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# Antimony Compounds as Flame Retardants for Cotton Textiles

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To render cotton fabrics fire retardant, three chemical formulations, viz. solvent suspension, emulsion, and titanium-antimony combinations containing some chlorinated compounds, were studied. The treated fabrics were tested for fire performance, tensile strength and effect of laundering. The results show that these treatments could be used to reduce fire hazards in tents, *pandals*, etc; such treated fabrics may also be useful for military purposes.

To minimize losses in cotton textiles owing to fire, several chemical treatments have been tried from time to time. In the present study, three types of fire-retardant treatments have been tried. The treatments involve the use of antimony and chlorinated compounds in combination. The treated fabrics have been evaluated for fire-retardance by using standard procedures.

A mixture of finely divided antimony oxide, vinyl chloride-vinyl acetate copolymer or halogenated hydrocarbons, viz. chlorinated paraffin wax, chlorinated rubber with zinc borate as glow retardant, and dibutyl phthalate as plasticizer, were dispersed in ethyl acetate/methyl ethyl ketone to prepare the suspension or emulsion. This was applied on cotton fabrics. The treated fabrics were dried and heated at 60°C for about an hour to remove the solvent from the fabrics. A chemical retention of 65-70% add-ons was found adequate for effective fire retardance.

A 10-12% aqueous solution of titanium tetrachloride and antimony trichloride was prepared by adding hydrochloric acid. The fabric was immersed in this solution for about 5-10 min to obtain about 15% retention on dry basis. The treated fabric was passed through a 12-15% sodium carbonate solution to remove the excess acidity of the solution. Finally, the fabric was washed with soap and dried. In the treated fabric, titanium and antimony were estimated as $TiO_2$ and $Sb_2O_3$, whose concentrations were found to be about 7%.

Treated samples were tested in accordance with British Standard 3119[1] for fire performance. The tensile strength of the samples was determined with a tensometer. The durability of the treated fabric on laundering was determined by repeated washings with a detergent solution.

Table 1 shows that the samples treated with antimony-copolymer binder system (solvent suspension) have neither any flame spread nor glow on

Table 1—Properties of Treated Fabrics* and Comparative Data† of Treatments

| Treatment | Add-on % (dry basis) | No. of washings | Duration of exposure s | Duration of flame spread s | After-glow s | Char length cm |
|---|---|---|---|---|---|---|
| Untreated | — | — | 12 | | Burned completely | |
| Antimony-copolymer-binder system | 65 | Nil | 12 | Nil | Nil | 7.60 |
| Antimony-copolymer-binder system | 65 | 10 | 12 | Nil | Nil | 7.85 |
| Antimony-halogenated hydrocarbon system | 65.2 | Nil | 12 | Nil | 14 | 8.10 |
| Antimony-halogenated hydrocarbon system | 65.2 | 10 | 12 | Nil | 16 | 8.80 |
| Titanium-antimony system | 15 | Nil | 12 | Nil | 15 | 8.95 |
| Titanium-antimony system | 15 | 10 | 12 | Nil | 16 | 9.10 |

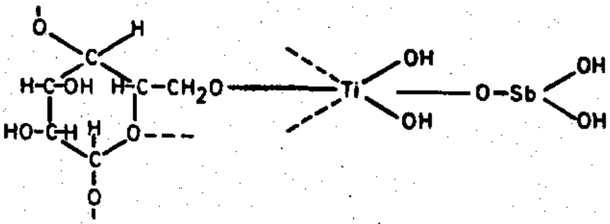
*All the tests were performed on coarse textiles.
†Average of 5 tests.

**Table 2—Tensile Strength of Treated and Untreated Fabrics**

| Treatment | Before laundering | | After 10 launderings | |
|---|---|---|---|---|
| | Warp way kg | Weft way kg | Warp way kg | Weft way kg |
| Untreated | 58.60 | 32.40 | 56.61 | 31.30 |
| Antimony-copolymer-binder system | 69.50 | 38.05 | 67.45 | 36.88 |
| Antimony-halogenated hydrocarbon system | 68.90 | 37.95 | 66.40 | 36.78 |
| Titanium-antimony system | 50.95 | 28.20 | 49.05 | 27.15 |

exposure to flame; samples treated with the antimony-halogenated hydrocarbon system (emulsion method) and the antimony-titanium combination gave afterglow only up to 14-16 s. The treated samples resisted laundering reasonably well and flame retardance did not decrease even after 10 washings. Table 2 shows that there is an increase of 17-18 % in the tensile strength when the antimony-copolymer binder system and the antimony-hydrocarbon system are used, while in titanium-antimony combination there is 13.5 % reduction.

Excellent fire retardance could be obtained on adding antimony oxide to a halogenated compound, which provides a source of hydrochloric acid at the ignition temperature. Hydrochloric acid reacts with antimony oxide to give antimony trichloride, which is strongly acidic and is considered to function as a catalyst[2] for dehydration of cellulose to carbon and water. Besides four primary valencies, titanium also possesses two secondary valencies, which add up to a coordination number of six. This permits the formation of a chelate complex by the interaction of titanium tetrachloride with hydroxyl groups of cellulose[3]. The titanium-antimony complex on reaction with hydroxyl groups forms a compound of the formula:



Titanium and antimony estimations and the fire performance of the treated fabric support the above reaction.

**Acknowledgement**

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**References**

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