



THE R.J.
MARSHALL
C O M P A N Y

Fire Retardants and Smoke Suppressants

Flame Defense Series

Antimony Trioxide (AO)
AO Replacements

Smoke Defense Series

Ammonium Octamolybdate (ADM)
ADM Replacements

Flame & Smoke Defense Series

Zinc Borate / Replacement
Zinc Stannate / Replacement
Zinc Hydroxy Stannate / Replacement

Metal Hydrate Series

Alumina Trihydrate (ATH)
Huntite / Hydromagnesite
Magnesium Hydroxide (MDH)



Marshall Additive
TECHNOLOGIES
DIVISION OF THE R.J. MARSHALL COMPANY

Marshall Additive Technologies (MAT), a division of The R.J. Marshall Company, is a leading supplier of innovative and cost attractive inorganic flame retardant and smoke suppressant technologies for the plastics and rubber industries.

Backed by a customer focused Applications and R&D team, MAT is focused on developing and offering reactive combinations of inorganic flame retardant and smoke suppressant products with the aim of enhancing performance and/or reducing cost of the final compound.

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The MAT division is constantly researching and working on new products. If you have a formulation problem you are trying to solve, or a cost reduction target, please feel free to contact us at

matsolutions@rjmarshall.com

We may be able to help with one of our existing products or partner with you to develop a custom solution.

Flame Defense Series

Antimony Trioxide (AO) and our AO replacement synergists enhance the flame retardancy of chlorine and bromine based chemicals and polymers. The mechanism works in the vapor phase by capturing the free radicals generated by the combustion process.

- FDAD** 100% antimony trioxide synergist for halogenated flame retardant systems.
- FD335** A reactive synergist blend specially formulated to provide the maximum flame retardant performance when used as an Antimony Trioxide replacement. This product is applicable to PVC, CPE, and a wide range of polymer systems where the flame retardant is bromine or chlorine based. Depending on the specific formulation, it is typically possible to *replace between 50 and 100%* of Antimony Trioxide.
- FD409** A reactive synergist blend specially formulated to provide a good balance of flame retardant performance and reduced cost when used as a partial Antimony Trioxide replacement. This product is applicable to PVC, CPE, and a wide range of polymer systems where the flame retardant is bromine or chlorine based. Depending on the specific formulation, it is typically possible to *replace 50%* of Antimony Trioxide.
- FD440** An antimony free inorganic synergist for halogenated flame retardant systems offering maximum cost savings. FD440 can allow the formulator to significantly reduce the antimony trioxide level in a formula while providing equivalent performance at a reduced cost. This product is applicable to PVC, CPE, and a wide range of polymer systems where the flame retardant is bromine or chlorine based. Depending on the specific formulation it is typically possible to *replace 50%* of Antimony Trioxide.

Flammability Performance Summary				
Formulation Ingredient (phr)	Control	FD335	FD409	FD440
PVC Resin	100	100	100	100
DINP	45	45	45	45
Ca-Zn stabilizer	6	6	6	6
Stearic Acid	0.3	0.3	0.3	0.3
ATH	60	60	60	60
AO	5	2.5	2.5	2.2
FD Synergist	0	2.5	2.5	2.8
Limiting Oxygen Index %	35.0	36.5	36.0	35.0
Peak Heat Release Rate (kW/m ²)	182.8 ± 17.3	63.8 ± 71.4	182.3 ± 13.5	154.2 ± 6.4
Total Heat Release (MJ/m ²)	31.8 ± 9.5	22.5 ± 9.6	36.3 ± 8.0	33.7 ± 6.5
Ignited Y/N	Y	N/Y	Y	Y

New products recently developed for PVC, CPE, and a wide range of polymer systems where the flame retardant is halogen based include:

FD455S FD313S FD493

In certain formulas these products can be used as a 100% replacement of AO.

Flame Defense Series continued...

FDVWI Specifically optimized for the cross-linked low voltage XLPE and EPDM wire & cable market. Within a segment of this market are wires and cables designed to meet the demanding VWI flame test requirement. To achieve this performance, it is common to formulate with brominated flame retardants and Antimony Trioxide synergists.

Leveraging The R.J. Marshall's long history with Antimony Trioxide replacement products for PVC applications, a research program was undertaken to design a specific product for the VWI application and similar systems where brominated flame retardants are used. FDVWI is the result of those efforts.

To demonstrate the basic efficacy of the product, a typical polyethylene recipe was constructed, compounded, press-molded and finally cross-linked using electron beam irradiation for convenience. After confirming cross-link density, UL94 sample bars were cut (0.03 inches thick) and laminated to a thin copper sheet (0.02 inches thick) to provide the heat sink effect and structural stability similar to that encountered in an extruded wire.

The laminated UL94 samples were then tested using the basic UL94 protocol but adapted to simulate the VWI test. Specifically, the flame was applied at a 20 degree from the vertical angle for 15 seconds for a total of 5 applications. The recipes evaluated and results obtained are shown below.

Ingredient (%)	Control	FDVWI
XLPE	59	59
Saytex 8010	26.7	26.7
Antioxidant	0.5	0.5
AD	13.8	4.6
FDVWI Synergist	0	9.2
Afterflame time 1 (s)	0	0
Afterflame time 2 (s)	0	0
Afterflame time 3 (s)	0	0
Afterflame time 4 (s)	0	1
Afterflame time 5 (s)	0	3
Cotton Ignited?	No	No

Control




FDVWI




Note: Images taken after fifth flame application.


Flame Defense Series continued...

FDPE94 Provides formulators of UL94 rated polyethylene compounds with options to reduce the cost of their flame retardant package. Designed specifically for formulations flame retarded with halogenated additives, the cost-efficient FDPE94 product can *replace over 50%* of the Antimony Trioxide synergist, while maintaining flammability performance. Additionally, FDPE94 has been observed to reduce the flow and dripping of the material during UL94 testing when compared to an equivalent version which incorporates only Antimony Trioxide as the synergist.

Polyethylene V2 UL94 Target			Control	Unburnt Sample	FDPE94 Version
Ingredient (%)	Control	FDPE94			
LLDPE	79.5	79.5			
Hordaresin NP70	15.0	15.0			
Antioxidant	0.5	0.5			
AO	5	2.2			
FDPE94 Synergist	0	2.8			
UL-94 Rating	V-2	V-2			

FDPP94 Provides formulators of UL94 rated polypropylene compounds with options to reduce the cost of their flame retardant package. Designed specifically for formulations flame retarded with halogenated additives, the cost-efficient FDPP94 product can *replace around 50%* of the Antimony Trioxide synergist, while maintaining flammability performance. Additionally, FDPP94 has been observed to reduce the flow and dripping of the material during UL94 testing when compared to an equivalent version which incorporates only Antimony Trioxide as the synergist.

Homopolymer V0 UL 94 Target			Control	50:50 AO:FDPP94
Ingredient (phr)	Control	FDPP94		
PP Homopolymer	116	116		
Saytex 8010	44	44		
Talc	28	28		
AO	12	6		
FDPP94 Synergist	0	6		
UL-94 Rating	V-0	V-0		

Copolymer V2 UL94 Target			Control	50:50 AO:FDPP94
Ingredient (%)	Control	FDPP94		
PP Copolymer	85.6	85.6		
Saytex 8010	10.4	10.4		
AO	4	2		
FDPP94 Synergist	0	2		
UL-94 Rating	V-2	V-2		

Other FD products are available on request for specific applications.

Smoke Defense Series

Ammonium Octamolybdate (ADM) is a well known additive for smoke suppression in plasticized PVC. Based on this technology, MAT has developed high performance, low cost, reactive blends that can improve upon the performance of ADM alone.

SDADM 100% Ammonium Octamolybdate smoke suppressant.

SD890 A reactive smoke suppressant blend specially formulated to provide the maximum reduction in smoke generation at the lowest possible cost when replacing molybdate based additives in PVC compounds. Specifically, work has been done which shows that it is possible to *replace 100%* of Ammonium Octamolybdate while achieving a further improvement in smoke suppression of a typical PVC plenum jacketing formulation and small gain in flame retardancy.

PVC Wire & Cable Jacket Example		
Formulation Ingredient (phr)	Control	SD890
PVC Resin	100	100
DINP	50	50
Ca-Zn stabilizer	5	5
Stearic Acid	0.2	0.2
ATH	70	70
ADM	15	0
SD890 Synergist	0	15
Limiting Oxygen Index %	30.5	32.0
Smoke Density ASTM E662 Flaming Ds 1.5 min	53.4 ± 16.0	23.3 ± 5.8
Smoke Density ASTM E662 Flaming Ds 4.0 min	114.6 ± 8.3	88.7 ± 13.7

SDZAM A reactive smoke suppressant blend that has been specifically formulated to provide a more cost effective alternative to Zinc Molybdate Coated Talc (ZMT) products in the market for application in PVC compounds. Our experimental work has shown that SDZAM can be used as a direct replacement for ZMT type products and deliver similar smoke suppression performance together with a gain in the Limiting Oxygen Index of the PVC compound.

PVC Wire & Cable Jacket Example		
Formulation Ingredient (phr)	Control	SDZAM
PVC Resin	100	100
DINP	50	50
Ca-Zn stabilizer	5	5
Stearic Acid	0.2	0.2
ATH	70	70
ZMT	15	0
SDZAM Synergist	0	15
Limiting Oxygen Index %	32.5	33.5
Smoke Density ASTM E662 Flaming Ds 1.5 min	33.1 ± 3.4	39.0 ± 2.7
Smoke Density ASTM E662 Flaming Ds 4.0 min	94.3 ± 17.4	80.8 ± 16.1
Ignition Time	Ignited after 4s Burned for 829s	Ignited after 9s Burned for 637s

Other SD products are available on request for specific applications.

Fire & Smoke Defense Series

Where a combination of smoke suppression and flame retardance is required in one product, MAT offers a range of single chemical zinc based products as well as an emerging family of proprietary reactive blends of zinc chemicals and other ingredients.

CTZHS Zinc Hydroxy Stannate (ZHS) combines smoke suppression and synergism with halogenated flame retardants where antimony trioxide is not desired or permitted. It is suitable for formulations that are processed below 200°C.

FSD479 An antimony free proprietary inorganic blend flame retardant synergist designed to give max performance when used in a halogen based flame retardant polymer compound where Zinc Hydroxy Stannate is used as the primary synergist. It allows the formulator to reduce the amount of the expensive Zinc Hydroxy Stannate while retaining flammability performance and hence provide an overall cost saving. This product is applicable to PVC, CPE, and a wide range of polymer systems where the flame retardant is bromine or chlorine based.

FSD508 An antimony free proprietary inorganic blend flame retardant synergist for use with halogen based flame retardant polymer compounds where Zinc Hydroxy Stannate is used as the primary synergist. It allows the formulator to reduce the amount of the expensive Zinc Hydroxy Stannate while retaining flammability performance and hence provide an overall cost saving. This product is applicable to PVC, CPE, and a wide range of polymer system where the flame retardant is bromine or chlorine based.

PVC Wire & Cable Jacket Example			
Formulation Ingredient (phr)	Control	FSD479	FSD508
PVC Resin	100	100	100
DINP	45	45	45
Ca-Zn stabilizer	6	6	6
Stearic Acid	0.3	0.3	0.3
ATH	60	60	60
ZHS	5	0	0
FSD Synergist	0	5	5
Limiting Oxygen Index %	32.0	33.5	32.0

Fire & Smoke Defense Series continued...

CTZST Zinc Stannate (ZST) combines smoke suppression and flame retardant synergy with halogenated flame retardants where antimony trioxide is not desired or permitted. It is suitable for formulations that are processed above 200°C.

FSD485 An antimony free proprietary inorganic blend flame retardant synergist for use with halogen based flame retardant compounds, where Zinc Stannate (ZST) is used as the primary synergist. It allows the formulator to reduce or completely replace expensive Zinc Stannate while retaining flammability performance and hence providing an overall cost saving. This product is applicable to PVC, CPE and a wide range of polymer systems where the flame retardant is bromine or chlorine based.

PVC Wire & Cable Jacket Example		
Formulation Ingredient (phr)	Control	FSD485
PVC Resin	100	100
DINP	45	45
Ca-Zn stabilizer	6	6
Stearic Acid	0.3	0.3
ATH	60	60
ZST	5	0
FSD485 Synergist	0	5
Limiting Oxygen Index %	31.5	32.0

CTZB400 Zinc Borate (ZB) is typically used as a formulating additive to increase char strength, reduce smoke, and to provide afterglow suppression.

FSD617 Zinc Borate reactive blend which can replace 100% Zinc Borate in a range of polymer compounds. This product, depending on the formulation, can offer performance improvements at lower cost than Zinc Borate.

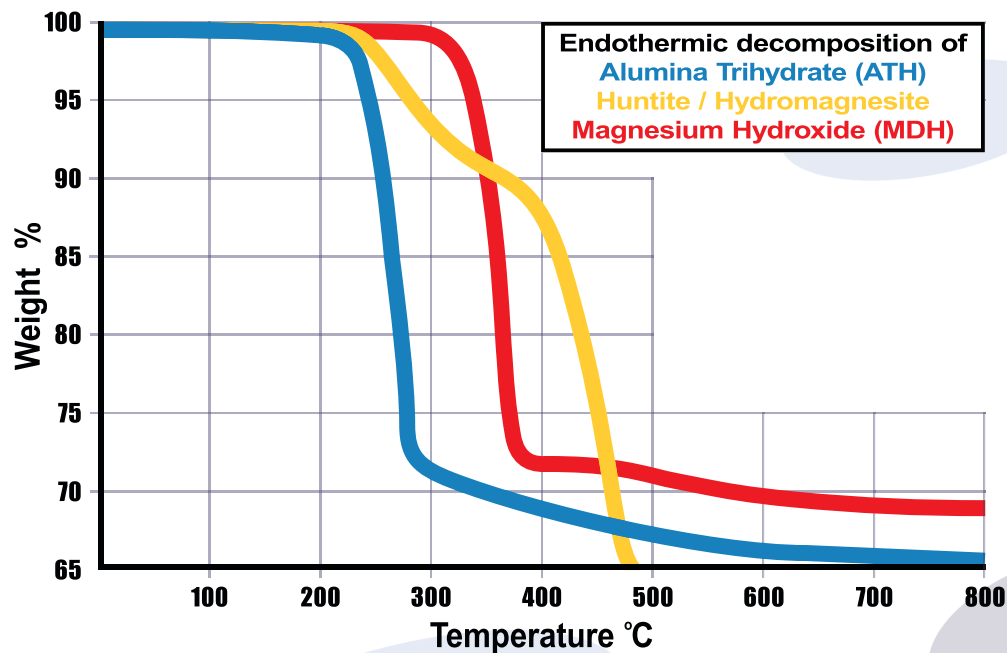
PVC Wire & Cable Jacket Example		
Formulation Ingredient (phr)	Control	FSD617
PVC Resin	100	100
DINP	45	45
Ca-Zn stabilizer	6	6
Stearic Acid	0.3	0.3
ATH	60	60
Zinc Borate	5	0
FSD617 Synergist	0	5
Limiting Oxygen Index %	31.0	32.0

Hydrate Series

Where a halogen-free solution is needed alumina trihydrate (ATH), magnesium hydroxide (MDH), and huntite/hydromagnesite can be used. MAT offers a range of ATH and MDH grades and a huntite/hydromagnesite blend. These products are typically selected for halogen free applications and work according to two modes. Release of water and endothermic decomposition. The water release reduces the temperature in the combustion zone, excludes oxygen and combines with soot particles to reduce smoke. The endothermic nature of the decomposition removes heat energy from the combustion process.

An important property in selecting a metal hydrate is:

Maximum Process Temperature	
Alumina Trihydrate	~220°C
Huntite / Hydromagnesite blend	~250°C
Magnesium Hydroxide	~330°C



Alumina Trihydrate

Alumina Trihydrate is the most widely used flame retardant in the world due to its versatility and low cost. Available in different particle sizes, it can be used in a wide range of polymers at processing temperatures below 220°C. ATH is non-toxic, halogen-free, chemically inert, and has low abrasiveness. Additional benefits are arc and track resistance in plastics exposed to electrical arcing, acid resistance, and smoke suppression. The non-toxic, zero halogen alumina trihydrate (ATH) is offered by MAT from a precipitated and fine grinding process. Additional grades of ATH are available. Please see our separate ATH literature or contact us for more information.

Grade	Type	Median Particle Size
HT1000	Precipitated	1.4 micron
A202	Ground	2 micron
A204	Ground	4 micron

Median particle size obtained using X-ray sedimentation analysis.

Hydrate Series continued...

Huntite / Hydromagnesite Blend

HTMC9 A white finely-divided combination of magnesium calcium carbonate (huntite) and hydrated magnesium carbonate. With thermal stability above that of ATH and low cost, it can be used as a replacement for magnesium hydroxide and can be used in halogenated systems as well. It can offer a cost/performance advantage over magnesium hydroxide and can allow higher processing temperature than ATH.

Magnesium Hydroxide

The non-toxic, zero halogen Magnapur[®] line is a pure, natural, fine MDH. The Magnapur series of products are suitable for a wide range of demanding flame-retardant polymeric applications. Endothermic decomposition begins at about 330°C releasing water, which produces a cooling effect, reduces oxygen availability and suppresses smoke evolution. The resulting Magnesium Oxide ash provides a char layer, which further reduces the combustion rate of the system. These combined mechanisms result in an overall powerful flame retardant performance which allows polymer formulators to design products to meet the most demanding specifications in wire & cable insulation and jacketing, sheet, film, and profile applications.

The relatively high decomposition temperature compared to other zero halogen fillers, such as Alumina Trihydrate, allows for a significantly higher processing temperature without the concern of developing porosity in the finished part. Where improved dispersion is needed, one of our coated Magnapur grades can be used. These coatings are selected for excellent compatibility in a wide range of resins and to provide the opportunity for chemical coupling with the polymer matrix. This can result in significant increases in physical properties, extrusion smoothness and resistance to moisture.

Magnapur Typical Properties and Tech Data				
Product Code	MGP-N2	MGP-N2SC	MGP-N4	MGP-N4SC
Appearance	Fine White Powder			
Particle Size (µm)	2.0	2.0	4.0	4.0
Decomposition temp. (°C)	~330			
Stearic Acid Coated (%)		1.5		1.5
Loss of Ignition (%)	30 - 33			
BET (m ² /g)	~11	~11	~7	~7
Specific Gravity	2.36			
Free Moisture (%)	≤0.50			

The R.J. Marshall Company Mission

At the R.J. Marshall Company, we seek to make our customers successful by supplying innovative, quality-focused products and services. We serve our customer's needs with perseverance and we continuously strive to create an environment where our customers, employees and suppliers are highly valued. Our core values include the following business principles:

Integrity – to maintain the highest ethical standards

Honesty – to be honorable and trustworthy, to always do the right thing

Respect – to show regard for worth, honor and esteem for our employees, customers and suppliers

Perseverance – to have a passion for excellence and a resolve for continuous improvement

Knowledge – to be lifetime learners and provide a continual learning environment which empowers our employees to solve problems

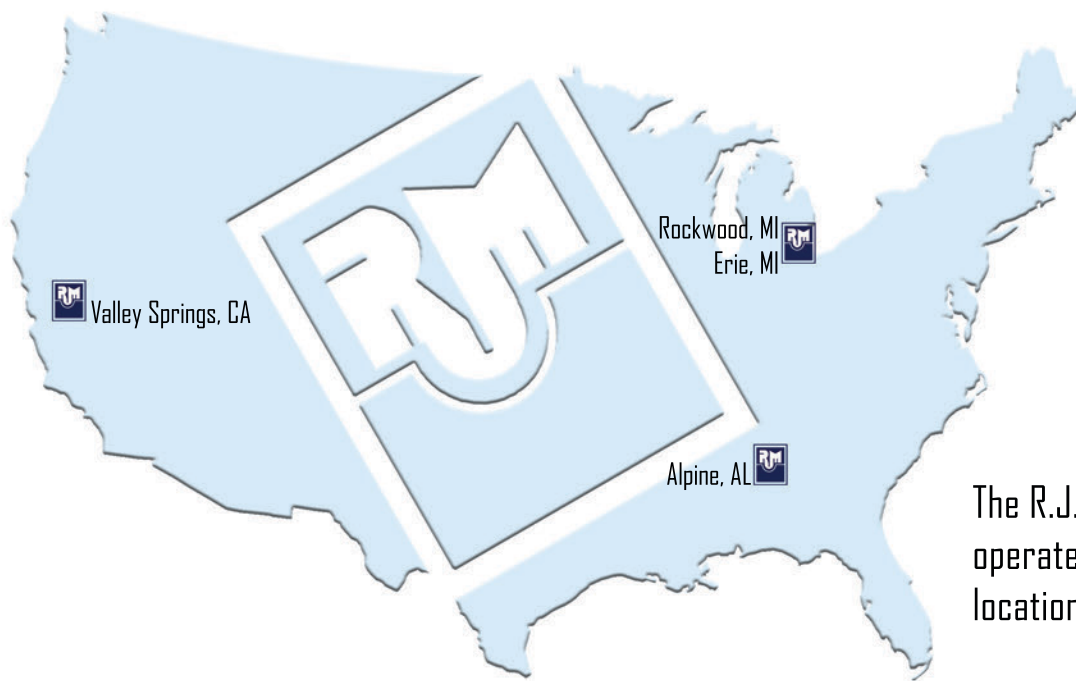
Forgiveness – to create an environment of trust where people are allowed to fail

Fairness – to treat all people in a just and equitable manner

Teamwork – to work together with mutual respect and courtesy realizing we can achieve more by working together

Competence – to do it right the first time by making smart, quick, common sense decisions

Family – to recognize and support the family and maintain a family atmosphere



The R.J. Marshall Company
operates 4 manufacturing
locations in the United States.

To discuss your specific requirements or to place sample orders or commercial orders, we encourage you to contact us at:

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