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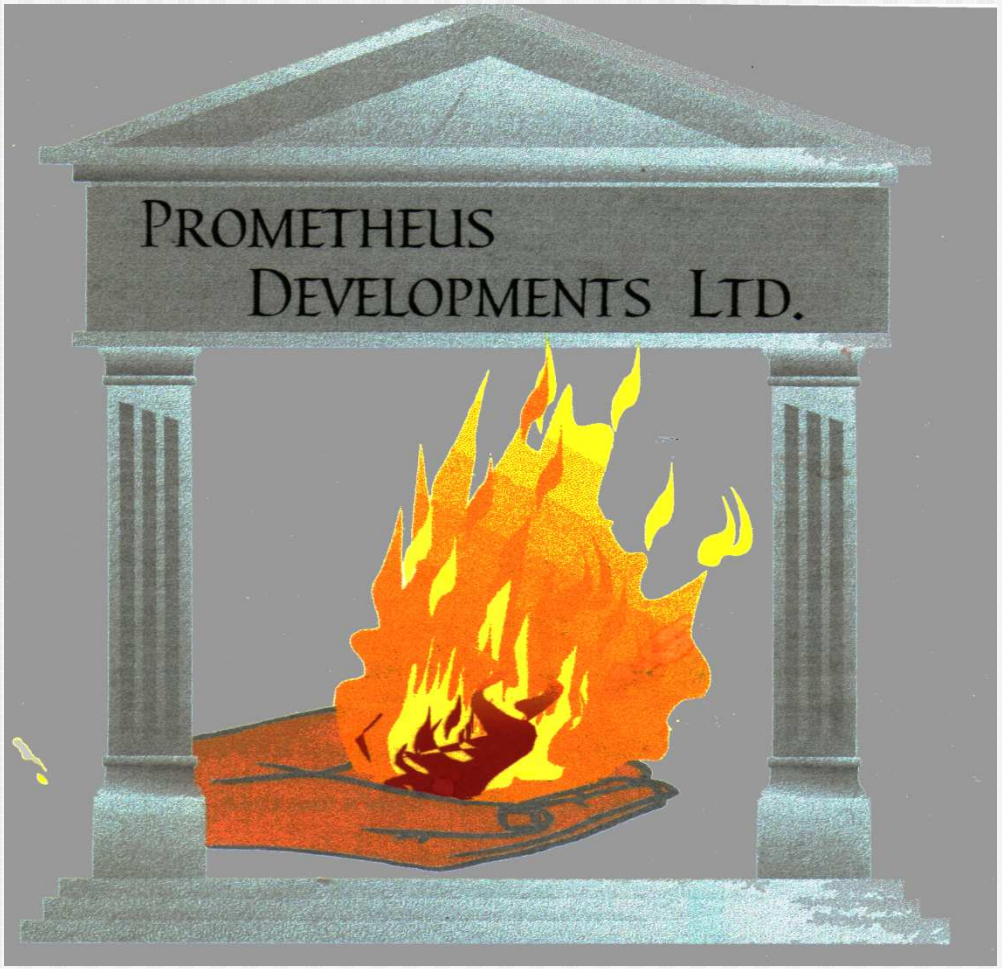

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

There is a confluencee in the demand for light weight structures in both railway rolling stock and naval structures.

- o There is some overlap in the fire test procedures of both market sectors, but with a differences in the limits for approval.
- o The supply chain in railway rolling stock is much shorter with closer association between the end user and constructor.
- o Project time scales may also be seen as shorter.
- oThe demands for urgent OPEX savings combined with the effect of EN 45545 have driven considerable effort in seeking light weight flame retardant composites for railway rolling stock.

We are presenting some of the results of this work to establish the relevance to composites in passenger carrying vessels, both for new build and retrofit.

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

Lightweighting projects in railways are concentrated on composites, which is why the results we are presenting may have relevance for linings and ceilings in accommodation modules.

The design projects appear primarily to consider the physical performance in stressed and unstressed structures, their manufacture, construction and performance.

The fire protection requirements appear to come afterwards.

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

Conventional flame retardants for composites have inherent drawbacks:

- oLower classical physical properties than the unmodified equivalent.
- o Are particulates or are low viscosity plasticisers.
- oHigher SG than the matrix resin. Hence an FR composite must be heavier than the non FR version.
- o Particulates limits the fabrication techniques available- particulates will filter out on the reinforcement cloth in RI and RTM.
- o Not UV or environmentally stable.
- oIncreased levels of smoke with potential for halogen components

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The solution we have been developing with resin suppliers, fabricators and rolling stock constructors is the application of a highly developed intumescent coating system to flammable substrates.

This is based on a system we refer to as Integrated Intumescent Technology.

This has been under continuous development since 1992, with four generations,

The latest generation is the Phyrolex™ technology, though it will appear under different trade names from suppliers in Europe and the USA.

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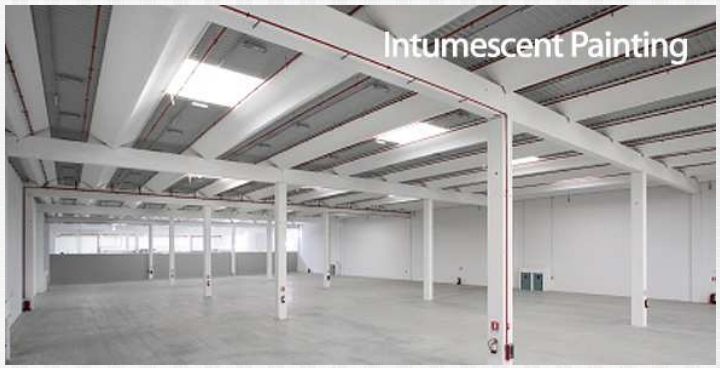
Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The conventional thin film Intumescent Coatings are used for the fire protection of steel structures .
These are Environmentally sensitive coatings not suitable for exposure to marine conditions or high traffic areas.



Marine applications currently only use thick film intumescents applied to offshore exploration and exploitation rigs.
These are heavy, thick and difficult to apply.

The IIT technology is somewhat different

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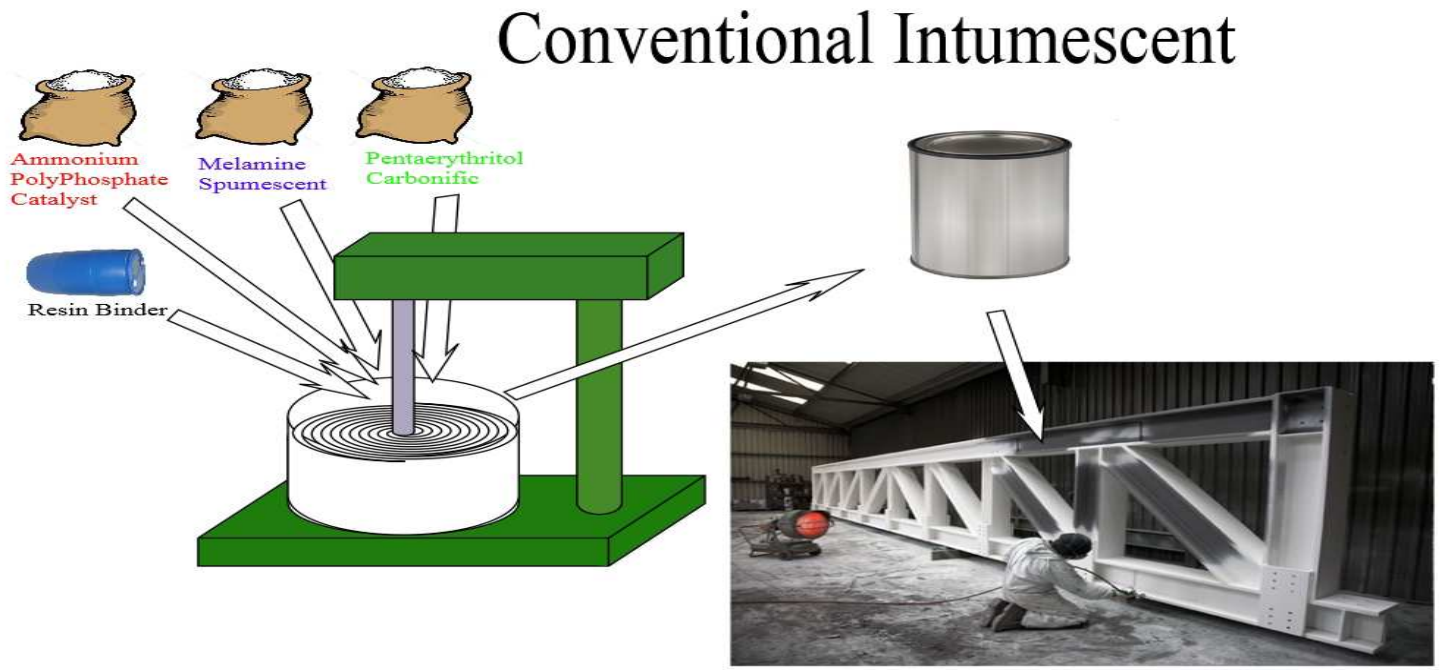
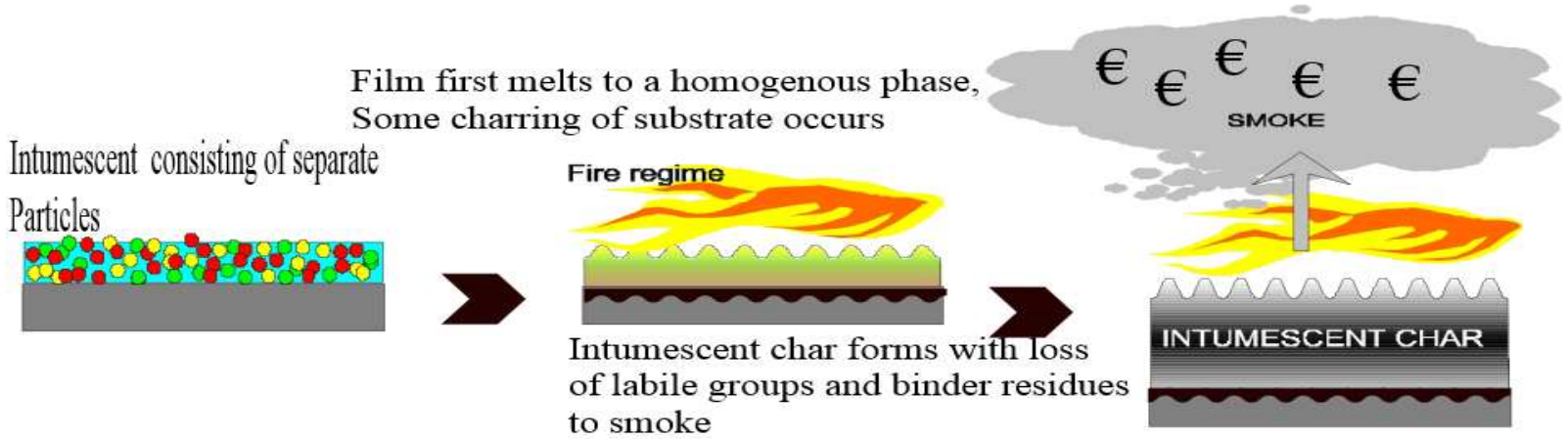
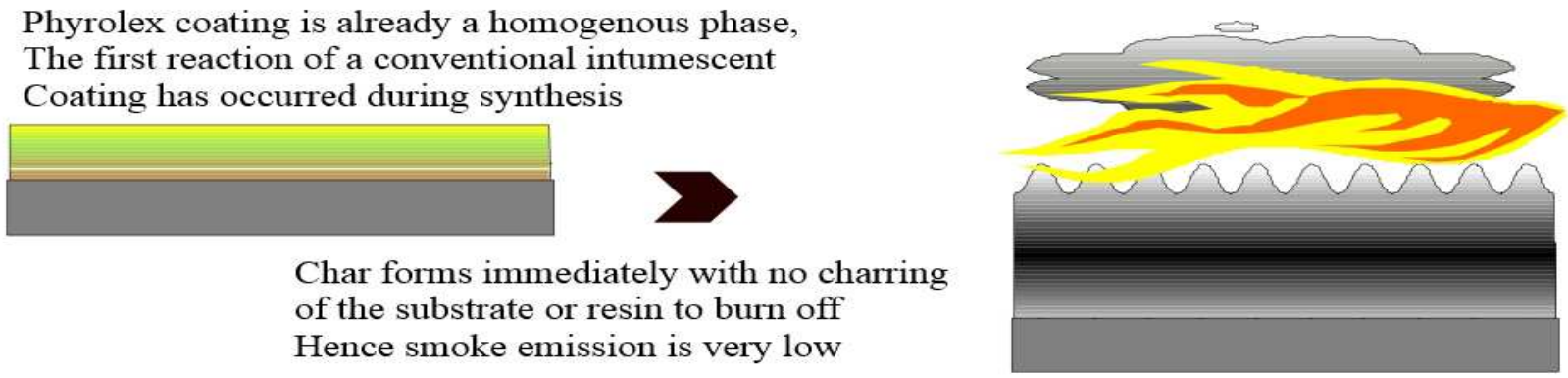
Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures



The principle of IIT is to take the active molecular structures present in conventional intumescents and combine these at the molecular level to form a single intumescent compound

Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures





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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The reaction to fire requirements for both market sectors for the radiant panel :-

	European Harmonised standard railway standard for interoperability EN45545 (HL3 rating)	FTP code 2010 bulkhead, wall and ceiling linings- Part 2
EN ISO5658		
Critical heat flux at extinguishment	CFE >= 20Kw/m^2	CFE >= 20Kw/m^2
Heat for sustained burning	Q_{sb} Not required (test house may display result)	Q_{sb} >=1.5 MJ/m^2
Total heat Release	Q_t Not required	Q_t <=0.7MJ
Peak Heat Release	Q_p Not required	Q_p <=4Kw

Thus apart from CFE the EN 45545 cannot be read directly across to the FTP Code

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The reaction to fire requirements for both market sectors for the smoke box are as follows:-

	European Harmonised standard railway standard for interoperability EN45545 (HL3 rating)	FTP code 2010 bulkhead, wall and ceiling linings- Part 2
EN ISO 5659-2		
Smoke Index (VOF_4)	<300	
Smoke Index (DS_4)	<150	
Conventional Toxicity Index (CIT_g)	<0.75	
Carbon Monoxide	Measured by combined as CIT_g	<1450ppm
Hydrogen Chloride		<600ppm
Hydrogen Fluoride		<600ppm
Nitrogen Oxides		<350ppm
Hydrogen Bromide		<600ppm
Hydrogen Cyanide		<140ppm
Sulphur Dioxide		<120ppm

Thus apart from smoke index EN45545 data cannot be read directly across to the FTP Code

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

EN 45545 specifically requires the use of the cone calorimeter (EN ISO 5660) to measure total heat release, whereas the FTP code only allows this test for use in High Speed Vessels.

However, I am unable to find any limits set for the Heat Release as measured by the cone calorimeter in FTP 2010 for approval.

The maximum heat release required for HL3 is (MAHRE) 60KW. We are unaware if there is any correlation between the heat release as measured by the modified radiant panel rig and the cone calorimeter.

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The following results were obtained by applying 360 gms/sq. metre of formulations based on PDs guideline formulations PD63V, which is a varnish or PD63P, which is white pigmented. The resultant dried film thickness is about 220µ and gives a weight penalty 260 gms/sq. metre.

In comparison if a 5 mm polyester composite is loaded with a conventional flame retardant such as ATH in order to meet the EN45545 HL3 requirement the weight penalty would be in the order of 1250 gms/sq. metre

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

		EN 5658	EN5659	EN5659	EN5659	EN5659	EN 5660	EN 5660
Substrate	Coating Version	Radiant panel	Smoke Box	Smoke Box	Smoke Box	Smoke Box	Cone Calorimeter	
		CFE	Smoke Ds(4)	Smoke DSMax	CITg	Smoke VOF4	MAHRE	SA
MDF	Varnish	20.5*	19		0.02	56	46	283
Marime Ply	Varnish	22.1	32		0.09	80	69	138
Veneered MDF	Varnish	25.5	25		0.03	56	47	643
PU Composite	Pigmented	25.7	6	166		18	29	
Polyester Composite	Pigmented						22	870
Polyester Composite	Varnish						17	1080

*EN5658 result on MDF show a Q_{sb} of just 0.68MJ/m^2

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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

Of particular note is the very low smoke and toxicity index given by the result from the EN 5859-2. The smoke toxicity data is of vital concern in FTP 2010. The tests results of the IIT coating on timber substrates show outstanding results.

	Toxicity limits	MDF	Plywood	Veneered MDF
Carbon Monoxide	>1450ppm	88.6	113	276
Hydrogen Chloride	>600ppm	0	0	0
Hydrogen Flouride	>600ppm	0	0	0
Nitrogen Oxides	>350ppm	0	0	0
Hydrogen Bromide	>600ppm	0	0	0
Hydrogen Cyanide	>140ppm	0	0	0
Sulphur Dioxide	>120ppm	0	0	0

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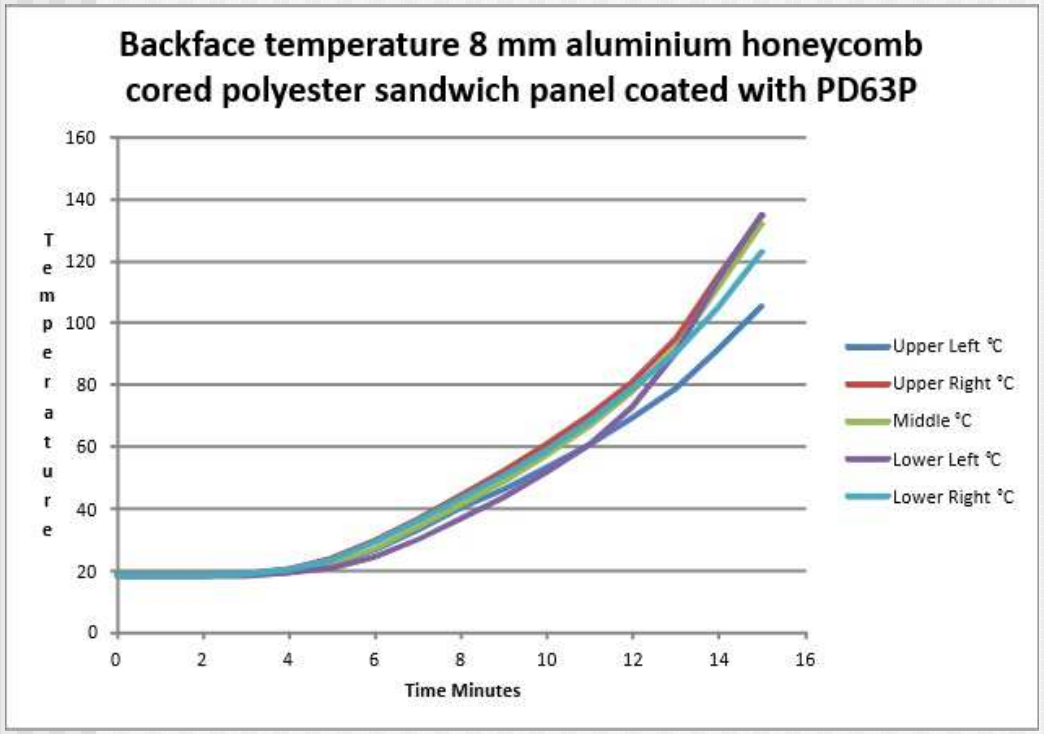
Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The IIT coatings can potentially also be used to allow composites to be used or upgraded to A15 or A30 Fire Barriers. We applied an IIT coating to a 8 mm polyester panel and fired it to the cellulosic curve on our indicative furnace. The backface response curve is shown and the post fire test panel.



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Potential Use of Integrated Intumescent Coatings In Light Weight Naval Structures

The IIT coatings can potentially have value in providing light weight flame retardant and fire protective linings for bulkheads and ceilings according to the FTP 2010 code, irrespective of the substrate.

The film may be over coated with almost anything providing the thickness is less than about 60µ and the coating can intumesce through the topcoat.

However, it is a coating and finish will depend on the skill of the applicator. Unless pre-applied such an operation could slow construction or interfere with following trades.

The product is in active use for building construction and rolling stock applications. PD is seeking collaboration to assess the system for marine applications.

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