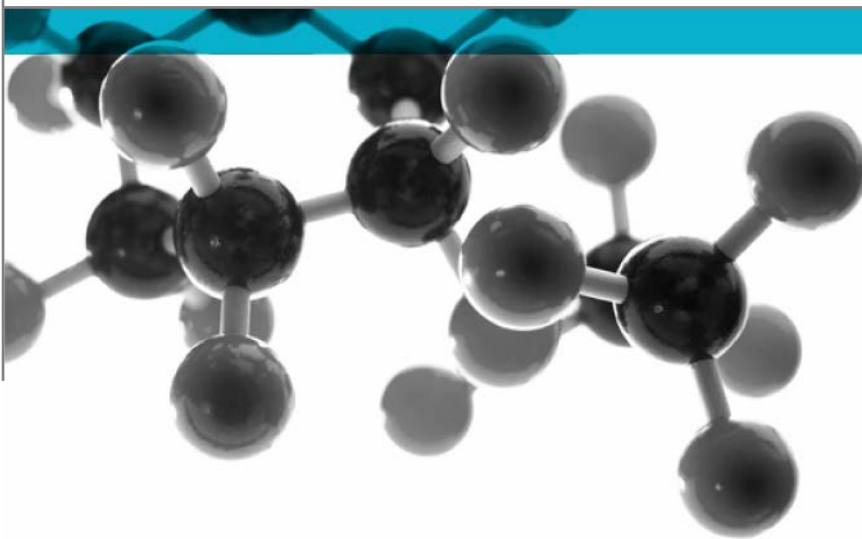


BS EN 45545-2:2013+A1:2015 – Test Methods T10.01, T10.02, T10.04 & T11.01



Smoke and Toxicity Assessment

Test Method References “T10.01” / “T10.02”/
“T10.04” (ISO 5659-2: 2017; Plastics – Smoke
Generation. Part 2 Determination of Optical Density
by a Single Chamber Method) and “T11.01” (Gas
Analysis in the Smoke Box EN ISO 5659-2, using
FTIR Technique)

A Report To: Smyth Composites Ltd

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Date: 28th January 2020

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Executive Summary

Objective To determine the toxic fume and optical density produced from the following product when tested in accordance with methods T10.01, T10.02, T10.04 and T11.01 as defined in BS EN 45545-2:2013+A1:2015 at an irradiance level of 50kW/m² without a pilot flame.

Generic Description		Product reference	Thickness	Weight per unit area
Coated fibre reinforced phenolic resin sheet		"Phenclad"	3.5mm	3.4kg/m ²
Individual components used to manufacture composite:				
Coating		"AE 265/8"	Unable to provide	Unable to provide
Moulded sheet	Phenolic resin	"Cellobond"	Not applicable	Not applicable
	Fibre reinforcement	"Dong Yu"	Not applicable	2 x 600g/m ²
Please see page 6 of this test report for the full description of the product tested				

Test Sponsor Smyth Composites Ltd, Panmure Industrial Estate, Carnoustie, Angus, DD7 7NP

Summary of Test Results:

The average $D_s(4)$ value determined was 60

The average VOF4 value determined was 93

The average D_s max value determined within 10 minutes was 142


The average D_s max value determined within 20 minutes was 142

The average CIT value at four minutes was 0.11


The average CIT value at eight minutes was 0.25

Date of Test 12th December 2019

Signatories



Responsible Officer
S. Jones *
Technical Officer



Authorised
T. Mort *
Senior Technical Officer

* For and on behalf of [Warringtonfire](#).

Report Issued: 28th January 2020

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Test Details

Introduction

Warringtonfire was commissioned to carry out an area based smoke and toxicity test in accordance with the method recommended in BS EN 45545-2:2013+A1:2015. This standard recommends that the test is carried out using the apparatus and procedures detailed in ISO 5659-2:2017. The standard provides equations which should be calculated in relation to the smoke density. In addition to this the quantitative determination of the gases emitted should be carried out in accordance with the procedure specified in EN 45545 Annex C, Method 1 (Smoke Chamber).

The test was performed in accordance with the procedures specified in EN 45545 and EN ISO 5659-2 and this report should be read in conjunction with these and other related standards.

Test method

The principle of the test methods referenced "T10.01", "T10.02", "T10.04" and "T11.01" is to expose a material to specified thermal conditions of pyrolysis and combustion in a continuous procedure.

The test was conducted in an "ISO 5659-2 Smoke Chamber" supplied by Concept (operated with "Concept" software), in combination with an "IGS FTIR Analyser" supplied by Thermo Scientific (operated with Thermo "Result" software).

Specimens were tested in the non-flaming mode in a horizontal position by exposure to the heating arrangement specified in ISO 5659-2. The heat flux was 50kW/m^2 . The change in optical density of the smoke produced when dispersed within a fixed volume of air is recorded throughout the period of test utilising the Concept software in order to determine information relating to the smoke density.

Quantitative determination of toxic gases emitted is carried out using Fourier Transform Infra Red (FT-IR) analysis and the TQ Analyst software. The FT-IR has been calibrated, the calibration spectra were produced by the FTIR supplier (Thermo) using bottled gases and library spectrum, plus Warringtonfire using bottles gases and calibrated solutions via an evaporator.

In all cases, the sample gases are taken from 300mm from the centre of the top of the chamber with sample lines being kept as short as possible to minimise sample losses.

The test method provides a means for the comparative assessment of products, however, it does not model a real fire situation and the results cannot therefore be used to describe the fire hazard of materials under actual fire conditions.

Fire test study group/EGOLF

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group and EGOLF have identified a number of such areas and have agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Groups. Where such Resolutions are applicable to this test they have been followed.

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Instruction to test The test was conducted on the 12th December 2019 at the request of Smyth Composites Ltd., the sponsor of the test.

Provision of test specimens The specimens were supplied by the sponsor of the test. Warringtonfire was not involved in any selection or sampling procedure. The specimens were prepared in accordance with EN 45545-2: 2013+A1:2015 Annex D.

Test face The smooth face of the specimen was exposed to the heating conditions.

Condition of specimen edges Layered product, with no layer covering the edges

Photograph of specimen



Conditioning of specimens The specimens were received on the 2nd December 2019.
The specimens were conditioned at temperatures of $23 \pm 2^{\circ}\text{C}$ and a relative humidity of $50 \pm 5\% \text{ RH}$, for a minimum period of 24 hours prior to testing.

Description of Test Specimens

The description of the system given below has been prepared from information provided by the sponsor of the test. This information has not been independently verified by [Warringtonfire](#). All values quoted are nominal, unless tolerances are given.

General description		Coated fibre reinforced phenolic resin sheet	
Product reference		"Phenclad"	
Name of manufacturer		Smyth Composites	
Colour		"White"	
Thickness		3.5mm (stated by sponsor) 3.83mm (determined by Warringtonfire)	
Weight per unit area		3.4kg/m ² (stated by sponsor) 4.77kg/m ² (determined by Warringtonfire)	
Coating	Generic type	2 pack polyurethane	
	Product reference	"AE 265/8"	
	Name of manufacturer	"Trimite"	
	Number of layers	See Note 1 Below	
	Specific gravity	See Note 1 Below	
	Application method	Spray	
	Colour reference	"Ral 9010" "White" (observed by Warringtonfire)	
	Flame retardant details	See Note 1 Below	
Moulded sheet	Resin	Generic type	Phenolic
		Product reference	"Cellobond"
		Name of manufacturer	Hexion
		Specific gravity/density	See Note 1 Below
		Flame retardant details	See Note 2 Below
	Glass reinforcement	Generic type	Powder bound chopped strand matt
		Product reference	"Dong Yu"
		Number of layers	2
		Weight per unit area of each layer	600g/m ²
		Configuration of glass reinforcement	See Note 1 Below
Name of manufacturer		Dong Yu	
Resin to glass ratio (by weight)		2.7:1	
Percentage glass reinforcement (by weight)		27%	
Curing process (duration and temperature)		2 hours at 90°C	
Brief description of manufacturing process		Hand lay	

Note 1: The sponsor of the test was unable to provide this information.

Note 2: The sponsor of the test has confirmed that no flame retardants were used in the production of this component.

Test Results

Applicability of test results

The test results relate only to the behaviour of the specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential smoke and toxicity hazard of the product in use.

The test results relate only to the specimens of the product in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and will therefore invalidate the test results. It is the responsibility of the supplier of the product to ensure that the product which is supplied is identical with the specimens which were tested.

Smoke Density

Test method referenced "T10.01" requires the $D_s(4)$ to be calculated. That is the specific optical density at 4 minutes test duration.

Test method referenced "T10.02" requires the VOF4 to be calculated. That is the area under the D_s vs. time curve during the period zero minutes to four minutes. This is calculated utilising the trapezium rule equation (assuming a finite element (t) of one minute):

$$VOF_4 = D_1 + D_2 + D_3 + \frac{D_4}{2}$$

Test method referenced "T10.04" requires the D_{smax} to be calculated. That is the maximum specific optical density within the first 10 minutes test duration.

The maximum specific optical density within the complete 20 minute test duration is also reported in case this is required by an alternative specification.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
$D_s(4)$	61	52	68	60
VOF4	97	86	95	93
D_{smax} within 10 minutes	154	145	128	142
D_{smax} within 20 minutes	154	145	128	142

Toxic Gas Emission

Test method referenced "T11.01" required the CIT to be calculated. That is the conventional index of toxicity, a summation term from the analysis of gases taken at four minutes and eight minutes test duration.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
CIT (4 minutes)	0.12	0.10	0.11	0.11
CIT (8 minutes)	0.26	0.25	0.25	0.25

Additional Test Data

Additional test data relating to the smoke & toxicity performance of the product is detailed in Appendix I of this report.

A graph of the results obtained is illustrated in Appendix II.

Summary of results The average $D_s(4)$ value determined was 60

The average VOF4 value determined was 93

The average D_{smax} value determined within 10 minutes was 142

The average D_{smax} value determined within 20 minutes was 142

The average CIT value at four minutes was 0.11

The average CIT value at eight minutes was 0.25

Validity

The specification and interpretation of fire test methods are the subject of ongoing development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over five years old should be considered by the user. Where this report is used to confirm compliance for use on European rolling stock as per the Technical Specification for Interoperability (LOC&PAS TSI (Commission Regulation (EU) No. 1302/2014)), all tests must have been conducted within the last 5 years or the test reports must have been reviewed within the last five years. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

These results relate only to the behaviour of the specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential smoke obscuration hazard of the product in use.

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Appendix I

Gas Concentration At Four Minutes:

The concentration of each gas species for which analysis was conducted for at the four minute sampling point (expressed in ppm and kg/m³) is provided in the below table:

Gas	Specimen 1		Specimen 2		Specimen 3		Mean Average	
	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³
Carbon Monoxide	134	0.0001	129	0.0001	102	0.0001	122	0.0001
Carbon Dioxide	225	0.0004	258	0.0004	140	0.0002	207	0.0003
Sulphur Dioxide	142	0.0003	104	0.0002	130	0.0003	126	0.0003
Hydrogen Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Bromide	ND	ND	2	0.0000	ND	ND	1	0.0000
Hydrogen Fluoride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen cyanide	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen Oxides	4	0.0000	3	0.0000	3	0.0000	4	0.0000

Where ND indicates None Detected

Gas Concentration At Eight Minutes:

The concentration of each gas species for which analysis was conducted for at the eight minute sampling point (expressed in ppm and kg/m³) is provided in the below table:

Gas	Specimen 1		Specimen 2		Specimen 3		Mean Average	
	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³
Carbon Monoxide	918	0.0009	1002	0.0010	831	0.0008	917	0.0009
Carbon Dioxide	1305	0.0020	1636	0.0025	1092	0.0017	1344	0.0021
Sulphur Dioxide	262	0.0006	224	0.0005	243	0.0005	243	0.0005
Hydrogen Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Bromide	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Fluoride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen cyanide	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen Oxides	8	0.0000	11	0.0000	8	0.0000	9	0.0000

Where ND indicates None Detected

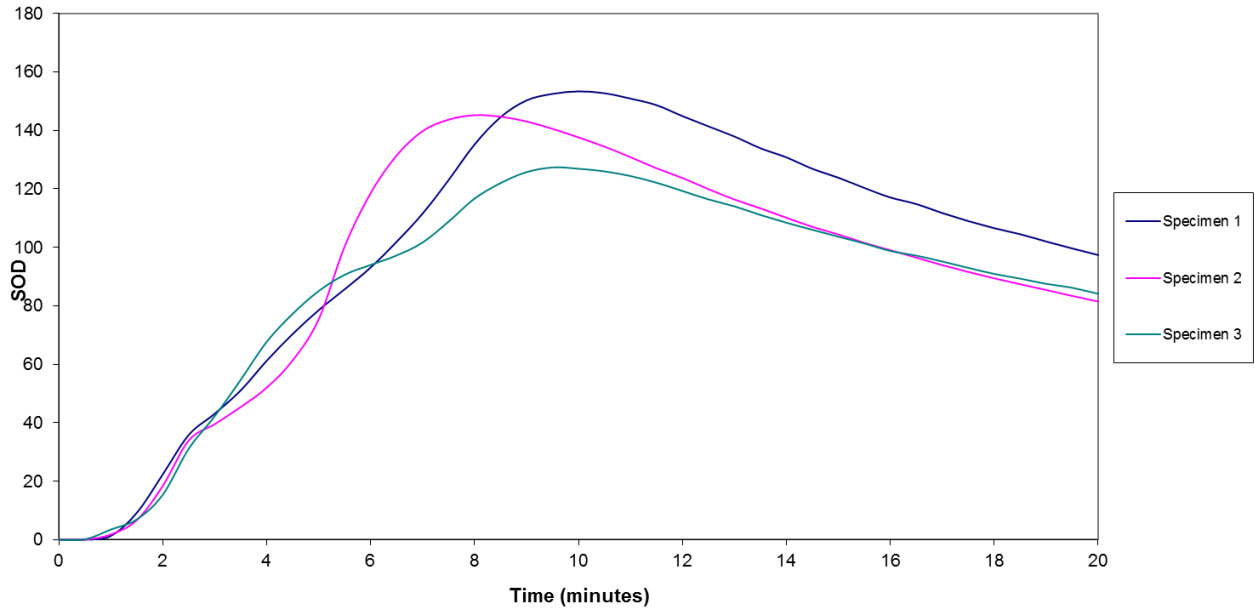
	SPECIMEN NUMBER			Mean
	1	2	3	
Clear Beam Correction Factor (D_c)	18	13	12	
Specific Optical Density at 10 minutes (D_{s10})	153	138	127	139
Specimen thickness	3.23	3.30	3.13	3.22
Initial specimen weight (g)	22.9	24.7	23.7	23.8
Final specimen weight (g)	9.3	11.5	11.4	10.7
Mass Loss (g)	13.6	13.2	12.3	13.0
Wire Grid	N/A	N/A	N/A	N/A
Neutral-density correction factor (C_f)	N/A	N/A	N/A	N/A
Test Duration (s)	1200	1200	1200	1200
Chamber back wall temperature	52	56	53	54
Test Operator	JE / DR	JE / DR	JE / DR	N/A

Observations:

	50kW/m ² In The Absence Of A Pilot Flame		
	1	2	3
Specimen No.			
Colour of smoke produced	Dark	Dark	Dark
Expansion distance towards heater (mm)	N/A	N/A	N/A
Ignition time in seconds	N/A	N/A	N/A
Extinction time in seconds	N/A	N/A	N/A
Unusual or unexpected behavior	No	No	No
Difficulties experienced during test	No	No	No
N/A = Not Applicable			

Appendix II

50kW/m² in the absence of a pilot flame



Revision History

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Reason for Revision:	

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