REPORT NUMBER
CFR131209 Rev1_A

CAMBRIDGE FIRERESEARCH

Determination of Expansion Ratio and Expansion Pressure, in accordance with EOTA Technical Report TR 024, of Therm-A-Flex reactive intumescent material.

Report prepared for:

Intumescent Seals (a Division of Dixon International Group Ltd), Brewery Road, Pampisford Cambridge CB2 4EW

Background

Cambridge Fire Research Ltd (CFR) Sample Report dated 29/08/13 details the sampling of 40No. 47mm dia. x 2mm nominal thickness discs of solid reactive intumescent material type 'Therm-A-Flex' from Intumescent Seals (a division of Dixon International Group Ltd). The samples, labeled in pairs A to T inclusive, were sent to Intertek Wilton, Cleveland, UK who randomly subjected one disc from each pair to durability testing in accordance with TR 024. The samples were then returned to CFR for measurement of Expansion Ratio and Expansion Pressure in accordance with TR 024 (Nov 2006 edition, amended 2009). In the following report, sample discs subjected to durability testing are referenced 'Aged' and those not subjected to durability testing are referenced 'Unaged'. Immediately prior to testing Expansion Ratio and Expansion Pressure all samples were checked for weight and thickness and found to be 3.785 ± 0.005g (originally 3.80g) and 1.82 ± 0.01mm respectively.

Cambridge Fire Research Ltd Brewery Road Pampisford Cambridge CB22 3HG
Tel. +44 (0) 1223 834752 **Fax.** +44 (0) 1223 837208 **Email.** testing@cambridge-fire.co.uk

Registered in England No. 5602112 Registered Office 5 High Green, Great Shelford, Cambridge CB22 5EG

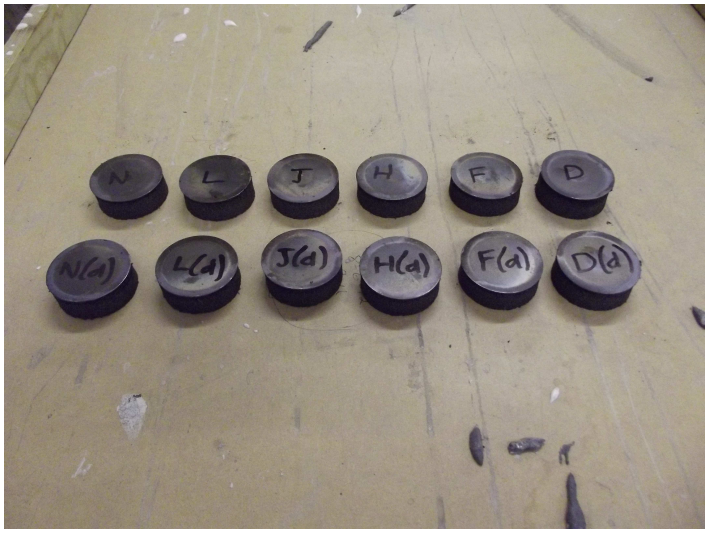
CAMBRIDGE FIRERESEARCH

Expansion Ratio Test

The foam height of the exfoliated intumescent samples was measured after direct exposure on a hotplate (set to 500°C) for 3 minutes. The apparatus, pictured below, comprised an arrangement that confined the sample disc within a 47.9mm I.D. cylinder with a free-running 521g piston on top. The foam height was measured using a digital vernier caliper.

Results Summary:

Sample Reference Letter	Unaged		Aged	
	Foam Height (mm)	Expansion Ratio	Foam Height (mm)	Expansion Ratio
D	22.44	12.33	21.74	11.95
F	20.98	11.53	20.54	11.29
H	20.22	11.11	20.35	11.18
J	20.10	11.04	20.40	11.21
L	20.87	11.47	20.02	11.00
N	20.47	11.25	20.42	11.22
Mean	**20.85**	**11.45**	**20.58**	**11.31**
S.D.	**0.85**	**0.47**	**0.60**	**0.33**



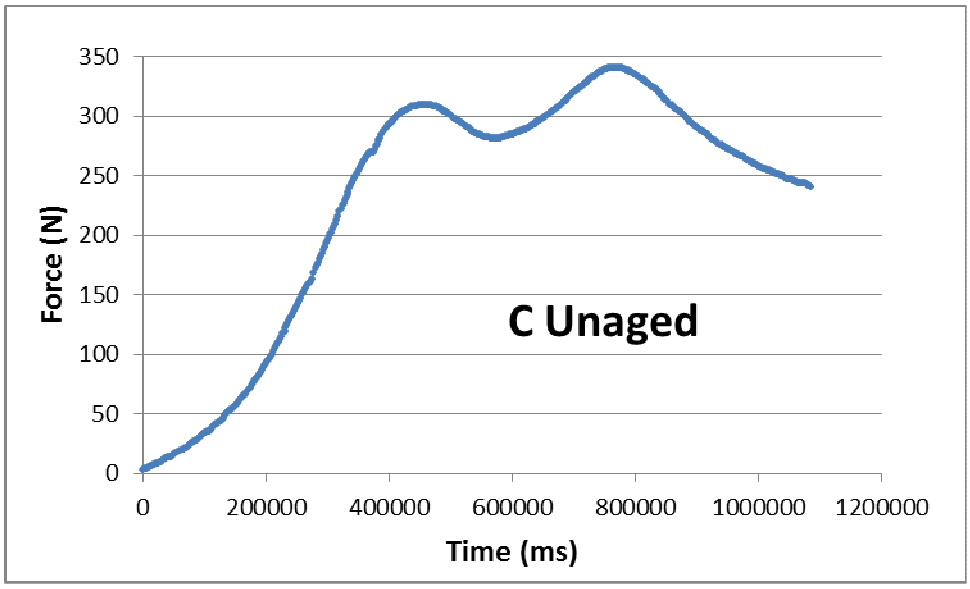
Expansion Pressure Test

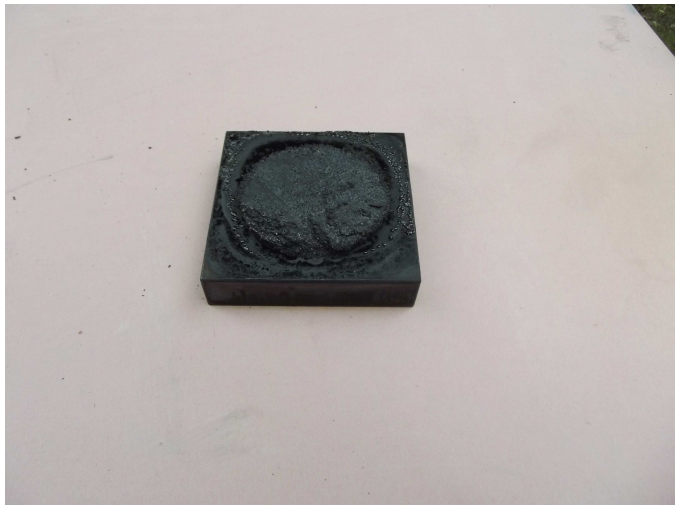
The peak force of the exfoliated intumescent samples was measured during direct exposure on a hotplate (ramped from ambient to 600°C at 25°C/min). The apparatus, pictured below, comprised an arrangement that confined the sample disc within a 47mm dia. x 8.27mm deep recess in a steel block on top of the hotplate. The peak force was measured using a digital load cell.

Results Summary:

Sample Reference Letter	Peak Force (N) - Unaged	Peak Force (N) - Aged
C	340.97	331.00
E	330.41	338.82
G	334.92	334.88
I	332.72	329.52
K	334.80	330.27
M	340.43	329.89
Mean	**335.71**	**332.40**
S.D.	**4.21**	**3.70**

The graph below shows a typical time/force trace (for sample C unaged).





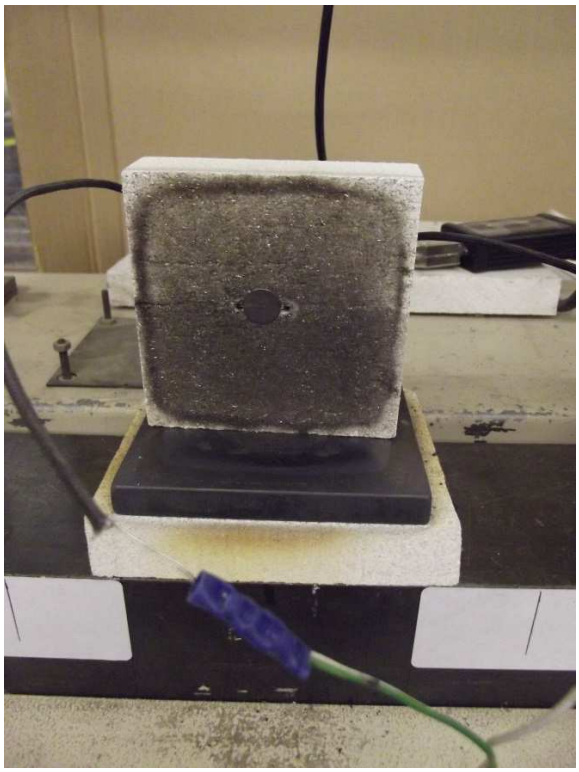
CAMBRIDGE FIRERESEARCH

Equipment Calibration

1. Expansion Ratio Apparatus

Hotplate: Checked against 12mm dia. copper disc thermocouple connected to CFR furnace data logger system. Serial N° DSC2065573-254 externally calibrated (certificate N° OU200039).

Hotplate Readout (°C)	Copper Disc Readout (°C)	Time (min)
497	518	0
494	514	1
497	513	2
502	519	3
502	522	4
499	518	5



Vernier Caliper: Serial N° LIN76995 externally calibrated (certificate N° 150552).

CAMBRIDGE FIRERESEARCH

2. Expansion Pressure Apparatus

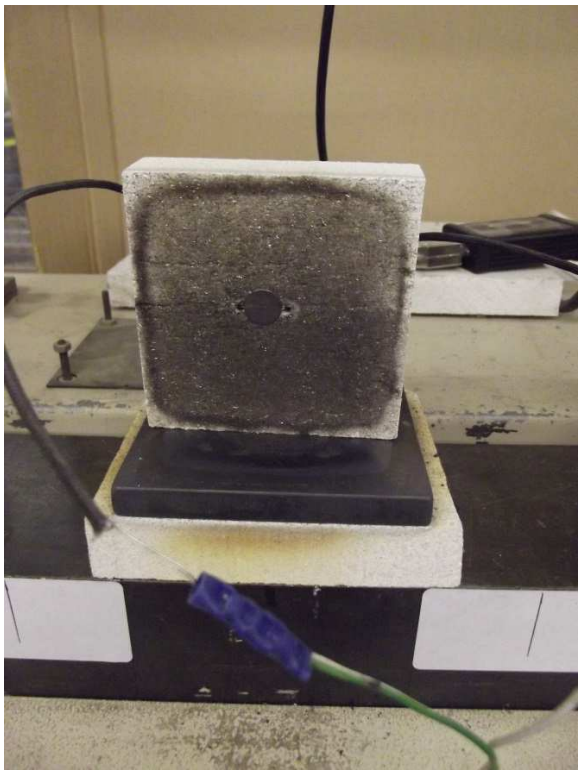
Load Cell: Calibrated and checked against 10kg and 40kg dead weights (+ 1.729kg weight of calibration frame).

Pre-testing, Dead weight = 115.06N (11.729kg), Load cell readout 115.10N
Dead weight = 409.36N (41.729kg), Load cell readout 409.33N

Post-testing, Dead weight = 115.06N (11.729kg), Load cell readout 115.24N
Dead weight = 409.36N (41.729kg), Load cell readout 409.62N

Hotplate: Checked against 12mm dia. copper disc thermocouple connected to CFR furnace data logger system. Serial N^{o} DSC2065573-254 externally calibrated (certificate N^{o} OU200039).

Hotplate Readout (^{o}C)	Copper Disc Readout (^{o}C)	Time (min/sec)
14	16	0:00
50	51	1:34
100	98	3:32
150	146	5:31
200	194	7:31
250	242	9:31
300	291	11:30
350	340	13:30
400	389	15:30
450	439	17:30
500	489	19:30
550	539	21:29
600	588	23:32
603	594	24:30
602	595	25:30
601	597	26:30
601	598	27:30
601	599	28:30



Linear Transducer: Checked against digital vernier caliper serial N° LIN76995 externally calibrated (certificate N° 150552).

Transducer Readout (mm)	Vernier Caliper Readout (mm)
0.00	0.00
10.01	9.98
20.05	20.00
30.03	29.98
40.05	40.00
50.01	49.97
60.02	59.98
70.03	69.98
80.06	80.01
90.01	89.94
100.03	99.97

CAMBRIDGE FIRERESEARCH

3. General

Vernier Caliper: Serial N° LIN76995 externally calibrated (certificate N° 150552).
Used to measure sample thickness.

Balance: Serial N° Ohaus 4315 externally calibrated (certificate N° CC/40345).
Used to measure sample weight.

Dead Weights: Checked against balance serial N° SR27870004 externally calibrated (certificate N° CC/40347).
Used to check load cell.

Nominal Dead Weight (kg)	Balance Readout (kg)
10	10.00
20 (a)	20.00
20 (b)	20.00

Copper Disc: Checked against boiling water and iced water when connected to CFR furnace data logger system.
Used to check hotplates.

Boiling water – copper disc readout, 101°C
Iced water – copper disc readout, 0°C

On behalf of Cambridge Fire Research Ltd

Dr Eric Southern
Managing Director

Mr Brian Richardson
Chief Technical Officer

Original Issue Date: 9th December 2013
Revision Issue Date: 1st April 2014