Zinc Borate and Alumina Trihydrate

Halogen-free systems of which zinc borate is a key ingredient are quickly becoming the norm as health safety and environmental issues and further regulation are taking center stage.

Zinc Borate

- **Firebrake® ZB / ZB Fine / XF**

Solid Phase Reaction

Firebrake ZB, a unique form of zinc borate, offers a number of advantages as a multifunctional product it works synergistically with antimony oxide. It can as well be used alone along with Alumina Trihydrate.

Firebrake ZB can be used either as a partial or complete replacement for antimony oxide. It serves mainly as a char promoter and smoke and afterglow suppressant. Char acts as an insulating barrier, which reduces oxygen penetration and reduces temperature of the substrate and smoke evolution. Its refractive index is similar to most organic polymers and does not induce opacity to the base polymer. Zinc borate typically in halogen-containing systems is used at 1:1 up to a 1:3 ratio with antimony oxide. In halogen-free sytsems it is typically used at a fairly high level as it along with ATH are the key flame retardant products being utilized.

Zinc Borate			
Table II			
	Firebrake ZB	**ZB Fine**	**XF**
Particle Size Mean-Microns	7	< 2.5	< 2.2
			Topsize 12

Alumina Trihydrate (ATH)

- Polyfill line

Alumina Trihydrate is a white powder that acts as a flame retardant and smoke suppressant. When surface treated with a coupling agent or dispersion aid, ATH can also act as a functional additive.

The ground product line consists of untreated and treated grades that have a broad particle size distribution that varies from the fine particle sized products at 2.5 microns average particle size to large coarse products.

ATH can be used at fairly high loading levels (20-35 phr) in halogen containing systems and (50-250 phr) in halogen-free systems.

Sample Inquiries:
Send an e-mail to: samples@harwick.com

ATH can be used in all polymer systems, including elastomers (EPDM,SBR) and thermoplastics(PVC,PE,PP,XLPE and ABS) If high processing temperatures are reached (>230°C) ATH should not be used and should be replaced with Magnesium Hydroxide. ATH and Magnesium Hydroxide both act as a heat sink by giving off "water of hydration" when the dehydration reaction temperature is reached. This reaction needs to be above the maximum temperature seen during processing, as premature water vapor evolution can cause porosity problems. The release of water from ATH reduces the temperature of the substrate and retards the combustion reaction.

Phosphorus based Sources

- Lindol™
- Phosflex™

Gas/Solid Phase Reaction

Organophosphorus compounds (liquids) are used at fairly low levels to replace aromatic, naphthenic, or paraffinic oils.

These materials react to form polyphosphoric acid char, which inhibits flame propagation,reduces the substrate temperature by char formation and acts as an oxygen barrier.

Phosphate Esters		
Table V		
Type	**Phosphate Ester**	**Chemistry**
Aryl	Lindol	Tricresyl
	Phosflex 375	Alkyl diphenyl (triaryl blend)
Alkylated Aryl	Phosflex 362	2-ethylhexyl diphenyl
	Phosflex 390	Diphenyl isodecyl
Alkyl	Phosflex T-BEP	Tris(2-butoxyethyl)

Additional Flame Retardant Literature/Product Specifications Available Upon Request

HARWICK STANDARD DISTRIBUTION

Flame Retardants

An Introduction to Flame Retardants

By David R. Schultz –Technical Director

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Harwick Standard Distribution Corporation has prepared this flame retardant handbook to help development chemists and rubber compounders who are looking for basic information on flame/fire retarding systems.

It highlights differences between halogenated and halogen-free compounds, methods for retarding combustion, and functions of various flame retardants.

The Flame Retardant Handbook also gives recommendations and typical usage levels for various flame-retardant materials.

Harwick Standard Can Help You!

As a full-line supplier of flame retardant materials and services, Harwick Standard Distribution is a valuable resource. We can:

- assist you with compound development and help solve compounding problems
- provide starting formulations to optimize your flame retardant requirements

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Two Types of FR Systems

Fire Presents Three Major Concerns:

1. Flame
2. Smoke
3. Toxic Fumes

Always select raw materials…

- that interfere with combustion reactions
- have low heat combustion

Combustion Requires 3 Conditions:

1. Oxygen
2. Heat
3. Fuel Source

Fuel sources can be:

1. Polymers
2. Plasticizers
3. Process Oils

Flame Retardant Functions

1. Vapor phase reactions disrupt the free-radical oxidation process.
2. Endothermic reactions act as heat sinks, which reduce temperatures.
3. Char promoters act as insulators and protect underlying polymers.

Two Types of Systems-Halogen Containing

	HALOGEN CONTAINING		
	(Flame Resistance Requirements)		
Additive (phr)	**Low**	**Medium**	**High**
Antimony Oxide	2.50	5.00	10.00
CPW-100 (70% Cl)	7.50	15.00	25.00
ATH	15.00	20.00	30.00
Total	**25.00**	**40.00**	**65.00**
	(Low Smoke, Flame Resistance)		
Additive (phr)	**Low**	**Medium**	**High**
Antimony Oxide	2.00	3.00	5.00
Zinc Borate	2.50	5.00	10.00
CPW-100 (70% Cl)	7.50	15.00	15.00
ATH	20.00	20.00	30.00
Total	**32.00**	**43.00**	**60.00**

HALOGEN FREE			
(Reduced Smoke & Toxicity Requirement)			
Additive (phr)	**Low**	**Medium**	**High**
Alumina Trihydrate (ATH)	35.00	100.00	150.00
Zinc Borate	5.00	15.00	30.00
Total	**40.00**	**115.00**	**180.00**

Antimony oxide – Key synergist

It is particularly important when compounding for flame retardant properties in an elastomeric compound to follow the basic rules of compounding when using halogenated additives/materials. The antimony oxide/halogen ratio should be maintained at 1-1.5:3, as this has been found to develop the optimum in flame retardant properties.

Gas Phase Reaction

Antimony oxide is a white, free-flowing powder used at fairly low loading levels (2-10 phr), that must be used with a halogen synergist (bromine or chlorine). Antimony oxides are available in various particle sizes; including H, L, UF and treated grades. The following table illustrates the ranges:

	Types of Antimony Oxide	
Grades	**Particle Size***	**Tint Strength**
H	1.0-1.8	High
L	2.5-3.5	Low
UF	Submicron (0.2-0.4)	High
***Microns**		

The H Grade product (High Tint), which has a smaller particle size, is the most common grade of antimony oxide. We currently sell Twinkling Star and Bright Sun HB as representative grades. If the application involves the use of pigment, it is necessary to use a low-tint type product such as L Grade, so that the color remains the same.

In critical applications, the submicron grade UF can be used to reduce loss in physical properties.

Antimony oxide reacts chemically with a halogen source to reduce flame spread by disrupting free-radical oxidation. It is important to remember that halogens must be present for antimony oxide to be effective.

Antimony oxide can also be used with zinc borate for enhanced smoke reduction at a 1:1 or 1:2 level. The use of zinc borate can also aid in cost savings. The synergist used in this system is halogen-chlorine or bromine. If the polymer that is being modified contains a halogen (CR, CSM, CPE or ECO) then it is suggested to eliminate the extra halogen additives. It is also very important to be sure to adjust the level of halogen if the source is less than 100% to maintain a proper ratio.

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Halogen Sources

- Wellpren® CPE – Chlorine Containing Polymers
- Paroil® AO Series and Chloroflo® – Chlorinated Paraffins (Liquid)
- CPW-100 (Solid)

Gas Phase Reaction

Chlorinated paraffins contain various levels of chlorine, depending on the form; liquid or solid. These products can be used as a halogen source to react with antimony oxide, or as a processing aid.

The liquids, Paroil and Chloroflo, can vary from 40-70% chlorine and exhibit viscosity within a range of SUS 130 – 210 at 37°C./100°F. Paroil can also be used as a secondary plasticizer in various elastomers, polyolefins, and PVC.

A solid product, CPW-100 contains 70% chlorine and is available in flake or powder form.

Wellpren CPE		
Table III		
	Thermoset	
Products	**Chlorine Content,%**	**Mooney Viscosity, ML (1+4) @ 125°C**
CM3678M	36	78
CM566M	36	78
CM3690M	36	90
	Thermoplastic	
Products	**Chlorine Content,%**	**Melt Flow Index**
IM500	35	9.0
IM888	36	1.2
IM898M	35	0.6
Melt Flow Index Tested @ 180°C/ 10kg		

Chlorinated Paraffin Additives		
Table IV		
Liquids	**Chlorine Content,%**	**Chain Length**
Chloroflo 42	40	Long C18-C28
Paroil 140	42	Long C18-C28
Paroil 152	51	Medium chain C14- C17
Paroil 54 NR	54	Chlorinated alkenes C12-C24
Paroil 58 NR	59	Mid chain-Chlorinated alkenes
Paroil 38 AO	38	Very Long Chain C24-C28
Paroil 40 AO	43	Very Long Chain C24-C28
Paroil 50 AO	47	Very Long Chain C24-C28
Solid	**Chlorine Content,%**	
CPW-100	70	Very Long Chain C21+