Sustainable Quality Parameters in Bullet Proof Jackets – Avenues & Approaches

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Abstract:

Militaryclothing is a vast textile field with requirement of multi functional fabrics. Since the fabrics used have special functions, though it belongs to apparel industry, needs and requirements of Bullet Proof Jackets are deviated from regular apparels. Quality process plays a very vital and inevitable role in rescue clothing- "SAFETY FIRST". The quality checking procedures should follow sustainable needs also parallel. This article is an effort towards creating that awareness in the industry.

KEY WORDS: Kevlar, Ballistic Panel, Dyneema, Quality, Sustainability, STF (Shear Thickening Fluid), Combat.

Introduction:

The rescue of the country has become ultimate objective in this third world. Hence, defense clothing has achieved an important role in combat. Quality has never the less role in defense clothing; in fact, much higher levels of expectation because, the consumer is nation's pride soldiers.

"There is always Zero ease in Quality for Bullet proof Jackets"

– The statement proves the importance of quality in bullet proof jackets. But the quality should not ignore the need of the era- SUSTAINABILITY.

Raw Material used in Bullet Proof Jacket:-

- **Kevlar**: It's a Para- Aramid HSHM (High strength & High Modulus fiber made by *Du-Pont* company) In 1965 stephanie kwolek invented Kevlar. This is trade mark for polypara – phenylene terephthalamide a liquid polymer that can be spun into aramid fibre and woven into cloth. Kevlar 29 & Kevlar 149 is dominant material.
- **Spectra Shield**: It's a Para- Aramid HSHM (High strength & High Modulus fiber made by *Honeywell)*
- **Dyneema:** It's a Para- Aramid UHMWPE (Ultra High Molecular Weight Polyethylene made by DSM, it is also known as **world's strongest**fiber. Dyneema doesn't need any specific process which is very big advantage because it will reduce the cost of garment.
- **Nomex:** It's a meta- Aramid HCCROF (High Chemical &Combustion – Resistance OrganicFiber made by *Du-Pont* company)
- **Lexan:**It is made through a patented chemical process.
- **Tawron:** (similar to Kevlar)It's a Para- Aramid HSHM (High strength & High Modulus fiber made by Acordis)
- **Bynema:**(similar to Spectra)
- **Steel or titanium**: In some bullet proof jackets we need metal pelts also so for that steel or titanium is used.
- **Ballistic Nylon**: Till 1970 this was best material for bullet proof jacket.In 1971 Lester shubin advocated is to replace bulky ballistic nylon in bullet proof vest.

Country manufacturing Bullet Proof Jacket:

China, India, UK, Russia are the global leaders in bullet proof jacket manufacturing.

Lead buyers in world scenario:-

US, Australia, Bangladesh, Taiwan , Nigeria, Malaysia, Arabia, China, Pakistan, India, Switzerland, Saudi Arabia, Dhaka.

Various finishes to be applied on bullet proof jacket:-

- **Rinsing & wash:-** Kevlar consist of O-H group & the benzene group thus there are oil particles which may reduce the ballistic strength so after weaving or knitting it should be thoroughly washed & rinsed to remove that oil particles.
- **Coating material:**
- ✓ **Silicon carbide (SIC):** It is high performance inorganic fiber help to improve the strength of bullet proof jacket.

- ✓ **Boron carbide:** It is high performance inorganic fiber help to improve the strength of bullet proof jacket.
- ✓ **P2i** is a high performance nano-coating is a newly developed technique with highest impact on strength. But it is much more expensive than other coatings.
- ✓ **D3o** is also gel type coating which is also very expensive.
- ✓ **(STF) Shear thickening fluid** is also used for coating which increase strength of the bullet proof jacket **STF** give more flexibility to bullet proof jacket due to number of layers which we used are reduce& it also reduce bulkiness &thickness of vest so it's comfort level & impact strength is also increases. **STF**also comprise of ethylene glycol & nano silica particles.

Machines used for Manufacturing Bullet Proof Jacket:-

- The **Doubler Winder** was selected for the winding process.
- In warping process the required tension is obtain by adjusting the **leasing rods** and **tension devices.**
- **Rigid rapier loom** was used for weaving process modification to let-off mechanism to obtain high initial warp tension.
- There are some **cutting tools** which are exclusively designed to cut HSHM fabric.

6 1/4" fiber optic KEVLAR Cutter, 8" KEVLAR Cutter, 5 1/2" fiber optic KEVLAR CUTTER, 5 1/2" fiber optic KEVLAR Cutter (Bi-Material), 5 1/2" fiber optic KEVLAR Cutter (With Breaker Notch), 5 3/4" Fiber Optic KEVLAR Cutter.

Quality Requirementsfor Bullet Proof Jacket:-

1. Safety and Health Evaluation: Flammability,toxicity, or abrasiveness
2. Sizing and Fitting for Upper & Lower Torso Garments: Testing for Anthropometry
3. Donning & Doffing: Evaluates the ease of garment and accessories in various conditions
4. Leakage: For the Water leakages under various climatic conditions
5. IR Reflectance: To check the sensitivity in Non- white light conditions.
6. Electrostatic Discharge: To check the compatibility of the vest in electro sensitive ambiance.
7. Decay: The degradation of the material into earth has to be checked to ensure its sustainability.
8. HFE: Human Factors Engineering: to check the comfort and clothing reaction whiles an active soldier in actual combat situation; also checks the field durability.
9. Mobility: To check the ease and comfort during movement of the wearer.

The following are the characteristics which are checked through above testing procedures:

Physical requirement:-

- ✓ Light wet and low bulk
- ✓ High durability and dimensional stability
- ✓ Cleanable
- ✓ Good handle and drape
- ✓ Low noise emission
- ✓ Antistatic

Environmental requirement:-

- ✓ Water- repellent
- ✓ Waterproof
- ✓ Windproof
- ✓ Snow- shedding
- ✓ Thermal insulating
- ✓ Water vapor permeable
- ✓ Rot resistant
- ✓ UV light resistant
- ✓ Air permeable
- ✓ Biodegradable

Camouflage, concealment and deception requirement:-

- ✓ Visual spectrum
- ✓ Ultra violet
- ✓ Near infrared
- ✓ Far infrared
- ✓ Acoustic emissions
- ✓ Radar spectrum

Flames, heat, and flash protection requirement:-

- ✓ Flame Retardant
- ✓ Heat resistance
- ✓ Melt resistance
- ✓ Low smoke emission
- ✓ Low toxicity

Economic considerations:-

- ✓ Easy care
- ✓ Minimal maintenance
- ✓ Long storage life
- ✓ Reparable
- ✓ De-contaminable or disposable
- ✓ Readily available
- ✓ Minimal cost

Specific battlefield hazards:-

- ✓ Ballistic fragments
- ✓ Low velocity bullets
- ✓ High velocity bullets
- ✓ Biological agents
- ✓ Nuclear radiation
- ✓ Directed energy weapons (DEW)
- ✓ Flechettes
- ✓ Chemical warfare agents

Recent development in Bullet Proof Jacket:-

Some of the recent developments in military clothing include progress made in minimizing weight and maximizing wear comfort. Militants are also turning to nanotechnology in an effort to make their armed forces more mobile and better protected from enemy assaults. Through nanotechnology, new personnel camouflage systems can be developed that can change pattern and colors as environment changes. “Chameleonic” camouflage allows the soldier to become a mirror of his surroundings. Other nano-technological developments include the use of fibers which can stimulate muscles and thereby give soldiers greater strength for lifting or jumping.

According to research study we came to know that many times during combat officers are injured or killed because of theirown weapons so, because of this each law enforcement agency or manufacture, military organization will have their own standard for armor performance ensure their bullet proof jacket will protects them from their own weapons.

Conclusion:

The study for this paper has understandings of Bullet proof Jackets Quality parameters meeting sustainability since eco harmony is the need of the era.

It proves that not only the testing procedures to carry out the tests to check the sustainability of the product but also the testing procedures are eco friendly as well.

Studies in this kind are really needed in enhancing the eco concerns and standards of humankind.

BIBLOGRAPHY:

- ✓ Rechard A Scott, 'Hand Book Of Technical Textiles', Woodhead Publishing Limited
- ✓ US Army Devlopmental Test Command, General Performance Tests Of Combat Uniform & Protective Clothing.
- ✓ R Paul, J Thampi & M Jayesh, ' Eco-Friendly Textile Processing – A global Challenge', Textile Dyer & Printer, 1996 29(16) 17-20
- ✓ S. Bazhenov. Dissipation of energy by bulletproof aramid fabric. J Mater Sci 32, p. 4167– 73,1997.
- ✓ JTATM (2003). Kevlar Research. Volume 3, pp.1-3.
- ✓ http://www.madehow.com/Volume-1/Bulletproof-Vest.html
- ✓ https://www.hardshell.ae/