposited aluminized materials that reflect the high radiant loads produced by the fire.

Also the maintenance and cleaning of the fabric can impact the economical aspect of the solution as the operational costs (cleaning) is high, a highly unlikely solution considering most of the underfunded Govt. Projects already waitlisted for grants or research funds.



*Conventional Fire Protective Garments
Source:- Google*

4. Solution Proposed

Usage of Thermal Batting Fabric



The fabric is made from hollow needle punched or Hollow Twistless Poly-Ester Fibres mixed with Rayon fibre (for increased comfort) that have been needle punched through a non woven substrate. Then they are needle punched through metalized polyfilm. This film acts a reflector and a radiation shield to protect form the high radiant loads form the fire.

The needle material is breathable, which would allow proper circulation (ventilation).

Along with this we recommend a battery powered fan to assist in thermo convective circulation. Since the body temperature is highest near the core, and lowest near the tips of the fingers and feet (even in the situation of thermal distress) we recommend to place the battery operated fan near the core.

5. Advantages

The fan would help in removing the thermally convective air to reduce heat transfer between the outer layer of material and core body temperature.

Even though non-woven fabrics are not recommended for apparel uses, we still recommend the same because of the least areal density that is offered.

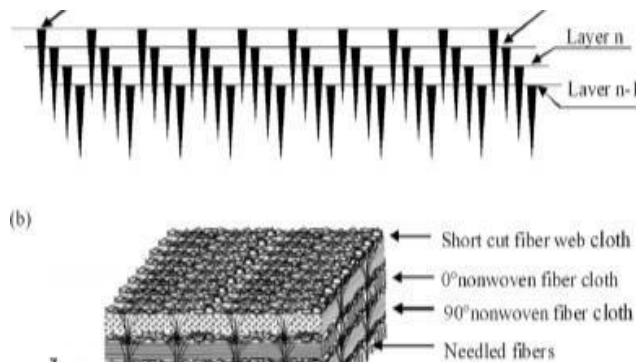
We know that doing hot environments Vaso-Dialition of the blood vessels happens, (to get rid of internal heat due to increased surface area and circulation) to rid the body of excess heat. A fabric offering a porous structure and extremely less areal density would strengthen the same physio-thermal response of the body.

Moreover, the fireproof material is not in direct contact with the body and is worn over the conventional apparel which makes it convenient to use non- woven textiles since chances of abrasion are greatly reduced.

The Thermal batting fibres are hollow, which means they have air inside them which has high Thermal Capacitance, which requires a lot of heat to change its temperature. This acts as a temperature buffer provided that the Temperature of Body is not more than that of Thermal Batting Fabric, in

which case it will produce the exact same effect as we hope to achieve through our product.

The use of metalized fibres instead of conventional aluminium deposits on the outer surface of the fabric greatly reduces the weight of the overall attire, thus making it more convenient to use and maneuver in, while offering similar thermally reflective properties.



6. Possible Challenges

The usage of the battery equipment is susceptible to thermal degradation which can result in swelling or leaking of its internal chemical components which on their own can be harmful if inhaled (vapour) or can harm the skin if they come into contact with the skin of the firefighter.



Source:- Google

Also the failure of the battery would completely render the Thermal-Convective circulation useless making the suit a potential greenhouse.

The battery itself should be properly insulated by the fabric so as to reduce chances of its damage.

In case of a Electrically or Potentially Electrically simulated fire, the fabric can act as a short for the current. If the suit is not lined completely with rubberised material, this can lead to a huge electric current being discharged through the suit, which make potentially result in burning of the Non-woven substance used. Since Poly-Ester, is a synthetic polymer, it can melt and deposit on the skin of the firefighter.

The metalized fibres are extremely hard to needle punch due to their incredibly high tensile strength and rigidity, which is why we recommend a mix of the metallic fibres with conventional natural/man-made fibres.

The natural/man-made fibres can be effectively needle punched and would easily conform to the desired shape of the apparel.

The cohesive forces between these fibres and metallic ones would lead to effective needle punching of the metallic fibres as well.

7. Economic Benefits

The amount of metal used for the apparel is less as compared to the conventional solutions which leads the

greater cost reduction whilst maintaining, to a reasonable degree, the quality of the fire suit.

The needle punching is a very frugal and economical way of producing non woven fabrics due to the vast reduction in the number of steps of the manufacturing steps. There is no need for a yarn or spinning process. This also helps in mass production reducing overhead costs of labour and administration.

8. Applications

These materials can be used in Fire Fighting situations. They can also be used to thermally insulate hot army camps with a few modifications to the implementations (greater battery, inclusion of coolants and compressors, increased fan capacity, etc.)

They can also be used in mining industry where at sub-level depths, the ambient temperatures may rise in excess of 60 degrees centigrade.

Up until now heavy drilling and mining process have been largely automated due to increased depths of the mines where human presence is not viable. But this leads to an absence of human supervision and oversight. But using these products can ensure a safe human presence whilst maintaining conducive thermal environment for the wearer.

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