Extinguish your agony with flame retardants

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1.Introduction

Flame retardants are materials that have the ability to inhibit or resist the spread of fire. Textiles are extremely flammable and contribute to rapid fire spread. However, the ignitable property of a textile can be considerably reduced by any one of three methods: by using inorganic materials such as asbestos, glass, etc; by chemically treating the textile with flame-retardant chemicals; and by modifying the polymer.

Today, flame retardant fabrics are important across all industrial and commercial workspaces, with workers whose duties bring them into direct contact with sparks, flame, fire, etc. These could be uniforms for firefighting agents or workers in foundries, welding places, automotive, engineering industries etc, while fire-retardant fabrics are also finding increased usage in applications such as automotive textiles. The purpose of a flame retardant is to impart resistance to flame on the substrate and protect human lives from injuries.

There have been some developments in flame-retardant finishes for polyester fabric and its blends. Flame-retardant finishes for synthetic fibres should either promote char formation by reducing the thermos-plasticity or enhance melt dripping so that the drops can be extinguish away from the igniting flame.

Flame-retardant chemicals that are applied to fabrics are intended to inhibit or suppress the combustion process. These fire retardants interfere with combustion at different stages of the process, such as during heating, decomposition, ignition or spreading of flame.

Now, if the textile is flame-resistant then the flame retardant can act physically and/or chemically by interfering at particular stages of burning. There are different mechanisms of flame retardants.

The traditional FR chemicals are based on elements such as phosphorus, nitrogen, halogen or water of dehydration. Phosphorus-containing compounds have been proved to be highly effective in conferring flame retardancy to highly oxygenated polymers. But the best results would be achieved if the FR formulation were a relatively water-insoluble, long-chain polymeric phosphorus compound. Synergism between two or more elements, as well as their compounds, becomes imperative since high doses of these substances are undesirable due to emission of non-eco-friendly toxic gases during the burning process. It is, therefore, necessary that the least amount of FR chemical must be present in the substrate while still giving the desired FR properties and while simultaneously protecting the environment.

Sarex has developed the flame retardants Flamguard-DPS and Flamguard-PS for synthetic fibres

Taking into consideration both environmental and fire-protection objectives, Sarex has developed the flame retardants Flamguard-DPS and Flamguard-PS for synthetic fibres.

Flamguard-DPS is durable flame-retardant finishing chemical for 100% polyester, polyamide and polypropylene fibres. It is a

halogen-free compound, and fabric finished with Flamguard-DPS shows minimum effect on shade and possesses good fastness to home laundering and dry cleaning. Flamguard-DPS does not have any effect on the drape of the treated fabric, has low volatility and does not lead to fogging. It is applicable by padding and by the spray method.

Flamguard-PS is a durable flame retardant for 100% polyester, applicable by exhaust application. Flamguard-PS is halogen-free, and fabric finished with Flamguard-PS shows minimum effect on shade and posseses good fastness to home laundering and dry cleaning. Flamguard-PS does not have any effect on the drape of the treated fabric and it is suitable for protective workwear, furnishing fabrics, curtains and automotive textiles made from 100% polyester and polyester-rich blends. It is also applicable by the spray method.

2.Application conditions

A 100% polyester and polyamide fabric was finished with Flamguard-DPS by padding application with 70% expression, dried at 120°C for 2 min and cured at 160°C for 3 min. A 100% polypropylene nonwoven was padded with Flamguard-DPS keeping 95% expression, dried at 110°C and cured at 130°C.

A 100% polyester fabric was dyed and finished simultaneously using Flamguard PS by exhaust application, using a material-to-liquor ratio of 1:10, pH 4.0-4.5, temp 130°C, and time 45 min.

3.Test method

The finished fabrics were evaluated for flame retardancy as per ASTM D 6413-94. Samples were weighed before being mounted in a frame and then placed in the flame chamber. The methane (CP grade) burner flame was adjusted to a height of 1.5in and the specimen set to 0.75in above the burner. The bottom of the specimen was exposed to the flame for 12 seconds, at which point it was observed for melting and dripping behaviour. The after-flame time, the length of time for which a material continues to flame after the ignition source has been removed, was recorded. Any afterglow time was recorded.

ASTM D-2863 Limiting oxygen Index (LOI) Fabric is held vertical in atmosphere of different oxygen/nitrogen ratios and ignited from the top. The text determines minimum oxygen level to support combustion.

Abstract

Demand for fire protection is continuously increasing in many technical fields, including building, automotive and protective wear. The physical environment is in a phase of transition to being highly mechanical and automatic, due to which there is high risk of accidents. One kind of accident is fire caused by mechanical or electrical failure, which necessitates development of materials that will not catch fire. Annual fire statistics have clearly demonstrated that most fire incidents occur in houses, involving upholstered furniture, bedding and nightwear.

Flame retardancy has witnessed intensive development of new technologies, products and materials to meet the challenges of ever-changing safety regulations. In the process of meeting with these requirements, synthetic fibres have played a significant role. However, along with many advantages, synthetic fabrics are also prone to fire.

Whether it concerns electrical or electronic items in offices or dealing with highly flammable materials in places including hotels, hospitals and even homes, the need for protective clothing is everywhere. Sarex has developed halogen-free flame retardants for synthetic fibres, which can be applied by exhaust and padding applications. These flame retardants were applied on polyester fabric, polypropylene fabric and polyamide with Flamguard-DPS, and 100% polyester fabric with Flamguard-PS. Treated fabrics underwent vertical flame testing and their LOI (limiting oxygen index) values were also evaluated.

Sr. No.	Fabric	Unfinished		160gpl Flamguard-DPS	
		Char Length (cm)	After glow time (sec)	Char Length (cm)	After glow time (sec)
1	100% Polyester	Completely burn	-	7	0
2	100% Polyamide	Completely burn	-	4	0
3	100% polypropylene nonwoven	Completely burn	-	3.9	0

Table 1 Flame Retardancy action of Flamguard-DPS on 100% Polyester, 100% Polyamide and 100% Polypropylene nonwoven

Name of Product	10% Flamguard-PS		160gpl Flamguard-DPS	
	Char Length (cm)	After glow time (sec)	Char Length (cm)	After glow time (sec)
Unfinished	Completely burn	-	Completely burn	-
Initial	7	0	7	0
5HL	6.1	0	6.5	0
10HL	5.8	0	6.1	0
25HL	5.4	0	5.5	0

Table 2 Durability of Flamguard-DPS and Flamguard-PS on 100% polyester fabric

4.Results and discussion

From Table 1 it is seen that the fabrics treated with 160gpl Flamguard-DPS showed excellent flame retardancy on 100% polyester, polyamide and polypropylene nonwoven fabrics. It can be also seen that the afterglow time of treated fabric was zero, indicating

Continues on page 63

concept and is relaxed due to the tumble-like movement, so that the residual shrinkage is reduced to a minimum. The individually adjustable air flow in the dryer and the wet spreading and shrinkage in the stentering zone allow optimisation of quality features such as shrinkage, fabric width and fabric surface. The curling of edges in the dryer is prevented by a systematic and selective arrangement of the circulating air. This new technology eliminates previously required, expensive process steps.

Brückner's technical director for mechanical design, an expert in the finishing of knitted fabric, wanted to assure himself that the recently developed concept was performing perfectly and visited CDL Knits in Mauritius directly after commissioning of the new line. Together with the customer, he conducted tests with different fabrics and determined the optimum process parameters for each fabric quality. The operators were directly involved and correspondingly trained.

After a short time, CDL was able to start production and reported that the fabric quality is better than expected, and both residual shrinkage and spirality are, for all fabric types, less than 5%. CDL is already saving about 40% of electrical and thermal energy compared to their previous process. But the biggest saving is the significantly reduced process time. Just 20 hours is required to deliver the productivity that previously demanded 90, offering enormous benefits in terms of turnaround.

The Tropic Knits Group is part of the Fine Knits cluster of Ciel Textiles, which is also located in Mauritius. The complete group has more than 20,000 employees, with an annual turnover of about US$300mn. Once a year Ciel Textiles hosts the Ciel Textile Chairman's Manufacturing Excellence Award for its capital-intensive companies. This serves as an occasion to bring together the employees of the individual business units, and to foster team spirit and solidarity.

The Knitting Division of CDL Knits won the award for Manufacturing Excellence twice, in 2015 and 2016. This year, in September 2017, CDL won the World Class Innovation & Creativity Award. The installation of the new Brückner line at CDL Knits, and the corresponding benefits for the company, played a small but nevertheless important role in winning the award.

The group and its individual business units attach great importance on sustainability. This includes the saving of resources (water, oil, electricity, etc), and also social responsibility, with a vision for the future. CDL Knits came up with the initiative 'Stairway to Hope', whose objective is to help underprivileged people in the community. Selvedge waste from production is provided to socially disadvantaged persons, who knit these into rug mats, which they sell and earn a living. The required equipment (for example, wooden frames or needles) is made available by CDL Knits, which also supports the sales of the products. The project is also known as 'WASTE to GOLD'.

Extinguish your agony with flame retardants

Continues from page 61

that it is not propagating the flame after the flame is withdrawn. The main reason for this flame-retardancy action is char formation combined with foaming, which then forms a protective top layer on the fabric surface. The advantage of such a flame retardant is that it causes less release of smoke and off-gases in a developing fire situation, thus keeping secondary fire damage as low as possible.

Durability of treated fabrics was tested after washing the fabric using AATCC-61 2A (accelerated washing), where one wash is equal to five washes, and the results are summarised in Tables 2 and 3. It was seen that all the fabrics treated with flame retardants showed good durability even after 25 home launderings.

The Limiting Oxygen Index (LOI) of the polyester fabric treated with Flamguard-DPS and Flamguard-PS was evaluated, and it was found that both the fabric show higher LOI than the unfinished fabric, indicating a higher amount of oxygen required for catching fire.

Name of Product	160gpl Flamguard-DPS	
	Char Length (cm)	After glow time (sec)
Unfinished	Completely burn	-
Initial	4	0
5HL	4.5	0
10HL	6	0
25HL	11	0

Table 3 Durability of Flamguard-DPS on 100% polyamide fabric

Sample Number	Description	Treated/Untreated	LOI Values
1	100% Polyester	Unfinished	22
2	100% Polyester	10% Flamguard PS	36
3	100% Polyester	100gpl Flamguard DPS	36

Table 4 Limiting Oxygen Index results of 100% polyester fabric

5.Conclusion

Textiles play an important role in everyday life and one of their main drawbacks is their structure, as they are mainly made of organic polymers, which are flammable and potentially dangerous species. Fabrics treated with Sarex flame retardants showed excellent flame retardancy and durability up to 25HL on synthetic fibres. The fabrics treated with these flame retardants showed minimum shade change and also showcased the versatility of being applied during dyeing. In the revolution that is imminent in the field of flame retardancy, Sarex aims to play a pivotal role in offering gamut of flame retardants for various substrates, which can pass the test methods required by the customers.