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Confidential Report

Fire Test on Sample

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By: **ITA Labs**

Date: **Wednesday 9th June 2021**

OAN: **L21-279** **Customer Identifier:** **Eco-Sol**

Author: **Date:** **9th June 2021**

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Fire Test on Sample

1. Introduction

1 sample was received for testing using the Cone Calorimeter to ISO 5660-1.

The sample supplied was labelled:

Flametect Nitro

2. Experimental Procedure

A Cone Calorimeter evaluation was carried out on a Govmark Cone Calorimeter using the procedures from ISO 5660-1. The specimen, measuring 100 mm x 100 mm x 16 mm was stored in the warm laboratory (*ca.* 29-30^{o}C, 25-50% RH) before testing. The specimen was wrapped in aluminium foil and placed in the sample holder with the top surface level with the top of the holder, such that only the upper face was exposed to the radiant heater. The edge-guard was used with all specimens. The sample was tested at 50 kW/m^2.

3. Results

It should be noted that the following results apply to the specimens submitted for test and may not necessarily be a representative sample of the product.

The results are grouped by Heat Flux and are reported as a series of observations, followed by data tables. General notes on the Cone Calorimeter are appended.

For the Flametect Nitro sample, which had a black/gold pattern on the thin top layer over a white central block and black bottom layer, the sample did not ignite on exposure to the heat source. The sample initially gave a little grey smoke from the top layer on exposure to the heat source. The test was stopped after 10 minutes. The residue consisted of top layer of grey char.

Cone Calorimeter Test Results at Heat Flux of 50 kWm^{-2}

	Flametect Nitro
Time to Ignition (secs)	None
Test Duration (secs)	600
Mass Loss (%)	15
Peak Rate of Heat Release (kWm^{-2})	30.8
Total Heat Released (MJm^{-2})	0.0
Fire Performance Index (m^2skW^{-1})	-
Smoke Parameter ($MWkg^{-1}$)	5.29
ConeTools™ Euroclass Prediction	A2/B
ConeTools™ THR 600s (SBI) (MJ)	1.9
ConeTools™ Figra02 Max (SBI) (Ws^{-1})	75.9
Averages from ignition to 3 minutes	
Rate of Heat Release (kWm^{-2})	19.5
Averages from ignition to 5 minutes	
Rate of Heat Release (kWm^{-2})	17.9
Averages for complete run	
Effective Heat of Combustion ($MJkg^{-1}$)	3.09
Specific Extinction Area (m^2kg^{-1})	171.61
CO Yield ($kg.kg^{-1}$)	0.0236
CO_2 Yield ($kg.kg^{-1}$)	0.20

Note: For the purposes of the ConeTools™ calculations the Time to Ignition was set to 10 seconds.

4. General Notes on the Cone Calorimeter

The Cone Calorimeter represents an important advance in laboratory-scale fire testing of polymeric materials and composites. More than any other method, it gives results which have been shown to correlate with those of full-scale fire tests.

The instrument in the Fireproof Laboratory uses a truncated conical heater element to irradiate test samples at heat fluxes up to 100kW m^{-2}, thereby simulating a range of fire intensities:

Heat flux (kW m^{-2})	Effect
10 - 20	Poor repeatability; too close to minimum heat flux for pilot ignition.
25*	Initial fire growth model. Good discrimination between non-FR materials. Recommended level for carpets and domestic upholstery.
35*	Developing fire model. Generally good repeatability. Recommended level for upholstery used in public and high risk areas.
50*	Developed fire model. Good repeatability for FR materials.
75 - 100	Fully developed fire model; often encountered in very severe fires (e.g. aircraft fires). Little discrimination between many organic materials.

*** Recommended irradiance levels for exploratory testing of materials.**

Experimental details

Specimens of dimensions 100mm x 100mm, with a thickness of up to 50 mm, are mounted horizontally beneath the radiant heater cone. Each specimen is wrapped in aluminium foil and only the upper face is exposed to the radiant heater. The specimen rests on a mineral fibre blanket. Three specimens should be tested at each level of irradiance selected, in accordance with BS 476 - Part 15 (ISO 5660-1).[1]

There has been much debate over the optimal conditions for specimen preparation and mounting.[2-5] In general, the Fireproof Laboratory carries out tests using the retainer frame, as recommended in BS 476 - Part 15. It should be noted that the use of the retainer frame reduces the exposed sample area to 0.0088 m^2, and that this value is used in all subsequent calculations.

The use of a stainless-steel wire grid over the specimen surface should only be considered when tests are to be carried out on materials which intumesce into the Cone heater during combustion.

Since it is well established that an underlying substrate will affect the burning behaviour of a thin covering material, it is recommended that specimens should be tested in a similar manner to that used in its actual end-application. However, in the case of materials which should ideally be tested over an air gap, it has been found that testing such materials over the standard mineral fibre blanket is probably satisfactory.[2]

Test data

The following parameters are given for each sample, averaged over all replications:

Ignition time (s)
Peak rate of heat release (kW m^{-2})
Total heat release (MJm^{-2})
Rate of heat release (kW m^{-2})*
Effective heat of combustion (MJ kg^{-1})*
Smoke specific extinction area (m^2 kg^{-1})*
Carbon monoxide production (kg kg^{-1})*
Carbon dioxide production (kg kg^{-1})*

* These data are presented as the averages for the time period between ignition and 180 seconds, and for the entire test period.

Although the Cone Calorimeter method allows the determination of a number of fire parameters, certain of these are considered to be of particular relevance as indicators of performance in full-scale fires:

(a) Peak rate of heat release

The peak rate of heat release may be the variable which best expresses the maximum intensity of a fire.[6]

(b) Average rate of heat release from ignition to 180 seconds

This parameter is thought to correlate with the heat release in a room burn situation, where not all of the material is ignited at the same time.[6]

(c) Fire Performance Index, FPI

This parameter is defined as:

$$\text{FPI (in } m^2\ s\ kW^{-1}) = \frac{\text{ignition time}}{\text{peak rate of heat release}}$$

Since it has been suggested that this parameter relates to the time to flashover (or, indeed, the time available for escape) in a real fire,[7] it may be considered to be the best individual indicator of overall fire hazard. Higher values of FPI indicate less fire hazard.

(d) Smoke Parameter, SP

Although the mean smoke specific extinction area parameter is meaningful in that it gives an indication of the smoke-generating potential of a material, it does not take into account the rate at which the smoke is being produced, nor does it allow for the effect of rate of heat release, which governs the spread of the fire. However, these factors are taken into account if smoke obscuration is expressed in terms of the Smoke Parameter[8]:

SP (in MW kg^{-1}) = mean smoke specific extinction area x peak rate of heat release

(e) EN 13825 (SBI) Euroclass Criteria

Class	FIGRA / Ws^{-1}	THR_{600s} / MJ
A2	≤ 120	≤ 7.5
B	≤ 120	≤ 7.5
C	≤ 250	≤ 15
D	≤ 750	
E	≥ 750	

Observations

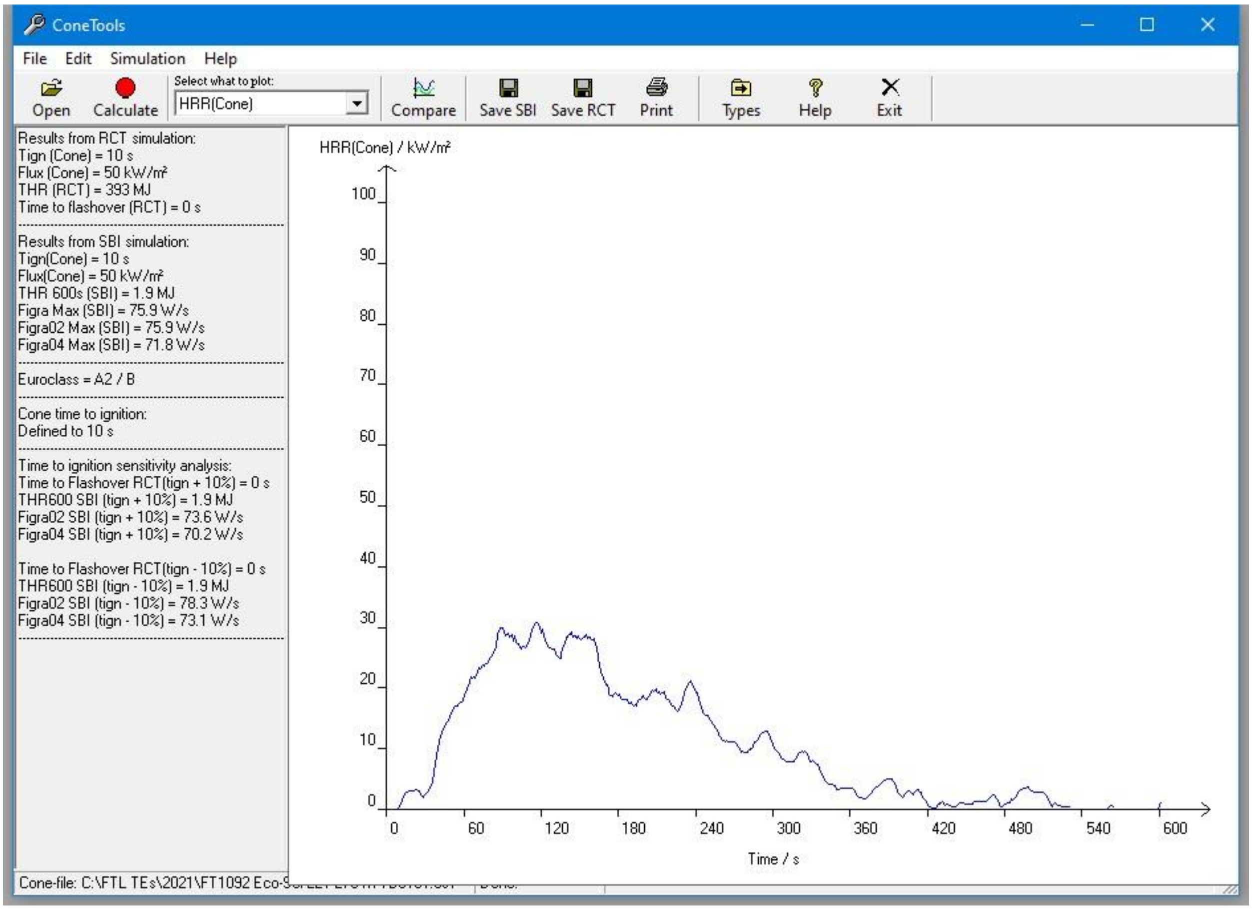
In addition to the numerical data provided, a summary test report should contain information on any unusual burning behaviour, such as transitory flaming, sample deformation, intumescence or spalling, and these observations should be taken into consideration when interpreting numerical data. Furthermore, with regard to variations observed in Cone Calorimeter measurements, it should be noted that these may be due to inhomogeneities in the sample itself as well as factors inherent in the apparatus.

References

1. BS 476 - Part 15 (ISO 5660-1) : 1993, "Fire tests on building materials and structures - Method for measuring the rate of heat release of products".
2. K.T.Paul, Proc. Flame Retardants '92, Elsevier Applied Science, London/New York, 1992, p.278.
3. L.Tsantaridis and B.Ostman, Fire & Materials, 1993, 17, 43.
4. E.Mikkola, Fire & Materials, 1993, 17, 47.
5. V.Babrauskas, W.H.Twilley and W.J.Parker, Fire & Materials, 1993, 17, 51.
6. E.D.Weil, M.M.Hirschler, N.G.Patel, M.M.Said and S.Shakir, Fire & Materials, 1992, 16, 159.
7. M.M.Hirschler and S.Shakir, Proc. Flame Retardants '92, Elsevier Applied Science, London/New York, 1992, p.77.
8. M.J.Scudamore, P.J.Briggs and F.H.Prager, Fire & Materials, 1991, 15, 65.

APPENDIX

Cone Tools
Results

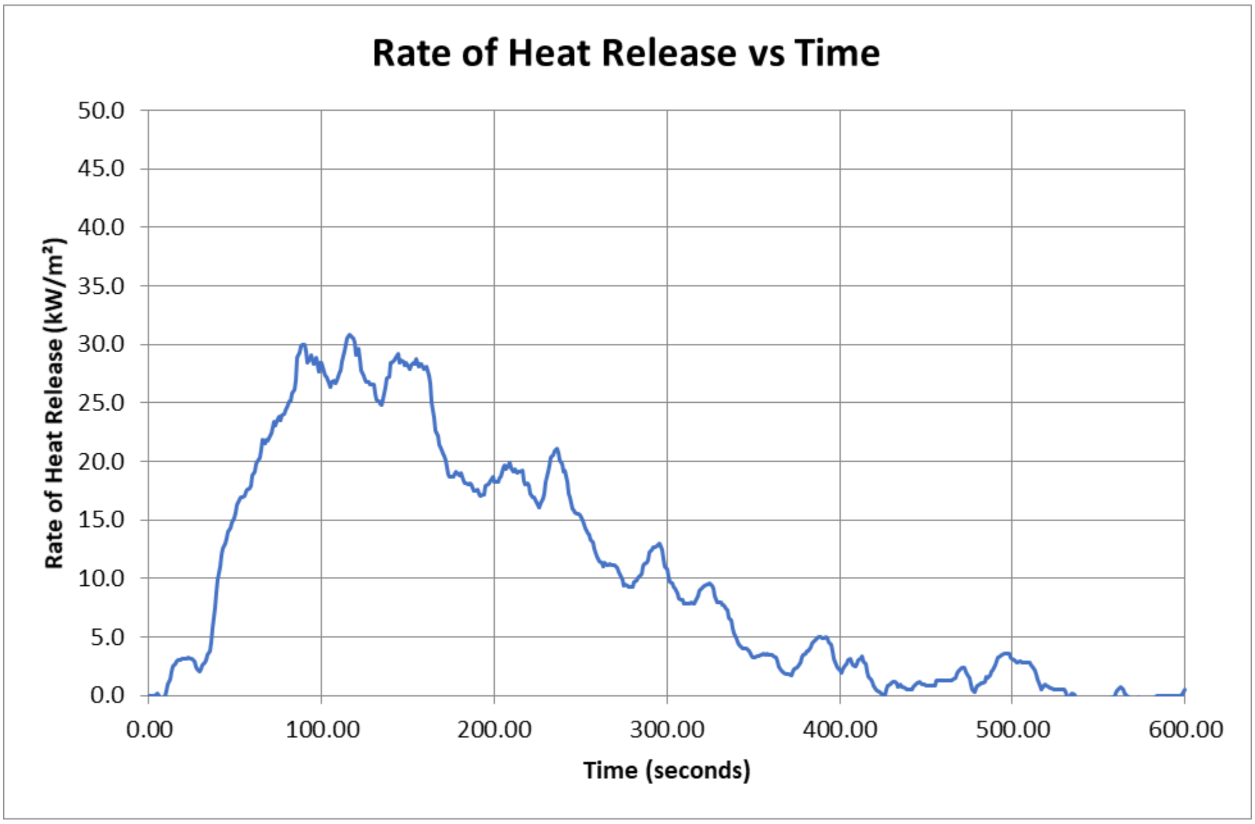


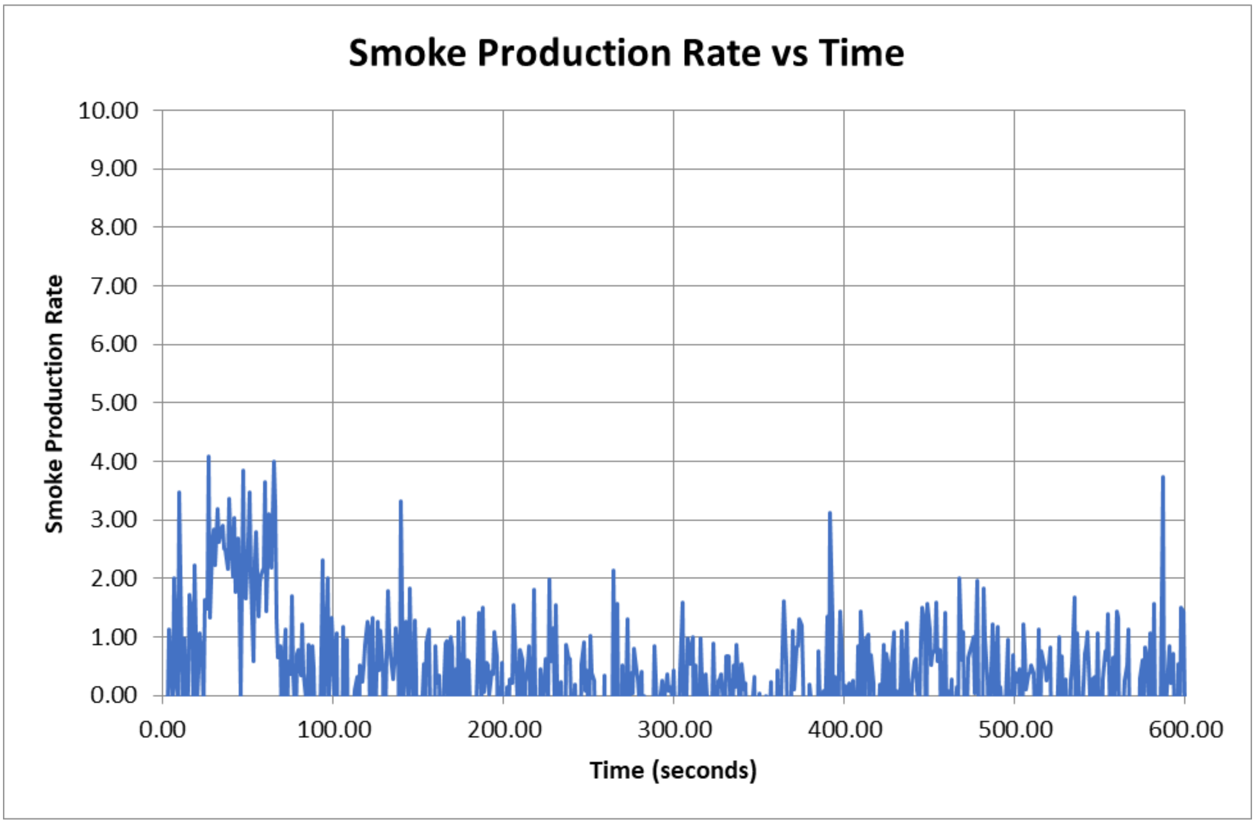
Flametect Nitro

Cone Calorimeter
Test Data

Test	**ISO 5660**	
Laboratory	ITA Labs	
Operator	AWM	
Material	Flametect Nitro	
Test ID	WTB01	
Material	Flametect Nitro	
Orientation	Horizontal	
Orifice Flow Rate Cal Const	0.0391	
Heat Flux	50	kW/m²
Test Duration	600	seconds
Time to Sustained Ignition	0	seconds
Peak Rate of Heat Release	30.8	kW/m²
Time of Peak RHR	116	seconds
Average RHR over 180 seconds	19.5	kW/m²
Average RHR over 300 seconds	17.9	kW/m²
Total Heat Released	0	MJ/m²
Avg Effective Heat of Combustion	3.09	MJ/kg
Initial Mass	120.86	g
Mass at Sustained Ignition	120.86	g
Final Mass	103.18	g
Sample Mass Loss	1960	g/m²
Avg Mass Loss Rate	3.3	g/m²s
Avg Mass Loss Rate (10% to 90%)	3.6	g/m²s
Pre-Ignition Smoke Production	0	m²/m²
Time of Max Smoke Production Rate (Pre-Ignition)	0	seconds
Post-Ignition Smoke Production	337.1	m²/m²
Time of Max Smoke Production Rate (Post-Ignition)	27	seconds
CO Yield	0.02361	kg/kg
CO2 Yield	0.19587	kg/kg

Test	ASTM E1354	
Laboratory	ITA Labs	
Operator	AWM	
Material	Flametect Nitro	
Test ID	WTB01	
Material	Flametect Nitro	
Orientation	Horizontal	
Heat Flux	50	kW/m²
Time to Sustained Ignition	0	seconds
Peak Rate of Heat Release	30.8	kW/m²
Time of Peak RHR	116	seconds
Average RHR over 60 seconds	6.7	kW/m²
Average RHR over 180 seconds	19.5	kW/m²
Average RHR over 300 seconds	17.9	kW/m²
Total Heat Released	0	MJ/m²
Avg Effective Heat of Combustion	3.09	MJ/kg
Initial Mass	120.86	g
Final Mass	103.18	g
Sample Mass Loss	1.96	kg/m²
Avg Mass Loss Rate (10% to 90%)	3.6	g/m²s
Avg SEA	171.61	m²/kg
Time of Peak SEA	517	seconds
CO Yield	0.02361	kg/kg
CO2 Yield	0.19587	kg/kg


Rate of Heat Release vs Time
Rate of Heat Release (kW/m²)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Time (seconds)


Smoke Production Rate vs Time
Smoke Production Rate
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Time (seconds)