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CONFIDENTIAL TECHNICAL REPORT

RC 24436A

Silicone Rubber (PR410/60)
Batch X5460/1, Testing to BS EN 549:1995

For the attention of:
Andrew Thomas
Primasil Silicones Ltd

Issued by:

Charles Forge

Date: 12th May 2015

Summary

Primasil Silicones Ltd supplied a sample of silicone rubber ref. PR410/60, Batch No. X5460/1, for testing to the BS EN 549:1995 standard. The silicone rubber sample was tested to determine if it would meet the requirements listed in the standard, for a material designated H3/E1, intended for use in the manufacture of seals. The silicone rubber sample was found to meet the requirements of the BS EN 549:1995 standard.

Materials and methods

A sample material referred to as silicone rubber PR410/60, Batch No. X5460/1, was received from Primasil Silicones Ltd 26th March 2015. The material was allocated the goods received number GR15/192 for internal tracking purposes.

The sample was a nominal 300 x 300mm with a section of sheet, 250mm x 300mm, of thickness 2mm. Compression set buttons and a hardness block, of nominal thickness 6mm, were located in a strip, of width 50mm, along one edge of the sheet. The material was tested to BS EN 549 using the test conditions listed for a material designated as H3/E1.

Tensile testing

The tensile properties of the silicone rubber sample were determined in accordance with ISO 37. Type 2 tensile dumb-bells were cut from the 2mm thick sheet using a manual cutting press. The dumb-bells were tested using an Instron 5567 materials testing system equipped with an advanced video-extensometer (AVE). The tensile properties of two sets of six test pieces were determined. One set was tested unaged and the second set following ageing for a period of 168 hours at a temperature of 175°C.

Microhardness

Three 50 x 20mm test pieces were cut from 2mm thick sheet, using a strip cutter and a hand-operated cutting press. The hardness was measured in accordance with ISO 48, method M (Microtest), using a Wallace Cogenix Microhardness Tester. The material was tested unaged and following ageing for a period of 168 hours at a temperature of 175°C.

Compression Set

The compression set property of the silicone rubber material was determined, in accordance with ISO 815. The compound was tested at an elevated temperature of 175°C for a test period of 168 hours. The low temperature compression set was determined at a temperature of 0°C for a test period of 72 hours.

Resistance to gas

The silicone rubber sample was tested for resistance to gas in accordance with ISO 1817. Three test pieces 20 X 50mm were cut from 2mm thick sheet using an appropriate cutter and a hand-operated cutting press.

The change in mass was determined following immersion in pentane for a period of 72 hours at a temperature of 23°C. The test pieces were transferred to a drying oven for a period of 168 hours at a temperature of 40°C. The test pieces were removed from the oven, conditioned under standard laboratory conditions, and the change in mass recorded.

Resistance to lubricant

The silicone rubber sample was tested for resistance to swelling in standard oil No. 2 (IRM 902) in accordance with ISO 1817. Three test pieces, 20 X 50mm, were cut from 2mm thick sheet. The change in mass and the change in hardness were determined following immersion in the oil for a period of 168 hours at a temperature of 100°C. The hardness was measured in accordance with ISO 48, Method M (Microtest).

Ozone resistance

The silicone rubber sample was subjected to ozone resistance testing in accordance with ISO 1431-1, Method A.

Three strips of width 10mm were cut from 2mm thick sheet using a twin-blade parallel strip cutter and a hand-operated cutting press. Gauge marks were marked on each test piece prior to mounting in the test jig. The test piece was extended to 20% strain and clamped in place. The cut edges of the strip were coated with a thin film of molten paraffin wax. The test pieces were conditioned in darkness for a period of 72 hours under standard laboratory conditions; a temperature of 23 +/- 2°C and a relative humidity of 50 +/-10%.

The test strips were examined under X7 magnification, using a hand lens, prior to transfer to a Satra Hampden HTE-P3C6R ozone test cabinet. Ozone gas was generated within the test chamber on passing air over an ultra violet (UV) light source. The ozone concentration within the chamber was determined using an integral UV analyser.

The jigs were suspended within the test chamber and the test pieces exposed to an ozone concentration of 50pphm at a temperature of 30°C for a period of 24 hours. The flow of air through the test chamber was equivalent to an air-ozone replacement rate of 1.2 changes per minute; equivalent to an airflow rate of $0.003 m^3 s^{-1}$ and velocity of $0.012 ms^{-1}$. The test pieces were removed from the cabinet, on completion of the study, and examined under X7 magnification.

Results

The results recorded on testing silicone rubber sample ref. PR410/60, Batch No. X5460/1, to BS EN 549:1995, are presented in Table 1. Copies of the results sheets are appended.

Table 1 : Silicone rubber sample ref. PR410/60, Batch No. X5460/1 – Results recorded on testing to BS EN 549:1995.

Silicone rubber sample ref. PR410/60, Batch No. X5460/1			
Property	**Test Result**	**Specification**	**Pass/Fail**
Tensile Strength (unaged)	9.4 MPa	≥7 MPa	Pass
Tensile Strength aged in air 168hr at 175°C	8.7 MPa		
Change in Tensile Strength	-7.5%	Max. -40%	Pass
Elongation at break (unaged)	682%	≥ 125%	Pass
Elongation at break aged in air 168hr at 175°C	618%		
Change in Elongation at Break	-9.4%	Max. -40%	Pass
Microhardness (unaged)	71 IRHD		
Microhardness on ageing in air 168hr at 175°C	71 IRHD		
Change in Microhardness	0 IRHD	+/-10 IRHD	Pass
Compression set 168hr at 175°C	26%	≤ 40%	Pass
Compression set 72hr at 0°C	10%	≤ 40%	Pass
Resistance to gas (immersion in pentane)			
Change in mass after immersion for 72 hr at 23°C	+133%	Not required	*N/A
Change in mass on drying for 168hr in air at 40°C	-2.3%	+/-5%	Pass
Resistance to lubricant (immersion in IRM 902 oil)			
Microhardness unaged	70		
Microhardness on immersion for 168hr at 100°C	64		
Change in Microhardness	-6 IRHD	+/- 15 IRHD	Pass
Change in mass aged in IRM 902 oil 168hr at 100°C	+5.8%	+10/-1%	Pass
Resistance to ozone 24hr, 50pphm, 30°C, 20% strain	No Cracks	No cracks	Pass
*N/A Not applicable			

The silicone rubber sample, ref. PR410/60, Batch No. X5460/1, was found to meet the requirements of the BS EN 549:1995 standard.

Charles D Forge Charles D. Forge

Checked by Sarah Moazami S. Moazami 12th May 2015

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TO: Mr C Forge RC 24436

Checked
Date 30/3/15

TENSILE PROPERTIES (MPa)

Reference: 24436.05.1
Tested by: CZ
Instron 5567

Test Lab Reference : 24317
Date of test : 27/03/2015
Aged : Unaged/23°C

Test pieces cut with grain

Tested to BS ISO 37: 2011

Sample ID	100%	200%	300%	400%	500%	T.S.	E.B.	Th. (mm)	CODE
1	1.40	2.42	3.78	5.31	6.91	9.21	636	1.96	
PR410/60	1.34	2.20	3.39	4.77	6.23	9.72	721	1.96	
Batch	1.38	2.37	3.71	5.23	6.82	8.86	622	1.97	
X5460/1	1.35	2.26	3.52	4.96	6.51	9.54	682	1.98	
	1.31	2.16	3.33	4.69	6.14	9.04	686	2.03	
	1.35	2.24	3.48	4.91	6.43	9.40	682	2.02	

Codes

Underlined value is the median

1 = Grip Break
2 = Sample slipped
3 = Extensometer stopped following marks (modulus data valid to E.B. indicated)
4 = Break not detected
5 = Neck break
6 = other

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TO: MR C FORGE RC24436

Checked
Date 24/4/15

TENSILE PROPERTIES (MPa)

Reference: 24436.05.1
Tested by: GM
Instron 5567

Test Lab Reference : 24317A
Date of test : 16/04/15
Aged : 168Hrs/175°C

Test pieces cut with grain

Tested to BS EN549 CLASS H3:E1

Sample ID	100%	200%	300%	400%	500%	T.S.	E.B.	Th. (mm)	CODE
1	1.50	2.50	3.83	5.33	6.90	8.23	584	2.02	
PR410/60	1.46	2.36	3.59	4.99	6.49	7.42	563	2.00	
Batch X	1.54	2.66	4.13	5.75	7.45	8.83	583	2.00	
5460/1	1.51	2.49	3.80	5.27	6.82	8.66	618	1.99	
	1.55	2.57	3.90	5.38	6.91	8.92	630	1.98	
	1.55	2.54	3.84	5.28	6.78	8.58	620	1.97	

Codes

Underlined value is the median

1 = Grip Break
2 = Sample slipped
3 = Extensometer stopped following marks (modulus data valid to E.B. indicated)
4 = Break not detected
5 = Neck break
6 = other

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TO: MR.C.FORGE RC 24436

Checked: [illegible]
Date: 30/4/15

MICROHARDNESS

Reference : 24436.05.1
Tested by : RB
Test Temp (°C) : 23
Type of Surface : Moulded
Sample Type : (50x20x2)mm sheet

Test Lab Reference : **24317**
Date of test : 20/04/2015
Aged : Unaged/23°C
Tested to EN549 Class H3:E1

Sample Identification	No.	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	MEDIAN
1	1	70	68	69	68	69	69
PR410/60 Batch x 5460/1	2	71	71	71	70	70	71
	3	71	72	72	70	71	71
	4	71	71	69	70	72	71
	5	70	70	70	71	71	70
	6	70	69	70	71	72	70

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TO:Mr.C.Forge RC 24436

Checked: S. Meggs
Date: 20/4/15

MICROHARDNESS

Reference : 24436.05.1
Tested by : SM
Test Temp (°C) : 23
Type of Surface : Moulded
Sample Type : (50 x 20 x 2)mm Sheet

Test Lab Reference : **24317A**
Date of test : 16.04.15
Aged : 168Hours/175°C
Tested to EN549 Class H3/E1

Sample Identification	No.	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	MEDIAN
PR410/60 batch X5460/1	1	70	69	69	70	72	70
	2	72	71	71	71	71	71
	3	72	71	71	71	71	71

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Checked: [signature]
Date: 27.4.15

MICROHARDNESS

Reference : 24436.05.1
Tested by : GM
Test Temp (°C) : 23°C
Type of Surface : MOULDED
Sample Type : (50X20X2)mmSheet

Test Lab Reference : **24317B**
Date of test : 27/04/2014
Aged : 168Hrs @ 100°C in IRM 902Oil
Tested to EN549 Class H3:E1

Sample Identification	No.	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	MEDIAN
PR410/60 BatchX 5460/1	4	65	61	64	65	62	64
	5	64	64	63	64	62	64
	6	64	65	63	64	65	64

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Checked
Date 22/4/15

% WEIGHT CHANGE

Reference : 24436.05.1
Tested by : GM
Sample Type: (50X20X2)mm Sheets

Test Lab Reference : **24317B**
Date of Test: 20/04/2015
Aged: 168Hrs@ 100°C in IRM 902 Oil

Sample Identification	No	WEIGHT(mg) before ageing	WEIGHT(mg) After ageing	%WEIGHT CHANGE	Mean % weight Change
PR410/60 Batch x 5460/1	4	2445	2584	5.7	
	5	2411	2550	5.8	5.8
	6	2410	2549	5.8	

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TO:Mr.C.Forge RC 24436

Checked----------
Date----11.5.15----------

% WEIGHT CHANGE

Reference : 24436.05.1
Tested by : GM
Sample Type: (50 x 20 mm) pieces.

Test Lab Reference : **24317C**
Date of test : 23.04.15
AGED: **Swollen for 72 hours @ 23°C in Pentane,weighed Dried for 168 Hours @ 40°C, conditioned for 16 hours, then re-weighed**

Sample Identification	No	WEIGHT(mg) before swelling	WEIGHT(mg) Immediately After swelling	%WEIGHT CHANGE	WEIGHT (mg) After drying for 168 hours/40°C	% WEIGHT CHANGE
1) PR410/60 BATCH X5460/1		2436	5526	126.85	2378	-2.38
		2358	5566	136.05	2304	-2.29
		2324	5491	136.27	2270	-2.32

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Checked [signature]
Date 8/4/15

COMPRESSION SET

Reference : 24436.05.1
Tested by : GM
Lab Temp(°C): 23°C

Test Lab Reference : **24317**
Date of test : 08/04/2015
Aged : UNAGED/23°C
Tested to : EN 549 Class H3:E1

Compression (%) = 25
Test Temp (°C) = 175°C
Test duration = 168Hrs
Recovery Time/ Temp. = 30Mins/23°C

No lubricant used.
Micrometer foot diameter = 4 mm.
The test pieces were tested as a set.

The sample is a moulded cylindrical disc of diameter 13mm, thickness 6.3mm (Type B in standard) and it is not laminated. If the test-piece thickness is non-standard the achieved compression will be quoted.

	Compression Set %			
Sample Identification	Test Piece 1	Test Piece 2	Test Piece 3	MEDIAN %
1 PR410/60 BATCH X 5460/1	26	25	26	26

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Checked S. Morgan
Date 20.4.15

LOW TEMPERATURE COMPRESSION SET

Reference : 24436.05.1
Tested by : CDF
Lab Temp(°C): 23°C

Test Lab Reference : **24317A**
Date of test : 14/04/2015
Aged : Unaged/23°C
Testing based on : EN549 Class H3/E1

Compression (%) = 25
Test Temp (°C) = 0
Test duration = 72 Hrs
Recovery Time = 30 Minutes @ 0°C

Micrometer foot diameter = 4 mm.
The test pieces were tested as a set.

The sample is a moulded cylindrical disc of diameter 13mm, thickness 6.3mm (Type B in standard) and it is not laminated. If the test-piece thickness is non-standard the achieved compression will be quoted.

	Compression Set %			
Sample Identification	Test Piece 1	Test Piece 2	Test Piece 3	MEDIAN %
PR410/60 Batch X5460/1	10	9	11	10

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Checked
Date 11.14.15

OZONE TEST

Reference : 24436.05.1
Tested by : RB
Test Temperature (°C) : 30
Conditioned for: 72 Hours @ 23°C
Test Duration (hours) : 24
Strain (%) : 20
Ozone Concentration (pphm) : 50

Test Lab Reference : **24317**
Date of test : 13/04/2015
Aged : Unaged/23°C

Tested to BS ISO 1431-1: 2012 Procedure A
Static Test

Test Piece Type : (10 x 150)mm strip, cut from sheet.

Sample Identification	TIME	Test Piece No.	OBSERVATIONS
1	24 Hours	1	No cracks, no bloom.
PR410/60 Batch x 5460/1		2	No cracks, no bloom.
		3	No cracks, no bloom.

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