



# PROMETHEUS DEVELOPMENTS LTD.

Unit 9 Langley Park  
North Street  
Langley Mill  
Nottingham  
NG16 4BS

Tel: +44 (0)1773 764206  
Fax: +44 (0)1773 765048

*For the answers you won't*

## Evaluation Of 1BX MIPS as a Flame Retardant in Unsaturated Polyester.

The newly developed Mixed Intumescent Polymeric Salt ( MIPS) has been evaluated as flame retardant in unsaturated polyester. This particular version of MIPS has performed well as flame retardant and intumescent additive in polypropylene, HIPS, epoxy resins and various latexes. These trails evaluate the performance of 1BX MIPS in unsaturated polyesters as a potential flame retardant for composites building construction, automotive, aerospace and surface rolling stock use.

### 1) Initial Trials

1BX MIPS was dispersed in a conventional orthophthalic unsaturated polyester ( Scott Bader Crystic 675) at increasing concentrations and cured with 1 and 2 % 2 butanone peroxide

The peak exotherms were and viscosity were as shown in table 1 :-

Table 1

	Peak Exotherm <sup>o</sup> C	Time to PE Minutes	Peak Exotherm <sup>o</sup> C	Time to PE Minutes	Viscosity poise
	1% MEKP	1% MEKP	2% MEKP	2% MEKP	
0	59.5	26	47.5	11	8.29
5	66.5	25	72	18	9.1
10	66.9	27	79.3	13	9.3
25	71.5	25	84.3	13	10.5
50	69	29	83	14	15.6

It was concluded that the addition of the flame retardant made no significant difference to the cure rate, and the viscosity growth relevant for hand laminating, cold press, gel coats and RTM.

### 2) Physical Properties and Preliminary Fire tests

The mixtures were cast unreinforced into platens. The platens were exposed to the EN ISO 11925-2 small flame test and tested according to EN 63 Determination of Flexural Properties: Three point Method.

The results are shown as table 2:-

Table 2

MIPS Concentration %	Time To Extinguish	Euroclass	$\sigma_f$ MPa	$E_f$ MPa
0	> 60 seconds	F or worse	1.15	20.4
5	> 60 seconds	F or worse	1.07	15.1
10	> 60 seconds	F or worse	1.18	19.7
25	2 secs	D or better	1.29	16
50	Instant	D or better	0.76	17.7

Dog bones were cast from the appropriate MIPS addition range and panels were prepared for firing in the PD EN 13823 Single Burning Item simulator both unreinforced and reinforced. Dog bones were cut from the reinforced panels. The reinforced panels were cold pressed at glass to resin ratio of 25% using 1200 gm continuous filament mat.

The results of the physical testing are shown in table 3

Table 3A

	$\sigma_t$ MPa	$E_t$ MPa
Crystic 675	0.179	15.8
10% 1BX MIPS	0.177	25.8
20% 1BX MIPS	0.190	35.5
30% 1BX MIPS	0.240	12.5

Table 3B All results in MPa

Condition	$\sigma_f$ MPa	$E_f$ MPa	$\sigma_t$ MPa	$E_t$ MPa
Crystic 675 25% CFM	164	323	76.5	143
Crystic 675 25% CFM 20% 1BX MIPS	116	304	75.5	176
Crystic 675 25% CFM 30% 1BX MIPS	138	205	68.5	189

There is indicated an anomalous increase in performance in the physical properties at around 25-30% MIPS.

### 3) Reaction to Fire

The results for the reaction to fire tests indicated are shown in Table 4

Table 4

Modification of Crystic 675	Predicted FIGRA <sub>0.2</sub>	Euroclass	Smoke Droplets Estimate
20 % MIPS 1BX unreinforced	163 W/sec	C	S2 D0
20% MIPS 1BX reinforced	129 W/sec	Borderline B/C	S2 D0
30 % MIPS 1BX unreinforced	37 W/sec	B	S1 D0
30% MIPS 1BX reinforced	37 W/sec	B	S1 D0

### 4) Protection From Fire

The Reaction to Fire results were complimented by preliminary evaluation for Protection From Fire.

A 600 x 600 panel was prepared consisting of 5 layers of continuous filament mat cold pressed with Crystic 675 modified with 30% 1BX MIPS. To this was added a 1 mm layer of Crystic 675 modified with 30% 1BX MIPS and 5% rutile titania representing a gel coat. This structure gave a total thickness of 4.5 mm. The thickness was kept low in order to decrease the fire load as the a previous trial with an unmodified polyester laminate fired on behalf on RNLi, ignited within five minutes and was difficult to extinguish.

This was mounted on the PD fire test simulation facility and exposed to EN 1381 cellulosic fire conditions as a fire barrier.

The barrier gave a failure to  $\Delta 140^{\circ}\text{C}$  at 15 minutes without any indication of penetration. While this was exceptionally thin for a fire barrier the results is a positive indication of the potential if developed further.

A photograph of the fired panel is shown below .



Exposed Face



Cold Face