

# **Material Testing Report**

**MAT5790**

**ISOPLLEN H2 T V NA**

Prepared for:

**SIRMAX SPA**

**VIA DELL'ARTIGIANATO 42**

**CITTADELLA, IT 35013**

**Italy**

Prepared by:

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Prepared on:

**20 April, 2016**

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20 April, 2016

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# Summary

## Description

Family name	POLYPROPYLENES (PP)
Trade name	ISOPLLEN H2 T V NA
Manufacturer	Sirmax SpA
Family abbreviation	PP
Material structure	Crystalline
Data source	Autodesk Moldflow Plastics Labs : pvT-Measured : mech-Measured
Date last modified	20-APR-16
Date tested	20-APR-16
Data status	Non-Confidential
Material ID	24081
Grade code	MAT5790
Supplier code	SIRMAX
Fibers/fillers	2% Talc Filled

## Recommended Processing

Mold surface temperature	40	°C
Melt temperature	228	°C

<b>Mold temperature range (recommended)</b>		
Minimum	20	°C
Maximum	60	°C

<b>Melt temperature range (recommended)</b>		
Minimum	210	°C
Maximum	245	°C

Absolute maximum melt temperature	285	°C
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Ejection temperature	112	°C
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Maximum shear stress	0.25	MPa
Maximum shear rate	100000	1/s

**Maximum shear stress and maximum shear rate values have been supplemented with generic estimates.**

## Rheological Properties

<b>Cross WLF Viscosity Model</b>		
n	0.29324	
Tau	26138.6	Pa
D1	9.33976e+013	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	31.375	
A2	51.600	K

<b>Juncture loss method coefficients</b>		
C1	0.00425	Pa <sup>(1-c2)</sup>
C2	1.694	

<b>Transition temperature</b>		
Ttrans	123	°C

Moldflow Viscosity Index	VI(240)54	
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<b>Melt mass-flow rate (MFR)</b>		
Temperature	230	°C
Load	2.16	Kg
Measured MFR	20.0	g/10min

## Thermal Properties

<b>Specific heat data</b>		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
243	2830.0	-0.33
185	2683.0	-0.33
130	2510.0	-0.33
126	2588.0	-0.33
124	3182.0	-0.33
122	6798.0	-0.33
119	14190.0	-0.33
115	8350.0	-0.33
110	3158.0	-0.33
106	2631.0	-0.33
100	2448.0	-0.33
80	2193.0	-0.33
60	2018.0	-0.33
32	1800.0	-0.33

<b>Thermal conductivity data</b>		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
253.5	0.190	0.0
231.4	0.182	0.0
210.3	0.177	0.0
189.3	0.175	0.0
168.9	0.172	0.0
148.4	0.173	0.0
128.8	0.226	0.0
107.5	0.230	0.0
86.9	0.234	0.0
66.4	0.234	0.0
46	0.229	0.0
28.7	0.243	0.0

### PVT Properties

Melt density	0.7412	g/cm <sup>3</sup>
Solid density	0.9119	g/cm <sup>3</sup>

2-domain Tait PVT model coefficients		
b5	438.15	K
b6	7.550e-008	K/Pa
b1m	0.001283	m <sup>3</sup> /Kg
b2m	1.045e-006	m <sup>3</sup> /Kg-K
b3m	8.58235e+007	Pa
b4m	0.006279	1/K
b1s	0.001162	m <sup>3</sup> /Kg
b2s	4.661e-007	m <sup>3</sup> /Kg-K
b3s	1.83740e+008	Pa
b4s	0.00352	1/K
b7	0.000121	m <sup>3</sup> /Kg
b8	0.085439	1/K
b9	1.134e-008	1/Pa

### Mechanical Properties

Mechanical properties data		
Elastic modulus, 1 <sup>st</sup> principal direction [E1]	1528.28	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	1609.90	MPa
Poisson's ratio [v12]	0.4110	
Poisson's ratio [v23]	0.4630	
Shear modulus [G12]	510.600	MPa

Transversely isotropic coefficient of thermal expansion [CTE] data		
Alpha1	1.160e-004	1/°C
Alpha2	1.180e-004	1/°C

### Shrinkage Properties

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.832724
A2	0.126623
A3	0.006741
A4	1.032783
A5	-0.330512
A6	0.009139

Residual strain model coefficients		
	Parallel	Perpendicular
A1	0.13543	0.17472
A2	0.001201	0.002966
A3	-0.000297	-0.000073
A4	1.9458e-007	2.2249e-007
A5	0.007773	0.007607

**The shrinkage models shown above are valid for Autodesk Simulation Moldflow Insight 2017.  
Shrinkage models for previous software versions are included in the 21000.udb file.**

### Filler Properties

Filler data	
Description	Weight %
Talc	2



# Viscosity

## Method:

AMPL Viscosity Test Method (QOP-14-M)

## Instrument:

Arburg Allrounder 270S Injection Molding Machine

## Test Specifications:

Sample Form:	Granules
Pre-Processing:	Dried at 70°C for 1 hours in a hopper dryer
Moisture Level:	0.025 %
Capillary A: Length:	32.0097 mm
L/D:	16.00485
Die Entry Angle:	90 degrees
Capillary B: Length:	7.9688 mm
L/D:	3.9844
Die Entry Angle:	90 degrees
Barrel Diameter:	30 mm
Plastication Time:	20 sec
Dwell Time:	20 sec
Corrections:	Bagley, Rabinowitsch and shear heating
Date Received:	01-FEB-16
Date Tested:	19-APR-16

## Operator's Notes:

Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

## Apparent Viscosity Data

Temperature (°C)	Apparent Shear Rate (sec <sup>-1</sup> )	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
199.5	212	243.03	2	16
199.5	326	189.5	2	16
199.7	778	111.51	2	16
200	1334	79.32	2	16
200.4	2574	51.65	2	16
201.3	6397	28.39	2	16
201.3	60357	6.27	2	16
201.8	12604	18.12	2	16
202.1	25254	11.02	2	16
214.9	211	199.09	2	16
214.9	326	159.01	2	16
214.9	778	96.72	2	16
215	1334	69.26	2	16
215.5	2572	45.64	2	16
216	6398	25.17	2	16
216.4	12601	16.26	2	16
216.4	60648	5.55	2	16
216.8	25256	9.98	2	16
229.5	211	168.91	2	16
229.8	326	137.2	2	16
229.8	1335	62.06	2	16
229.9	778	85.94	2	16
229.9	2577	41.22	2	16
230.6	6396	23.03	2	16
231.2	12600	14.86	2	16
231.4	25246	9.3	2	16
231.8	63621	4.74	2	16
244.8	210	146.03	2	16
244.8	775	77.75	2	16
244.9	324	121.3	2	16
244.9	2573	37.8	2	16
245	1333	56.59	2	16
245.4	6391	21.18	2	16
245.8	12593	13.68	2	16
246.1	25253	8.73	2	16
246.3	63931	4.53	2	16
197	326	271.73	2	3.98
197.2	212	346.74	2	3.98
197.8	778	164.06	2	3.98
198.6	1334	118.85	2	3.98
199.7	2574	80.16	2	3.98
200.3	60357	12.47	2	3.98
200.9	6397	46.68	2	3.98
201.2	12604	31.9	2	3.98
201.4	25254	20.84	2	3.98
214.4	211	269.02	2	3.98
214.5	326	217.19	2	3.98
214.5	778	135.2	2	3.98
214.9	1334	99.47	2	3.98
215.4	2572	67.77	2	3.98
216.1	6398	40.07	2	3.98

Temperature (°C)	Apparent Shear Rate (sec <sup>-1</sup> )	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
216.2	60648	10.88	2	3.98
216.3	12601	27.51	2	3.98
217	25256	18.3	2	3.98
228.8	211	220.56	2	3.98
229.2	326	181.16	2	3.98
229.2	778	116.11	2	3.98
229.5	1335	86.19	2	3.98
230	2577	59.24	2	3.98
230.8	6396	35.34	2	3.98
231.1	12600	24.2	2	3.98
231.5	25246	16.63	2	3.98
231.9	63621	9.25	2	3.98
245.1	210	187.21	2	3.98
245.2	1333	76.52	2	3.98
245.4	775	102.06	2	3.98
245.7	324	154.34	2	3.98
245.9	2573	53.01	2	3.98
246.5	6391	31.71	2	3.98
246.6	25253	15.01	2	3.98
246.7	12593	21.74	2	3.98
246.9	63931	8.52	2	3.98

### Calculated Viscosity Data

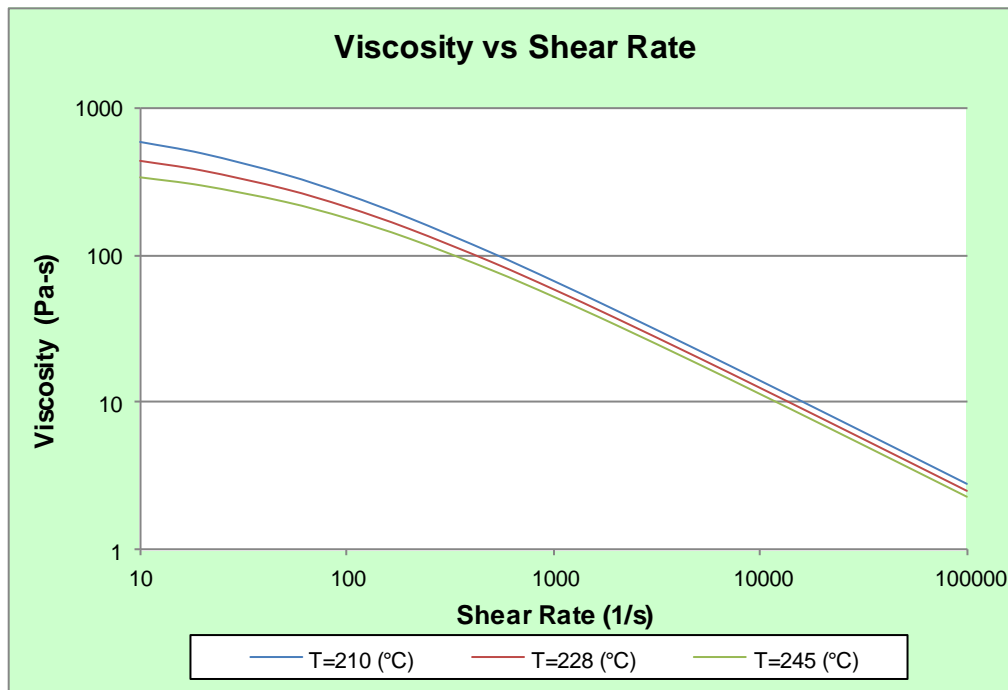
Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
197	326	152.29
197.2	212	196.8
197.8	778	87.07
198.6	1334	60.57
199.5	212	192.34
199.5	326	148.79
199.7	778	85.7
199.7	2574	38.53
200	1334	59.91
200.3	60357	4.26
200.4	2574	38.33
200.9	6397	20.42
201.2	12604	12.71
201.3	6397	20.36
201.3	60357	4.23
201.4	25254	7.8
201.8	12604	12.65
202.1	25254	7.76
214.4	211	166.94
214.5	778	76.16
214.5	326	130.02
214.9	211	166.16
214.9	1334	53.53
214.9	778	75.92
214.9	326	129.57
215	1334	53.49
215.4	2572	34.43
215.5	2572	34.41
216	6398	18.41
216.1	6398	18.39
216.2	60648	3.82
216.3	12601	11.49
216.4	60648	3.82
216.4	12601	11.48
216.8	25256	7.05
217	25256	7.04
228.8	211	146.15
229.2	326	114.73
229.2	778	68.26
229.5	211	145.23
229.5	1335	48.32
229.8	1335	48.22
229.8	326	114.16
229.9	778	67.92
229.9	2577	31.26
230	2577	31.24
230.6	6396	16.81
230.8	6396	16.79
231.1	12600	10.5
231.2	12600	10.49
231.4	25246	6.46

Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
231.5	25246	6.46
231.8	63621	3.37
231.9	63621	3.37
244.8	210	127.22
244.8	775	61.36
244.9	324	101.38
244.9	2573	28.56
245	1333	43.73
245.1	210	126.9
245.2	1333	43.67
245.4	775	61.11
245.4	6391	15.45
245.7	324	100.75
245.8	12593	9.68
245.9	2573	28.39
246.1	25253	5.96
246.3	63931	3.11
246.5	6391	15.36
246.6	25253	5.95
246.7	12593	9.63
246.9	63931	3.1

**Rheological Data**

Cross WLF Viscosity Model		
n	0.29324	
Tau	26138.6	Pa
D1	9.33976e+013	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	31.375	
A2	51.600	K

Juncture loss method coefficients		
C1	0.00425	Pa <sup>(1-c2)</sup>
C2	1.694	



# Thermal conductivity

**Method:**

ASTM D 5930, Standard Test Method for Thermal Conductivity of Plastics by Means of a Transient Line-Source Technique.

**Instrument:**

Moldflow K-System II

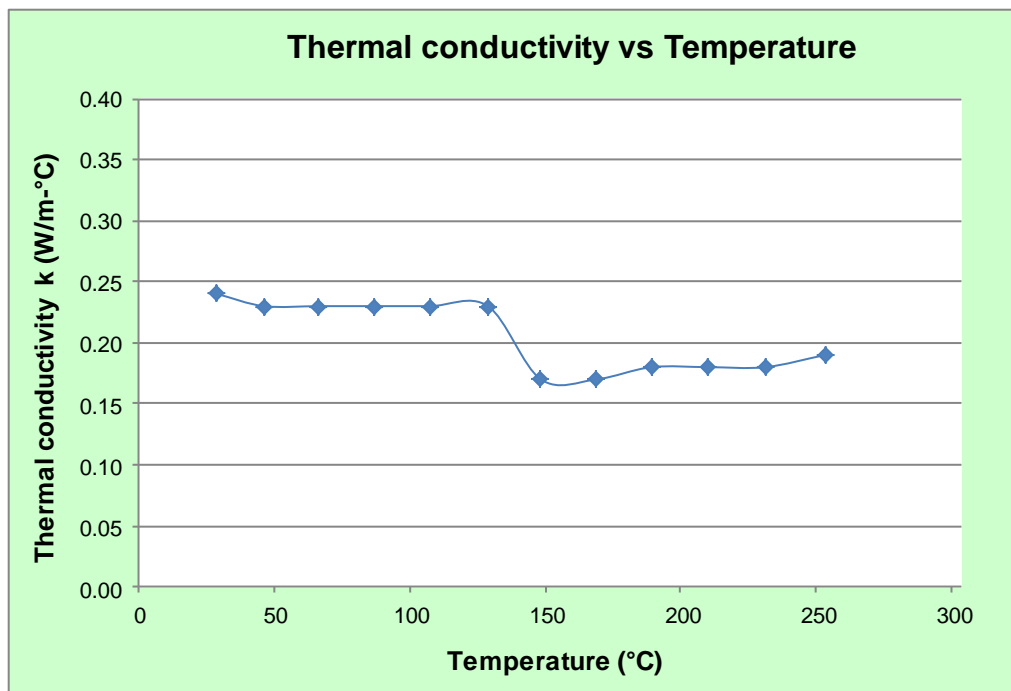
**Test Specifications:**

Sample Form:	Granules
Pre-Processing:	Dried at 70°C for 1 hours in a hopper dryer
Moisture Level:	0.016 %
Probe Constant:	0.721
Probe Length:	50 mm
Data acquisition time:	45 sec
Probe Voltage:	4.0 V
Date Received:	01-FEB-16
Date Tested:	04-APR-16

**Operator's Notes:**

Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

Thermal conductivity data		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
253.5	0.190	0.0
231.4	0.182	0.0
210.3	0.177	0.0
189.3	0.175	0.0
168.9	0.172	0.0
148.4	0.173	0.0
128.8	0.226	0.0
107.5	0.230	0.0
86.9	0.234	0.0
66.4	0.234	0.0
46	0.229	0.0
28.7	0.243	0.0





# Specific heat

## Method:

ASTM E 1269, Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry

ASTM D 3418, Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry

## Instrument:

Perkin Elmer Pyris Diamond Differential Scanning Calorimeter

## Test Specifications:

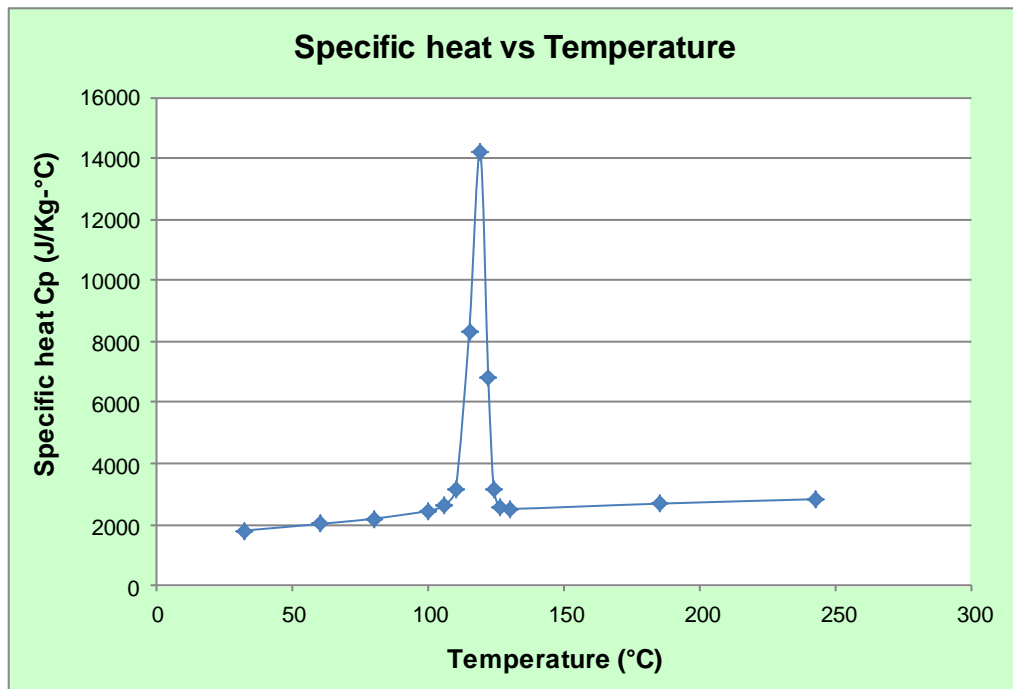
Sample Form:	Granules
Pre-Processing:	Dried at 70°C for 1 hours in a hopper dryer
Moisture Level:	0.025 %
Initial Temperature:	245°C
Final Temperature:	30°C
Cooling Rate:	20°C/min
Equilibrium Time:	2 min
Sample holder material:	Aluminium
Sample holder dimensions:	6.7 mm diameter, 1.6 mm tall
Sample holder mass:	25 mg (pan + lid)
Purge gas:	99.99% pure nitrogen
Purge gas flow rate:	30 cm <sup>3</sup> /sec
Date Received:	01-FEB-16
Date Tested:	11-APR-16

## Operator's Notes:

Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

Specific heat data		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
243	2830.0	-0.33
185	2683.0	-0.33
130	2510.0	-0.33
126	2588.0	-0.33
124	3182.0	-0.33
122	6798.0	-0.33
119	14190.0	-0.33
115	8350.0	-0.33
110	3158.0	-0.33
106	2631.0	-0.33
100	2448.0	-0.33
80	2193.0	-0.33
60	2018.0	-0.33
32	1800.0	-0.33

Ttrans	123	°C
Ejection temperature	112	°C



# Pressure-Volume-Temperature

**Method:**

High Pressure Indirect Dilatometry

**Instrument:**

Gnomix pVT Apparatus

**Test Specifications:**

Sample Form:	Molded Plaque
Pre-Processing:	Not required
Scan type:	Isothermal Cooling
Date Received:	01-FEB-16
Date Tested:	19-APR-16

**Operator's Notes:**

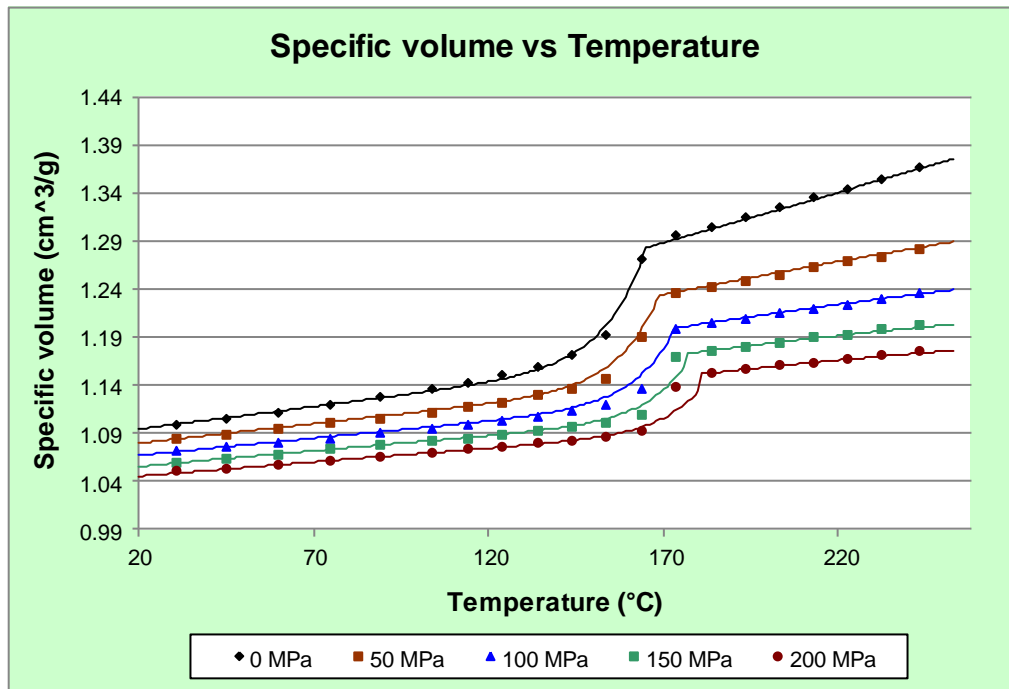
Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

### pvT Experimental Data

Temperature (°C)	Pressure (MPa)				
	0MPa	50MPa	100MPa	150MPa	200MPa
30.8	1.0990	1.0840	1.0710	1.0600	1.0510
45.1	1.1050	1.0890	1.0750	1.0640	1.0540
59.7	1.1120	1.0940	1.0800	1.0680	1.0580
74.5	1.1190	1.1000	1.0850	1.0730	1.0620
88.9	1.1270	1.1050	1.0900	1.0770	1.0660
103.9	1.1360	1.1120	1.0950	1.0820	1.0700
113.8	1.1420	1.1170	1.0990	1.0850	1.0730
123.7	1.1500	1.1220	1.1030	1.0890	1.0760
134	1.1590	1.1290	1.1080	1.0930	1.0790
143.9	1.1720	1.1360	1.1140	1.0970	1.0830
153.7	1.1930	1.1470	1.1200	1.1010	1.0860
163.7	1.2710	1.1890	1.1370	1.1100	1.0920
173.7	1.2960	1.2350	1.1980	1.1700	1.1380
183.6	1.3050	1.2420	1.2040	1.1750	1.1520
193.6	1.3150	1.2490	1.2090	1.1800	1.1560
203.4	1.3250	1.2550	1.2140	1.1840	1.1600
213	1.3350	1.2620	1.2190	1.1890	1.1640
222.7	1.3440	1.2680	1.2240	1.1930	1.1680
232.4	1.3550	1.2740	1.2300	1.1980	1.1720
242.9	1.3660	1.2820	1.2350	1.2020	1.1760

Melt density	0.7412	g/cm <sup>3</sup>
Solid density	0.9119	g/cm <sup>3</sup>

2-domain Tait PVT model coefficients		
b5	438.15	K
b6	7.550e-008	K/Pa
b1m	0.001283	m <sup>3</sup> /Kg
b2m	1.045e-006	m <sup>3</sup> /Kg-K
b3m	8.58235e+007	Pa
b4m	0.006279	1/K
b1s	0.001162	m <sup>3</sup> /Kg
b2s	4.661e-007	m <sup>3</sup> /Kg-K
b3s	1.83740e+008	Pa
b4s	0.00352	1/K
b7	0.000121	m <sup>3</sup> /Kg
b8	0.085439	1/K
b9	1.134e-008	1/Pa



# Shrinkage

## Method:

AMPL Shrinkage Test Method (QOP-17-M)

## Instrument:

Battenfeld BK-T 1500/400 Injection molding machine  
 Test mold inscribed with a fine grid pattern  
 Thermoline TRH 460 Temperature-Humidity Cabinet  
 OGP Smartscope Flash 400 metrology system

## Test Specifications:

Sample Form:	Granules
Pre-Processing:	Dried at 70°C for 1 hours in a hopper dryer
Moisture Level:	0.016 %
Date Molded:	04-APR-16
Post-Processing:	Conditioned at 23°C / 50% relative humidity for 7 days
Date Measured:	11-APR-16
Shrinkage Data Correlated With:	Autodesk Simulation Moldflow Insight 2017
Default Model:	Residual Stress (CRIMS)
Date Received:	01-FEB-16

## Operator's Notes:

Testing was performed per standard testing procedures.

No anomalies were noted during the course of testing.

Shrinkage measurements have been corrected to account for mold thermal expansion.

Data for some process conditions may have been removed in the determination of the favored model.

### Shrinkage Experimental Data

Process Condition	Melt Temperature (°C)	Mold Temperature (°C)	Flow Rate (cc/sec)	Part Thickness (mm)	Packing Pressure (MPa)	Packing Time (sec)	Cooling Time (sec)
1	227.4	40.4	36.5	2	44.8	30.1	15
2	227.9	40.5	36.5	2	59.6	30.1	15
3	228.3	40.5	34.5	2	76.3	30.1	15
4	227.9	40.2	17.0	2	59.4	30.1	15
5	227.9	40.5	55.6	2	59.7	30.1	15
6	210.7	41.2	34.5	2	46.0	30.1	15
7	210.5	41.5	35.5	2	60.2	30.1	15
8	211.0	41.6	36.5	2	76.7	30.1	15
9	210.6	41.5	17.0	2	59.9	30.1	15
10	210.5	41.9	55.6	2	60.1	30.1	15
11	244.4	42.5	37.6	2	44.5	30.1	15
12	244.5	41.6	34.5	2	59.7	30.1	15
13	244.7	41.8	35.5	2	76.0	30.1	15
14	245.3	41.1	17.5	2	59.7	30.1	15
15	245.2	41.6	55.6	2	59.7	30.1	15
16	230.5	41.0	13.6	1	83.9	15.1	15
17	230.5	41.1	13.9	1	93.7	15.1	15
18	231.1	41.2	13.6	1	104.8	15.1	15
19	230.7	40.6	6.8	1	93.5	15.1	15
20	230.6	41.2	20.7	1	93.6	15.1	15
21	226.9	41.3	40.9	3	19.9	45.1	15
22	227.4	41.5	39.2	3	39.2	45.1	15
23	227.5	41.1	45.7	3	60.4	45.1	15
24	227.0	41.2	22.9	3	39.2	45.1	15
25	227.4	41.5	66.2	3	39.6	45.1	15

### Part Shrinkage

Process Condition	Average Measured Parallel	Average Measured Perpendicular	Average Predicted Volumetric
1	1.250%	1.477%	3.096%
2	1.143%	1.322%	2.351%
3	1.011%	1.194%	1.570%
4	1.164%	1.352%	2.363%
5	1.133%	1.333%	2.329%
6	1.251%	1.448%	3.106%
7	1.160%	1.331%	2.384%
8	1.030%	1.173%	1.608%
9	1.212%	1.357%	2.397%
10	1.142%	1.318%	2.373%
11	1.222%	1.444%	3.085%
12	1.140%	1.346%	2.316%
13	0.995%	1.181%	1.560%
14	1.150%	1.343%	2.304%
15	1.124%	1.329%	2.295%
16	1.314%	1.121%	2.890%
17	1.271%	1.077%	2.292%
18	1.201%	1.014%	1.719%
19	1.431%	1.092%	1.888%
20	1.185%	1.072%	2.430%
21	1.378%	1.756%	3.846%
22	1.238%	1.506%	2.847%
23	1.094%	1.315%	1.850%
24	1.249%	1.522%	2.869%
25	1.232%	1.497%	2.806%



### Residual Stress Coefficients

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.832724
A2	0.126623
A3	0.006741
A4	1.032783
A5	-0.330512
A6	0.009139

### Residual Strain Coefficients

Parallel				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.13543	0.008953	0.041501	0.024488
2	0.001201	0.027075	0.82358	0.49519
3	-0.000297	4.9798	24.448	11.005
4	1.9458e-007	4108.40	51588.00	17624.00
5	0.007773	0	0	0

Perpendicular				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.17472	0.008953	0.03599	0.023486
2	0.002966	0.027075	0.82358	0.49917
3	-0.000073	4.9798	21.951	10.839
4	2.2249e-007	1843.30	5010.60	3127.40
5	0.007607	0	0	0

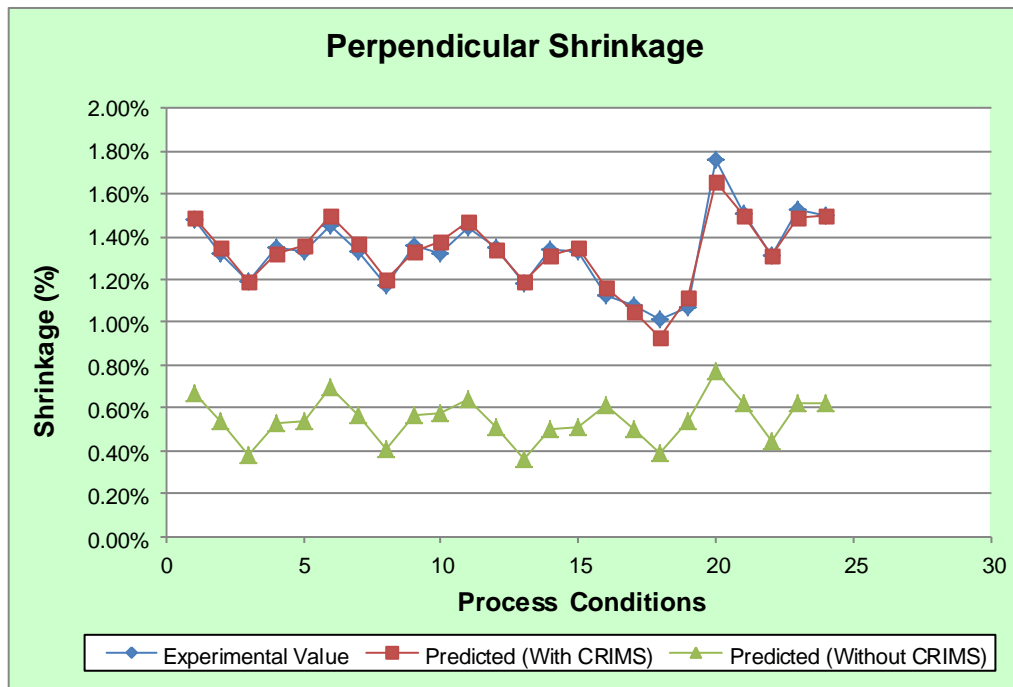
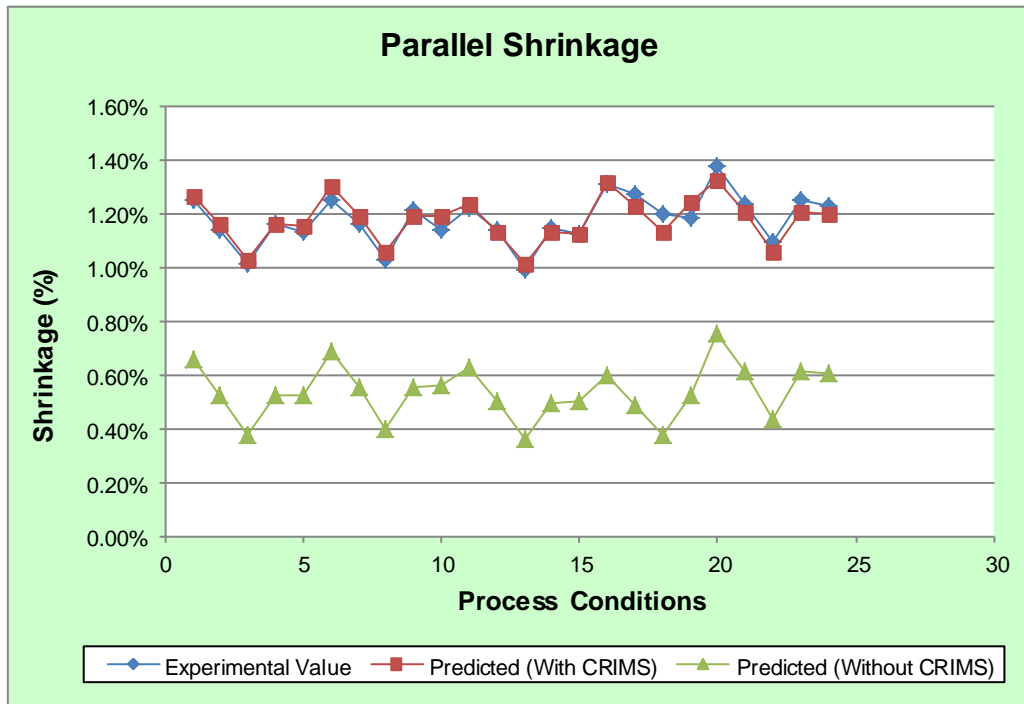
**The shrinkage models shown above are valid for Autodesk Simulation Moldflow Insight 2017. Shrinkage models for previous software versions are included in the .21000.udb file.**

### Observed Shrinkage

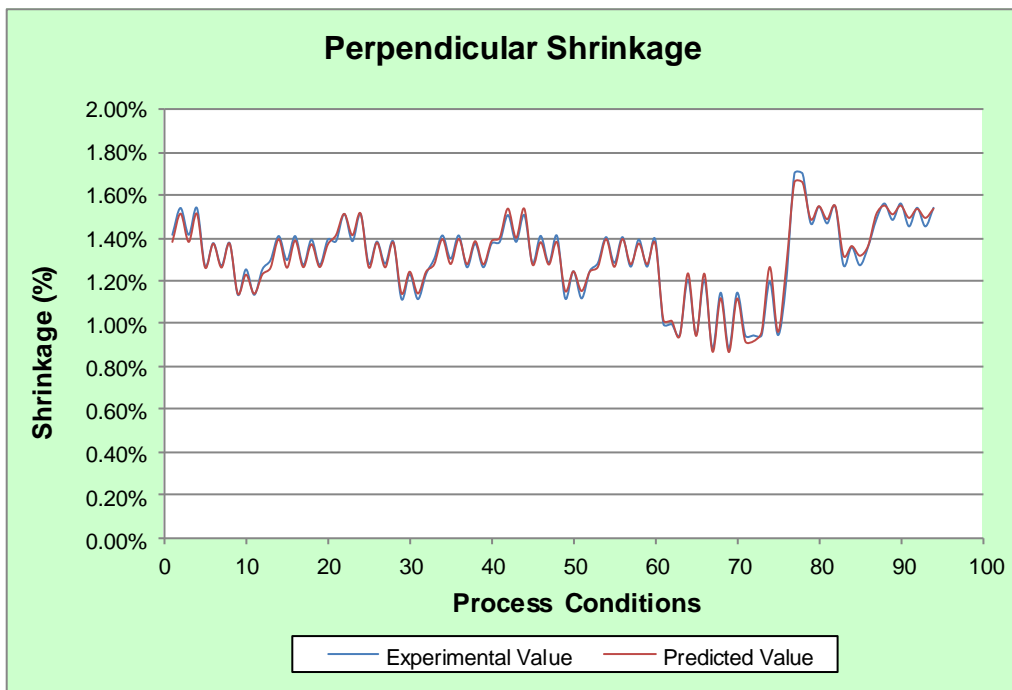
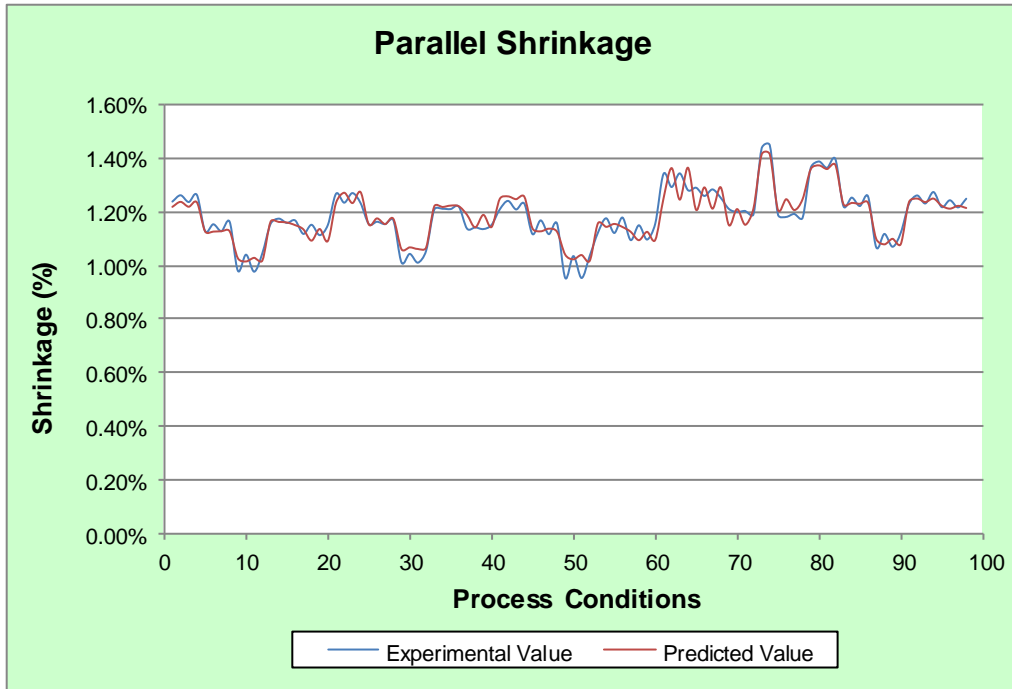
Observed nominal shrinkage	
Parallel	1.189%
Perpendicular	1.317%

Observed shrinkage	
Minimum Parallel	0.995%
Maximum Parallel	1.431%
Minimum Perpendicular	1.014%
Maximum Perpendicular	1.756%

### Residual Stress Plots



### Residual Strain Plots



# Mechanical

## Elastic modulus and Poisson's ratio

### Method:

ASTM D 638, Standard Test Method for Tensile Properties of Plastics  
 ASTM E 132, Standard Test Method for Poisson's Ratio at Room Temperature

### Instrument:

Instron 3367 Universal Testing Machine

### Test Specifications:

Specimens Tested:	8 (per direction)
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Test Speed:	5 mm/min
Date Received:	01-FEB-16
Date Tested:	18-APR-16

### Operator's Notes:

Testing was performed per standard testing procedures.  
 No anomalies were noted during testing.

Elastic modulus		
Elastic modulus, 1 <sup>st</sup> principal direction [E1]	1528.28	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	1609.90	MPa

Poisson's ratio		
Poisson's ratio [v12]	0.4110	
Poisson's ratio [v23]	0.4630	

## Shear modulus

### Method:

ASTM D 638, Standard Test Method for Tensile Properties of Plastics

### Instrument:

Instron 3367 Universal Testing Machine

### Test Specifications:

Specimens Tested:	8
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Test Speed:	5 mm/min
Date Received:	01-FEB-16
Date Tested:	18-APR-16

### Operator's Notes:

Shear modulus is calculated using orthotropic elasticity from the tensile modulus measured on a sample cut at an angle of 45° with the flow direction.

Testing was performed per standard testing procedures.

No anomalies were noted during testing.

Shear modulus		
Shear modulus [G12]	510.600	MPa

## Coefficient of linear thermal expansion

### Method:

ISO 11359-2, Plastics – Thermomechanical analysis (TMA)

### Instrument:

TA Instruments Thermomechanical Analyser Q400

### Test Specifications:

Specimens Tested:	4 (per direction)
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Specimen Geometry:	Square, 10mm x 10mm, full thickness
Temperature Range:	10°C to 40°C
Date Received:	01-FEB-16
Date Tested:	15-APR-16

### Operator's Notes:

Testing was performed per standard testing procedures.  
No anomalies were noted during testing.

Transversely isotropic coefficient of thermal expansion [CTE] data		
Alpha 1	1.160e-004	1/°C
Alpha 2	1.180e-004	1/°C

# Mold verification

**Method:**

AMPL Mold Verification Test Method (QOP-16-M)

**Instrument:**

Battenfeld BK-T 1500/400 Injection Molding Machine

**Test Specifications:**

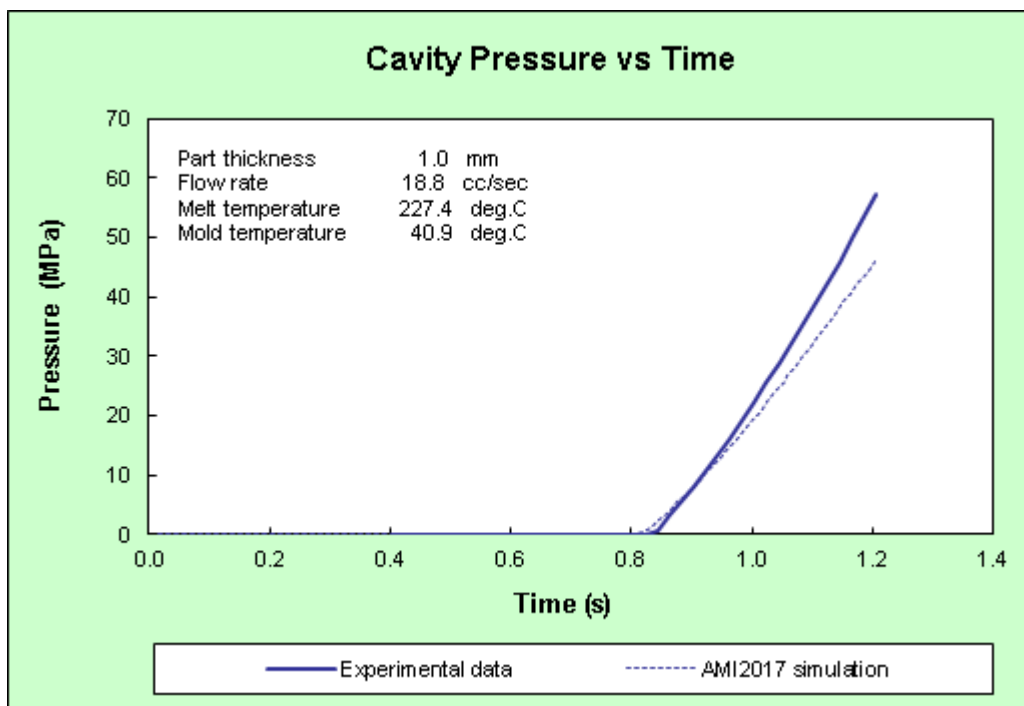
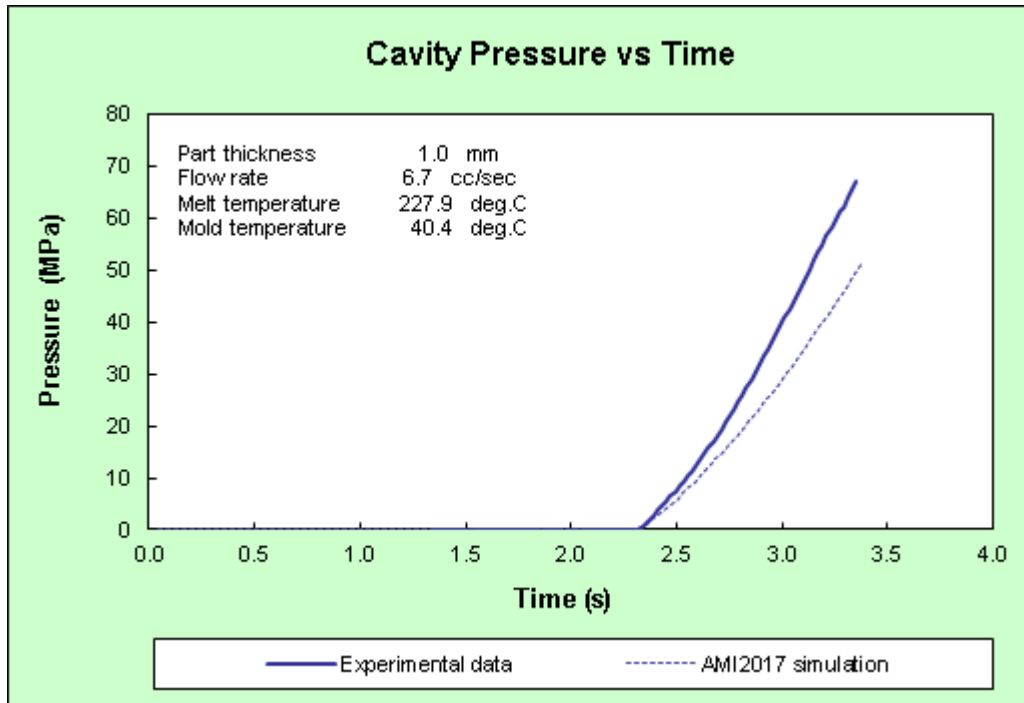
Sample Form:	Granules
Pre-Processing:	Dried at 70°C for 1 hours in a hopper dryer
Moisture Level:	0.016 %
Date Received:	01-FEB-16
Date Tested:	04-APR-16

**Operator's Notes:**

Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

**1mm tag die**

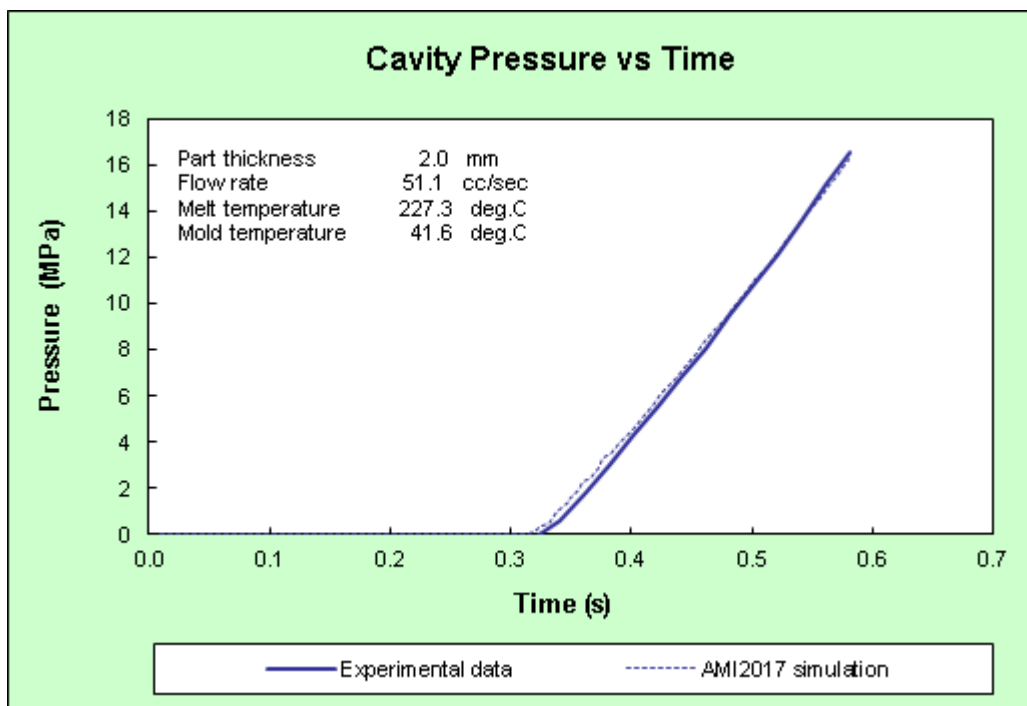
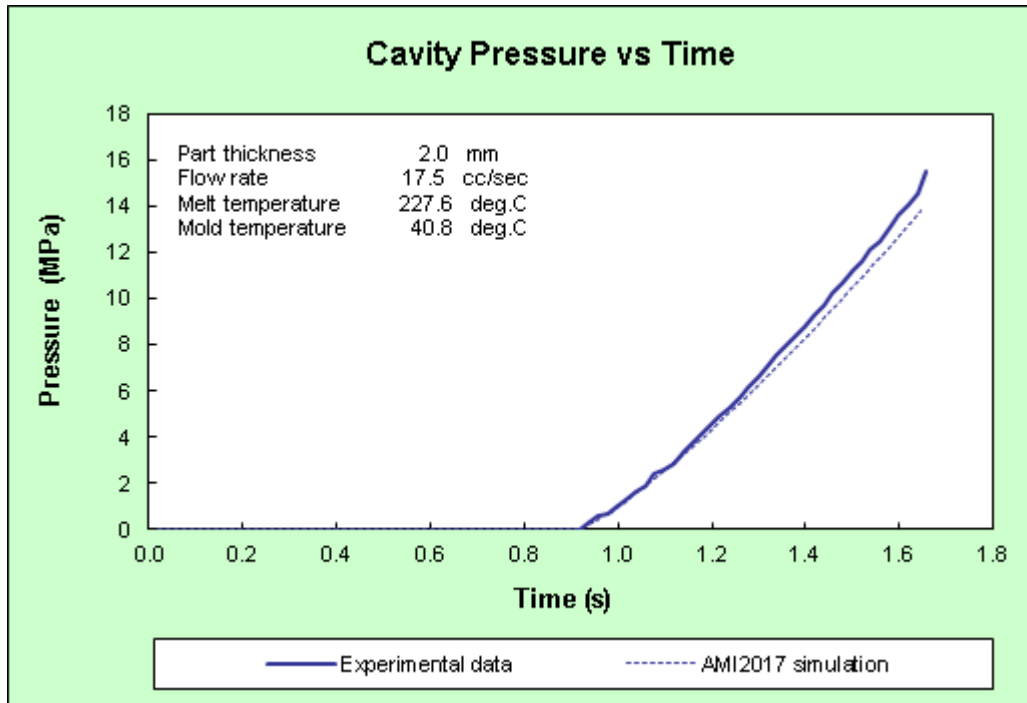
Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0110	6.7	227.9	40.4
Cyc0120	18.8	227.4	40.9





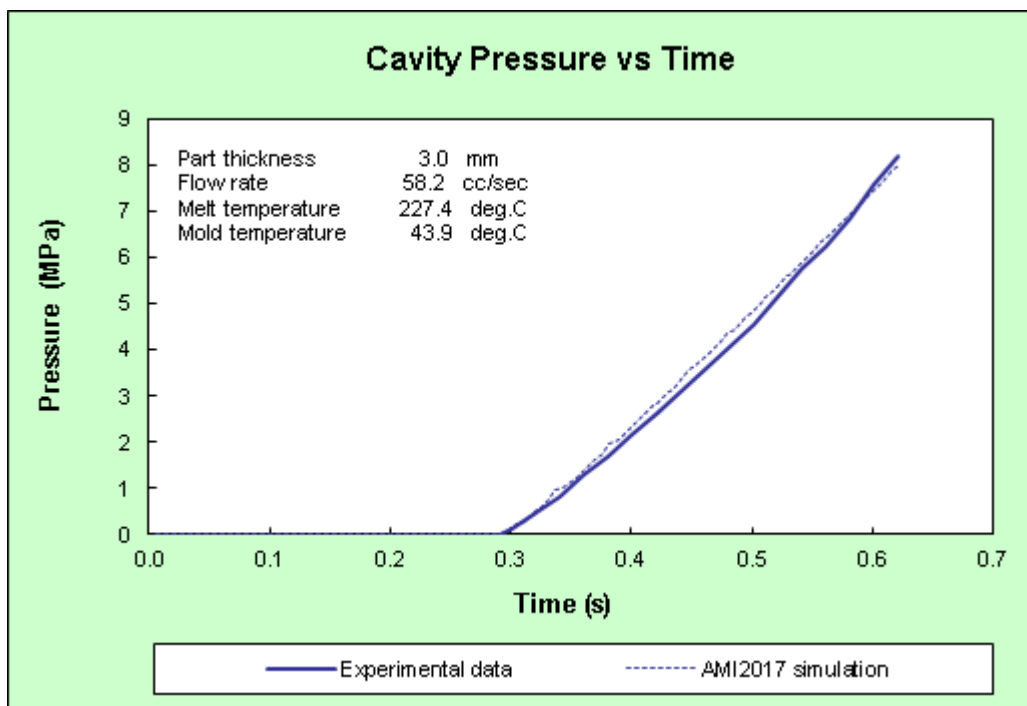
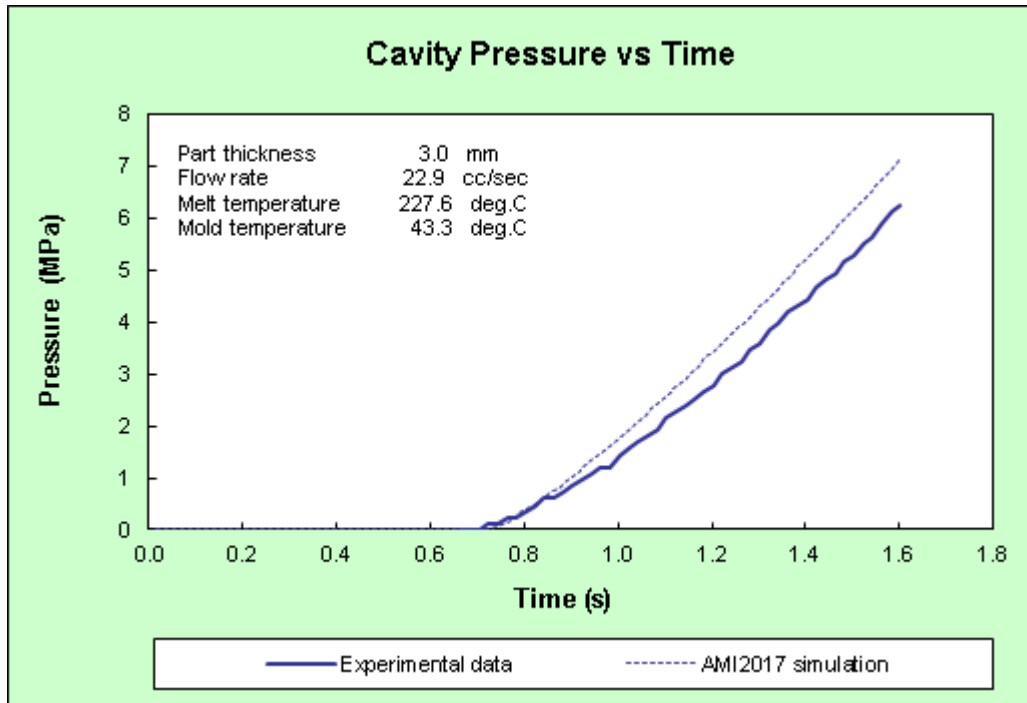
**2mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0018	17.5	227.6	40.8
Cyc0027	51.1	227.3	41.6



**3mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0161	22.9	227.6	43.3
Cyc0171	58.2	227.4	43.9



## Contact details

### United States of America

Autodesk Inc.

2353 North Triphammer Road

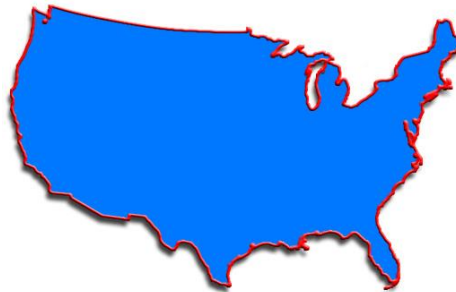
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