

# 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

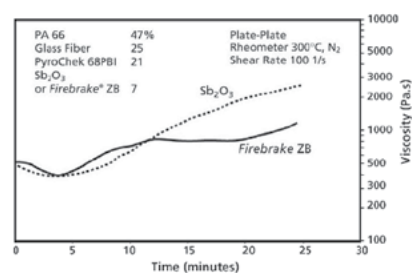




Table 1. Fire Retardant Non-Reinforced Polyamide 6,6

		Examples (wt.%)			
Components		1	2	3	4
Polyamide 6,6		70	70	78	85
Dechlorane Plus		20	20	16	12
Sb <sub>2</sub> O <sub>3</sub>		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 <sub>2</sub> O <sub>3</sub>		–	–	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 east 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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