

Firebrake ZB in polyamides



U.S. Borax offers a line of zinc borate products called *Firebrake*[®], which are multifunctional fire retardants for polyamides in applications such as electrical connectors, bobbins, circuit breakers, housings, transformer components, and encapsulations. The major criteria in choosing the right *Firebrake* product in polyamide applications is temperature stability: *Firebrake ZB* is stable up to about 290-300° C, while the *Firebrake 500* are suitable for high temperature applications, where the processing temperature could be as high as 500° C.

In halogen-containing polyamides:

Flame retardant synergist – *Firebrake* acts as a synergist of halogen sources such as brominated polystyrene and Dechlorane Plus. Depending on the type of polyamide and halogen source used, *Firebrake ZB* can either partially or completely replace antimony trioxide or sodium antimonite to reduce the formulation cost and still maintain the UL 94 V-0 performance for either unfilled or glass filled polyamides (Tables 1 and 2). In high temperature polyamides, *Firebrake ZB* can replace antimony trioxide completely.

Improve comparative tracking index (CTI) – While halogen sources, antimony oxide, and glass fiber are all detrimental to CTI, *Firebrake* products are known to improve CTI.

Improve thermal stability – *Firebrake* products improve the thermal stability of the fire retardant polyamide formulations as evidenced by color stability, melt viscosity stability (Figure 1), and the polymer weight retention during processing.

Improve corrosion resistance – *Firebrake* is known to alleviate corrosion life of equipment and metal substrates that are in contact with polyamides during processing.

Smoke suppression – Smoke suppression is a general function of *Firebrake* products in any polymer system, especially in halogen-containing formulations.

In halogen-free polyamides:

- Improve flame retardancy, reduce afterglow, and prevent burning drips in polyamide formulations
- Improve CTI of polyamides containing melamine polyphosphate or melamine pyrophosphate
- Improve char formation and thermal stability of polyamides, especially when containing aluminum diethylphosphinate and melamine polyphosphate
- Improve glow wire ignition temperature (GWIT) or glow wire flammability index (GWFI)
- Alleviate corrosion and suppress phosphine formation in polyamides containing red phosphorous

Figure 1. Melt Viscosity Stability of *Firebrake ZB* vs. Antimony Trioxide In Polyamide 6,6

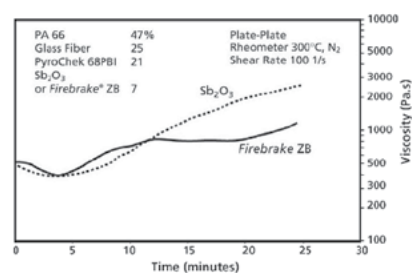




Table 1: Fire Retardant Non-Reinforced Polyamide 6,6

		Examples (wt.%)			
Components		1	2	3	4
Polyamide 6,6		70	70	78	85
Dechlorane Plus		20	20	16	12
Sb ₂ O ₃		10	–	2	–
Firebrake® ZB		–	10	4	1.5
Ferric Oxide		–	–	–	1.5
		Test Results			
UL-94	3.2mm	V-0	V-0	V-0	V-0
	0.8mm	V-0	V-0	V-0	V-0
	0.4mm	V-0	V-0	V-0	V-0
CTI (Volts)		275	300	450	350

Table 2: Fire Retardant Glass Reinforced Polyamide 6,6 (Sb-Free)

		Examples (wt.%)							
Components		1	2	3	4	5	6	7	8
Polyamide 6,6		75	54	47	47	47	47	47	47
Glass Fiber		25	25	25	25	25	25	25	25
Pyro-Chek 68PB		–	21	21	21	21	21	21	21
Sb ₂ O ₃		–	–	7	–	–	–	–	–
Firebrake® ZB		–	–	–	7	–	–	7	–
Firebrake® 500		–	–	–	–	7	–	–	–
Firebrake® 415		–	–	–	–	–	7	–	–
Firebrake® ZB-XF		–	–	–	–	–	–	–	7
Properties									
		Test Results – Dry As Molded							
UL-94	1.6mm	NC	NC	V-0	V-0	V-2	V-0	V-0	V-0
	0.8mm	NC	NC	V-0	V-2	V-2	V-2	V-0	V-2
		Test Results – Aged for 168 hours at 70 °C							
UL-94	1.6mm	NC	NC	V-0	V-2	V-2	V-1	V-0	V-2
	0.8mm	NC	NC	V-0	V-2	NC	V-2	V-0	V-2
CTI (Volts)		550	325	225	225	400	400	450	470

General guidelines

Recommendations for levels of treatment depend on the desired fire test performance, other components of the fire retardant system (either halogen-containing or halogen-free), and the CTI/GWIT/GWFI required.

- In halogen-containing polyamides, a good starting-point would be the replacement of 40% of antimony trioxide with *Firebrake* ZB. If an improved fire performance is achieved, higher levels of antimony oxide replacement can be tested.
- To achieve antimony-free formulation in polyamide 6,6, a good starting point is to use about 5 to 7 wt% of *Firebrake* in combination with an increased level of brominated polystyrene (by about 2 wt.%).
- To improve CTI, a maximum amount of *Firebrake* and minimum amount of antimony trioxide shall be used in the formulation.
- In halogen-free polyamides, about 1 to 4 wt% of *Firebrake* can be used in conjunction with aluminum diethylphosphinate/melamine polyphosphate or red phosphorus.

About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles. We pioneer the elements of modern living, including:

- **Minerals that make a difference:** Consistent product quality secured by ISO 9000:2001 registration of its integrated quality management systems
- **People who make a difference:** Experts in borate chemistry, technical support, and customer service
- **Solutions that make a difference:** Strategic inventory placement and long-term contracts with shippers to ensure supply reliability



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