

# **Material Testing Report**

**MAT5789**

**ISOFIL HK 25 TVH0 WT0822**

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	ISOFIL HK 25 TVH0 WT0822
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	24080
Grade code	MAT5789
Supplier code	SIRMAX
Fibers/fillers	25% Talc Filled

## Recommended Processing

Mold surface temperature	40	°C
Melt temperature	223	°C

Mold temperature range (recommended)		
Minimum	20	°C
Maximum	60	°C

Melt temperature range (recommended)		
Minimum	200	°C
Maximum	245	°C

Absolute maximum melt temperature	285	°C
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Ejection temperature	119	°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	0.3250	
Tau	23724.7	Pa
D1	2.07168e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	32.394	
A2	51.600	K

<b>Juncture loss method coefficients</b>		
C1	0.00398	Pa <sup>(1-c2)</sup>
C2	1.678	

<b>Transition temperature</b>		
Ttrans	128	°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	23.0	g/10min

### Thermal Properties

<b>Specific heat data</b>		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
243	2436.0	-0.33
190	2307.0	-0.33
135	2153.0	-0.33
130	2307.0	-0.33
129	2605.0	-0.33
124	11601.0	-0.33
121	6667.0	-0.33
118	3176.0	-0.33
115	2446.0	-0.33
110	2209.0	-0.33
100	2102.0	-0.33
80	1946.0	-0.33
60	1781.0	-0.33
32	1609.0	-0.33

<b>Thermal conductivity data</b>		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
254.8	0.282	0.0
232.5	0.272	0.0
210.8	0.274	0.0
189.6	0.272	0.0
169.1	0.274	0.0
148.6	0.272	0.0
107.6	0.379	0.0
86.9	0.392	0.0
66.4	0.388	0.0
46	0.368	0.0
28.4	0.407	0.0

### PVT Properties

Melt density	0.9301	g/cm <sup>3</sup>
Solid density	1.1202	g/cm <sup>3</sup>

2-domain Tait PVT model coefficients		
b5	438.15	K
b6	7.650e-008	K/Pa
b1m	0.001032	m <sup>3</sup> /Kg
b2m	7.356e-007	m <sup>3</sup> /Kg-K
b3m	9.36189e+007	Pa
b4m	0.004912	1/K
b1s	0.000957	m <sup>3</sup> /Kg
b2s	4.626e-007	m <sup>3</sup> /Kg-K
b3s	1.65096e+008	Pa
b4s	0.005688	1/K
b7	0.000075	m <sup>3</sup> /Kg
b8	0.133374	1/K
b9	1.502e-008	1/Pa

### Mechanical Properties

Mechanical properties data		
Elastic modulus, 1 <sup>st</sup> principal direction [E1]	2710.18	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	2524.06	MPa
Poisson's ratio [v12]	0.3270	
Poisson's ratio [v23]	0.3270	
Shear modulus [G12]	962.200	MPa

Transversely isotropic coefficient of thermal expansion [CTE] data		
Alpha1	6.570e-005	1/°C
Alpha2	7.210e-005	1/°C

### Shrinkage Properties

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.388824
A2	-0.043945
A3	0.003695
A4	0.630353
A5	-0.266591
A6	0.005053

Residual strain model coefficients		
	Parallel	Perpendicular
A1	0.026456	0.10119
A2	0.002272	-0.0002
A3	0.000062	-0.000149
A4	3.6283e-009	2.0295e-007
A5	0.003841	0.006992

**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	25



# 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 65°C for 1 hours in a hopper dryer
Moisture Level:	0.023 %
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:	20-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
199.4	332	188.48	2	16
199.5	783	114.07	2	16
199.8	1341	81.95	2	16
199.9	217	238.11	2	16
200.3	2580	53.88	2	16
201.2	6406	29.38	2	16
201.8	12617	18.66	2	16
202.1	62925	7.08	2	16
202.2	25283	11.93	2	16
214.8	785	95.85	2	16
214.9	216	190.1	2	16
214.9	332	153.1	2	16
215.1	1341	69.96	2	16
215.3	2579	46.79	2	16
216	6409	25.9	2	16
216.5	12617	16.64	2	16
217	25274	10.65	2	16
217.4	63887	6.01	2	16
230	784	82.66	2	16
230.1	217	159.2	2	16
230.1	1342	61.25	2	16
230.2	332	129.18	2	16
230.2	2582	41.48	2	16
230.8	6406	23.27	2	16
231.2	59650	5.94	2	16
231.3	12614	15.05	2	16
231.7	25264	9.66	2	16
245.1	217	135.53	2	16
245.2	332	111.43	2	16
245.2	784	72.64	2	16
245.2	1340	54.7	2	16
245.2	2579	37.59	2	16
245.6	6407	21.25	2	16
246.1	12611	13.8	2	16
246.4	60942	5.28	2	16
246.5	25259	8.94	2	16
195.9	332	253.99	2	3.98
196.8	783	158.02	2	3.98
198.1	217	314.28	2	3.98
198.1	1341	115.59	2	3.98
199.7	2580	78.2	2	3.98
200.9	6406	45.36	2	3.98
201.3	62925	13.3	2	3.98
201.6	12617	30.5	2	3.98
201.7	25283	20.87	2	3.98
213.5	785	127.56	2	3.98
213.7	332	196.27	2	3.98
214	216	237.43	2	3.98
214.5	1341	95.62	2	3.98
215.3	2579	65.93	2	3.98
216.3	6409	39.04	2	3.98

Temperature (°C)	Apparent Shear Rate (sec <sup>-1</sup> )	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
217	12617	26.49	2	3.98
217.1	25274	18.1	2	3.98
217.6	63887	11.19	2	3.98
229.5	784	107.62	2	3.98
230	217	190.68	2	3.98
230.1	1342	82.15	2	3.98
230.2	332	160.55	2	3.98
230.7	2582	57.64	2	3.98
231.2	59650	10.88	2	3.98
231.7	6406	34.61	2	3.98
232.1	12614	23.55	2	3.98
232.3	25264	16.14	2	3.98
245.4	217	159.54	2	3.98
245.4	332	136.89	2	3.98
245.6	1340	72.25	2	3.98
245.7	784	94.08	2	3.98
246.1	2579	51.25	2	3.98
247	6407	31.04	2	3.98
247.4	60942	9.48	2	3.98
247.6	12611	21.19	2	3.98
247.7	25259	14.48	2	3.98

### Calculated Viscosity Data

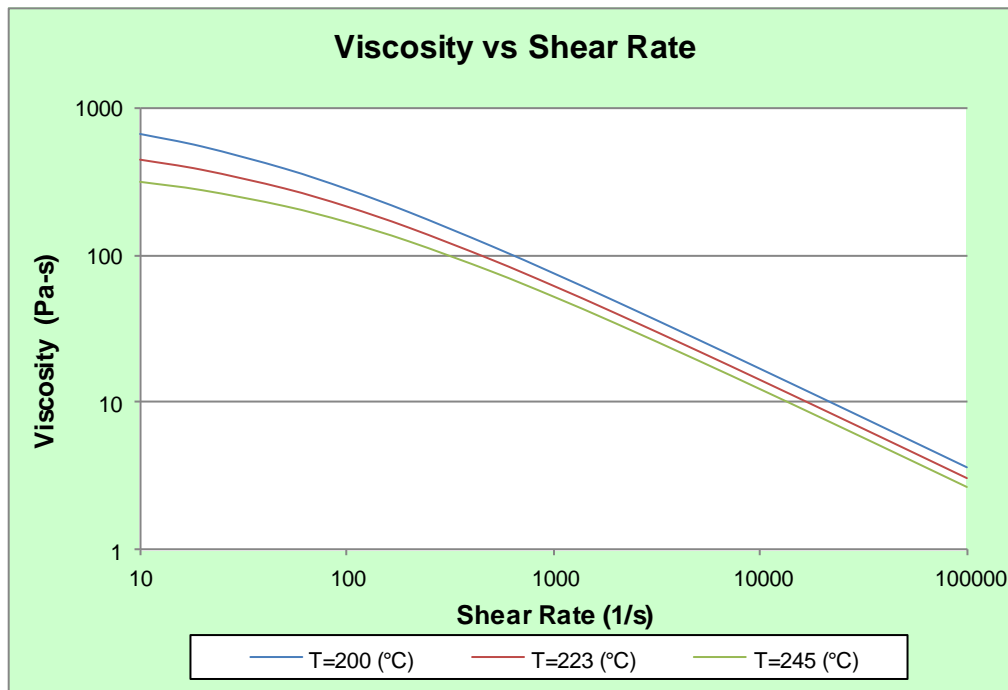
Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
195.9	332	153.77
196.8	783	90.69
198.1	217	191.6
198.1	1341	63.88
199.4	332	148.3
199.5	783	88.42
199.7	2580	41.36
199.8	1341	62.91
199.9	217	187.87
200.3	2580	41.15
200.9	6406	22.57
201.2	6406	22.51
201.3	62925	4.9
201.6	12617	14.32
201.7	25283	9
201.8	12617	14.29
202.1	62925	4.87
202.2	25283	8.96
213.5	785	77.82
213.7	332	128.61
214	216	162.22
214.5	1341	55.47
214.8	785	76.95
214.9	216	160.72
214.9	332	127.13
215.1	1341	55.2
215.3	2579	36.41
215.3	2579	36.41
216	6409	20.04
216.3	6409	20
216.5	12617	12.77
217	25274	8.02
217	12617	12.73
217.1	25274	8.01
217.4	63887	4.3
217.6	63887	4.29
229.5	784	68.13
230	217	137.85
230	784	67.86
230.1	217	137.72
230.1	1342	49.03
230.1	1342	49.03
230.2	2582	32.54
230.2	332	110.21
230.2	332	110.21
230.7	2582	32.43
230.8	6406	18.05
231.2	59650	4.1
231.2	59650	4.1
231.3	12614	11.53
231.7	6406	17.94

Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
231.7	25264	7.25
232.1	12614	11.47
232.3	25264	7.22
245.1	217	119.44
245.2	1340	43.94
245.2	2579	29.37
245.2	332	96.55
245.2	784	60.29
245.4	332	96.39
245.4	217	119.11
245.6	1340	43.82
245.6	6407	16.39
245.7	784	60.06
246.1	2579	29.19
246.1	12611	10.5
246.4	60942	3.68
246.5	25259	6.62
247	6407	16.25
247.4	60942	3.66
247.6	12611	10.4
247.7	25259	6.57

**Rheological Data**

Cross WLF Viscosity Model		
n	0.3250	
Tau	23724.7	Pa
D1	2.07168e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	32.394	
A2	51.600	K

Juncture loss method coefficients		
C1	0.00398	Pa <sup>(1-c2)</sup>
C2	1.678	



# 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

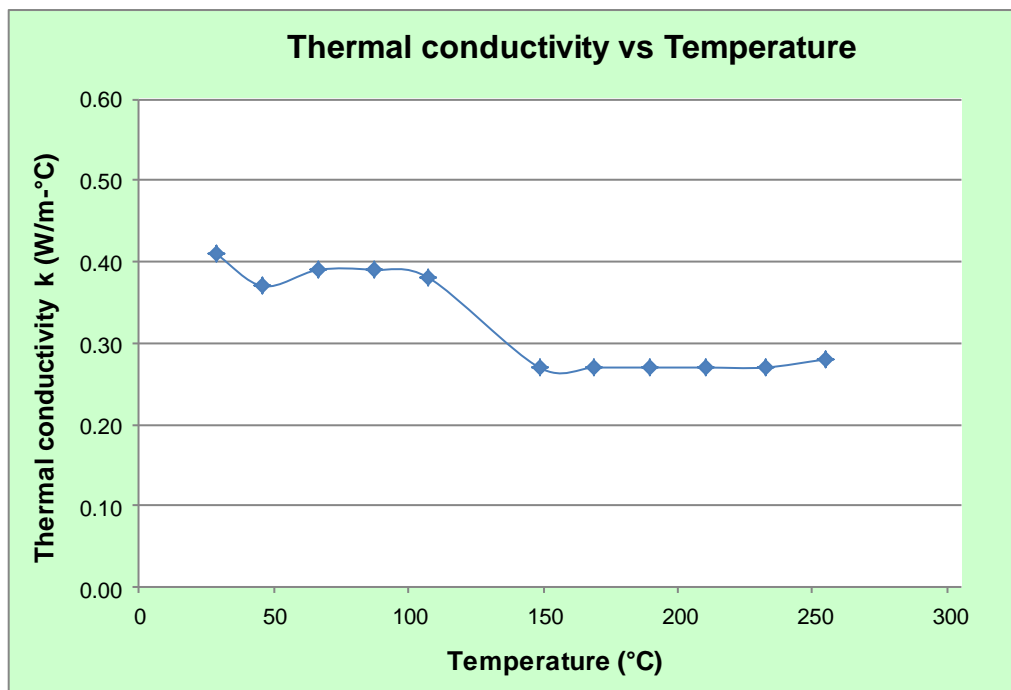
**Test Specifications:**

Sample Form:	Granules
Pre-Processing:	Dried at 65°C for 1 hours in a hopper dryer
Moisture Level:	0.023 %
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:	06-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
254.8	0.282	0.0
232.5	0.272	0.0
210.8	0.274	0.0
189.6	0.272	0.0
169.1	0.274	0.0
148.6	0.272	0.0
107.6	0.379	0.0
86.9	0.392	0.0
66.4	0.388	0.0
46	0.368	0.0
28.4	0.407	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:

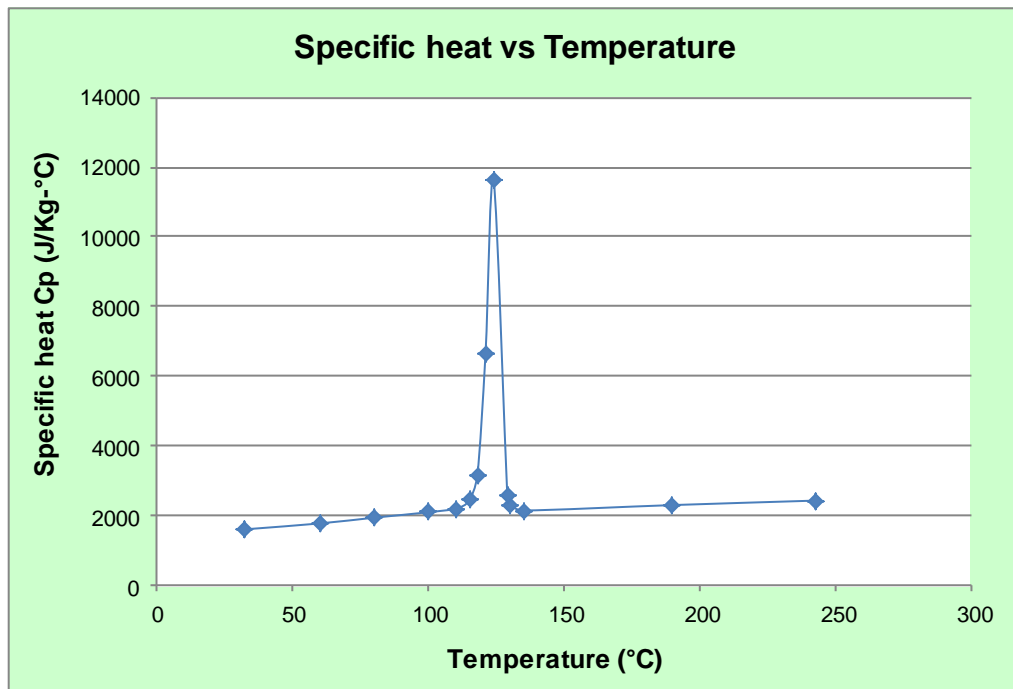
Sample Form:	Granules
Pre-Processing:	Dried at 65°C for 1 hours in a hopper dryer
Moisture Level:	0.023 %
Initial Temperature:	245°C
Final Temperature:	30°C
Cooling Rate:	20°C/min
Equilibrium Time:	2 min
Sample holder material:	Aluminium
Sample holder dimensions:	6.7 mm diameter, 1.6 mm tall
Sample holder 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:	01-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	2436.0	-0.33
190	2307.0	-0.33
135	2153.0	-0.33
130	2307.0	-0.33
129	2605.0	-0.33
124	11601.0	-0.33
121	6667.0	-0.33
118	3176.0	-0.33
115	2446.0	-0.33
110	2209.0	-0.33
100	2102.0	-0.33
80	1946.0	-0.33
60	1781.0	-0.33
32	1609.0	-0.33

Ttrans	128	°C
Ejection temperature	119	°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:	15-APR-16

**Operator's Notes:**

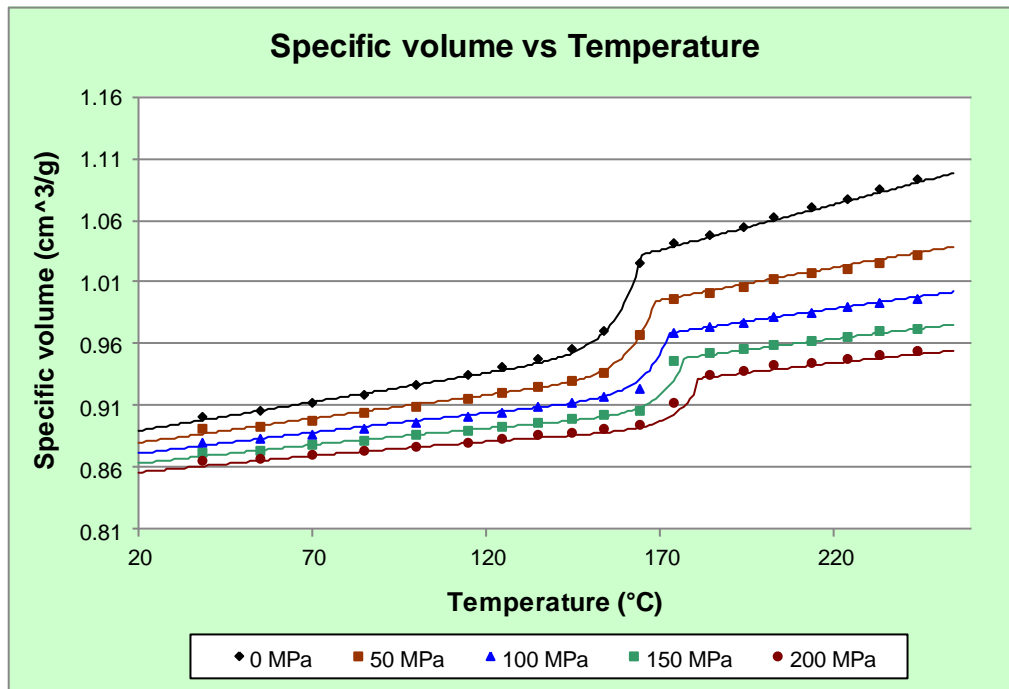
Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

### pvT Experimental Data

Temperature (°C)	Pressure (MPa)				
	0MPa	50MPa	100MPa	150MPa	200MPa
38.4	0.9004	0.8910	0.8805	0.8720	0.8648
55.1	0.9062	0.8936	0.8830	0.8743	0.8666
70	0.9124	0.8985	0.8872	0.8779	0.8698
84.9	0.9190	0.9035	0.8915	0.8816	0.8730
99.7	0.9265	0.9094	0.8963	0.8858	0.8766
114.7	0.9346	0.9157	0.9013	0.8899	0.8803
124.7	0.9406	0.9201	0.9048	0.8930	0.8829
135.2	0.9475	0.9245	0.9088	0.8964	0.8859
144.9	0.9557	0.9296	0.9125	0.8996	0.8887
154.2	0.9703	0.9360	0.9164	0.9023	0.8909
164.4	1.0260	0.9669	0.9235	0.9063	0.8939
174.4	1.0410	0.9964	0.9690	0.9468	0.9117
184.4	1.0480	1.0010	0.9731	0.9523	0.9354
194.4	1.0550	1.0060	0.9769	0.9555	0.9386
203.1	1.0620	1.0120	0.9817	0.9598	0.9424
214.2	1.0700	1.0170	0.9853	0.9629	0.9451
224.1	1.0770	1.0210	0.9890	0.9659	0.9479
233.4	1.0850	1.0260	0.9931	0.9697	0.9511
244.5	1.0930	1.0310	0.9966	0.9724	0.9537

Melt density	0.9301	g/cm <sup>3</sup>
Solid density	1.1202	g/cm <sup>3</sup>

2-domain Tait PVT model coefficients		
b5	438.15	K
b6	7.650e-008	K/Pa
b1m	0.001032	m <sup>3</sup> /Kg
b2m	7.356e-007	m <sup>3</sup> /Kg-K
b3m	9.36189e+007	Pa
b4m	0.004912	1/K
b1s	0.000957	m <sup>3</sup> /Kg
b2s	4.626e-007	m <sup>3</sup> /Kg-K
b3s	1.65096e+008	Pa
b4s	0.005688	1/K
b7	0.000075	m <sup>3</sup> /Kg
b8	0.133374	1/K
b9	1.502e-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 65°C for 1 hours in a hopper dryer
Moisture Level:	0.023 %
Date Molded:	01-APR-16
Post-Processing:	Conditioned at 23°C / 50% relative humidity for 7 days
Date Measured:	08-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	219.9	40.7	36.5	2	25.7	25.1	20
2	220.6	40.7	37.6	2	48.7	25.1	20
3	221.5	40.9	36.5	2	74.2	25.1	20
4	221.0	40.6	18.5	2	48.2	25.1	20
5	221.3	40.9	58.1	2	48.1	25.1	20
6	199.5	39.8	37.6	2	25.6	25.1	20
7	200.0	39.8	37.6	2	49.9	25.1	20
8	200.8	39.8	36.5	2	74.6	25.1	20
9	200.0	39.6	17.8	2	49.4	25.1	20
10	199.8	39.9	58.1	2	48.6	25.1	20
11	243.9	41.3	38.7	2	24.7	25.1	20
12	244.6	41.6	37.6	2	47.3	25.1	20
13	245.2	41.8	36.5	2	72.5	25.1	20
14	244.5	41.4	18.3	2	47.8	25.1	20
15	244.3	41.8	58.1	2	47.3	25.1	20
16	223.0	40.6	11.0	1	56.8	12.1	15
17	223.7	40.9	10.9	1	70.1	12.1	15
18	224.1	40.9	10.9	1	83.5	12.1	15
19	223.7	40.6	4.3	1	71.6	12.1	15
20	223.9	41.2	18.3	1	70.0	12.1	15
21	220.8	42.1	45.7	3	19.7	32.1	20
22	221.1	42.3	43.6	3	39.0	32.1	20
23	215.2	42.6	42.7	3	57.3	32.1	20
24	221.2	42.0	23.4	3	39.0	32.1	20
25	220.1	42.6	71.1	3	39.4	32.1	20

### Part Shrinkage

Process Condition	Average Measured Parallel	Average Measured Perpendicular	Average Predicted Volumetric
1	0.736%	1.106%	5.380%
2	0.656%	0.925%	3.665%
3	0.543%	0.763%	2.373%
4	0.682%	0.972%	3.703%
5	0.643%	0.911%	3.707%
6	0.754%	1.112%	5.532%
7	0.664%	0.925%	3.708%
8	0.566%	0.780%	2.421%
9	0.710%	0.970%	3.721%
10	0.657%	0.908%	3.783%
11	0.732%	1.096%	5.294%
12	0.656%	0.912%	3.670%
13	0.537%	0.764%	2.372%
14	0.664%	0.946%	3.628%
15	0.627%	0.895%	3.637%
16	0.727%	0.858%	5.392%
17	0.666%	0.787%	4.688%
18	0.636%	0.734%	3.709%
19	0.775%	0.835%	1.668%
20	0.634%	0.776%	5.034%
21	0.764%	1.194%	4.734%
22	0.670%	0.969%	3.503%
23	0.576%	0.837%	2.619%
24	0.677%	0.997%	3.571%
25	0.657%	0.953%	3.447%



### Residual Stress Coefficients

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.388824
A2	-0.043945
A3	0.003695
A4	0.630353
A5	-0.266591
A6	0.005053

### Residual Strain Coefficients

Parallel				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.026456	0.01466	0.068109	0.037984
2	0.002272	0.004544	0.67121	0.3016
3	0.000062	7.3838	45.44	16.522
4	3.6283e-009	5395.00	70686.00	22821.00
5	0.003841	0	0	0

Perpendicular				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.10119	0.019006	0.068109	0.038872
2	-0.0002	0.004544	0.67121	0.31367
3	-0.000149	7.3838	31.30	15.574
4	2.0295e-007	1911.00	6151.30	3252.80
5	0.006992	0	0	0

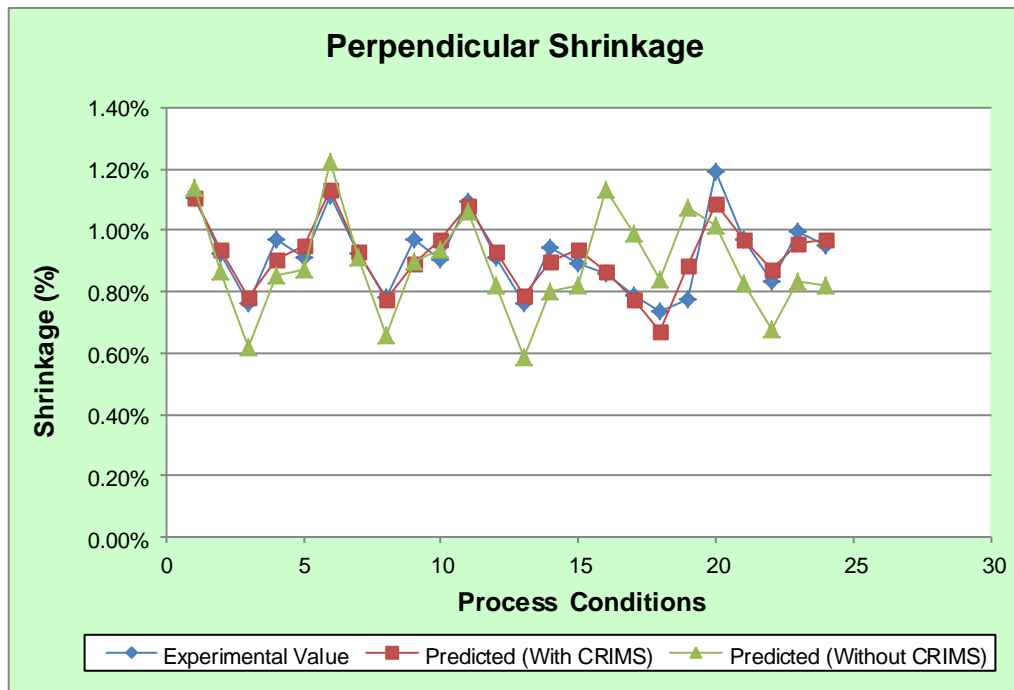
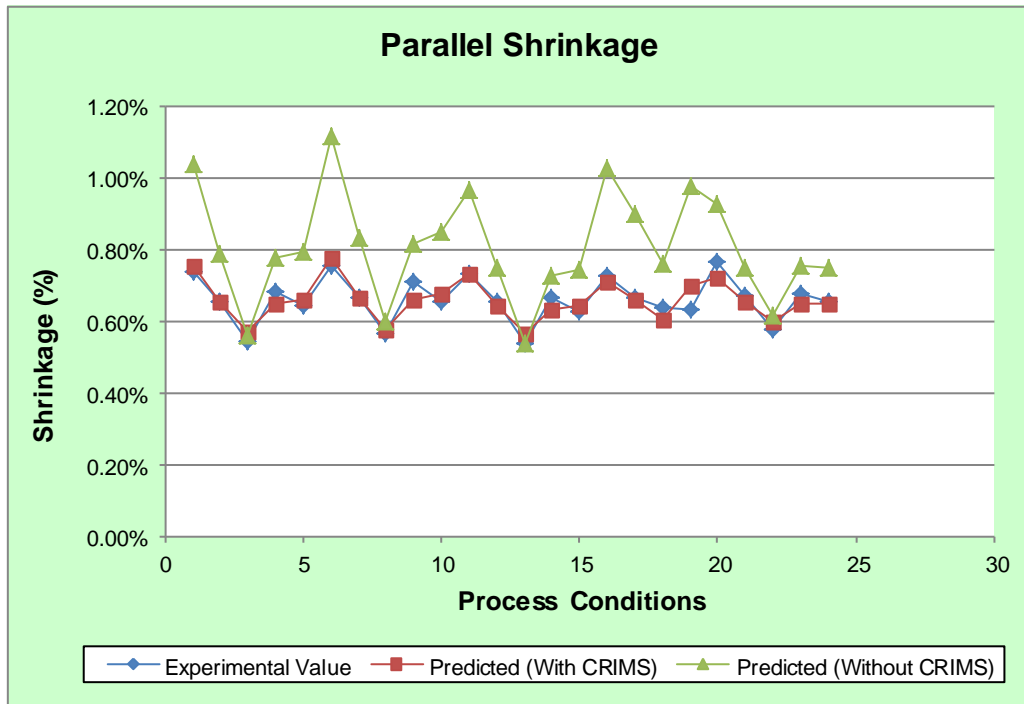
**The shrinkage models shown above are valid for Autodesk Simulation Moldflow Insight 2017. Shrinkage models for previous software versions are included in the .21000.udb file.**

### Observed Shrinkage

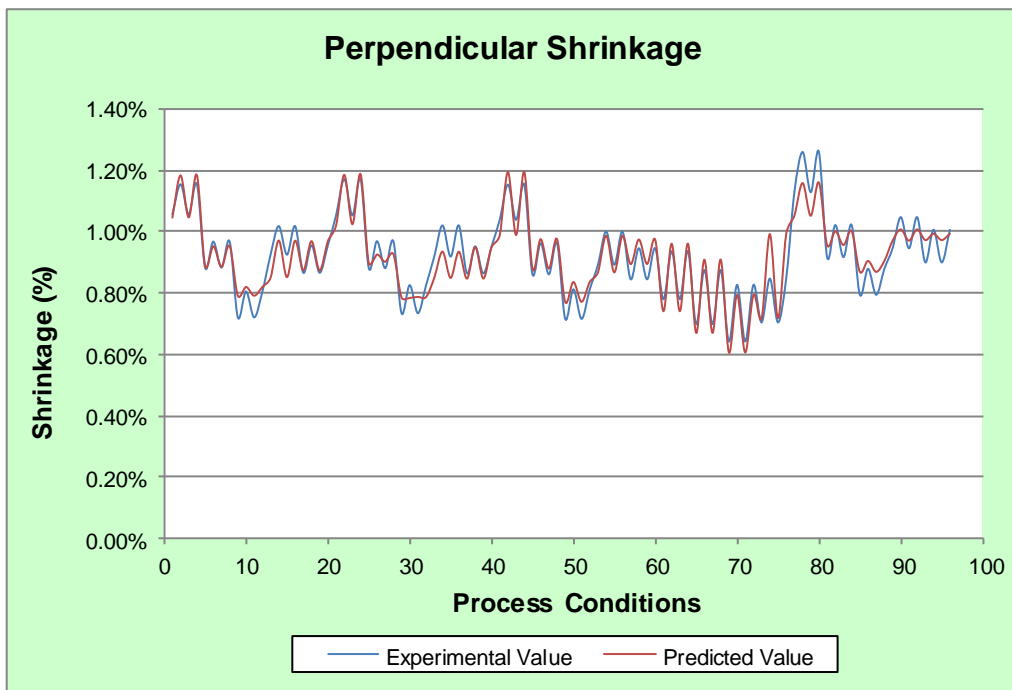
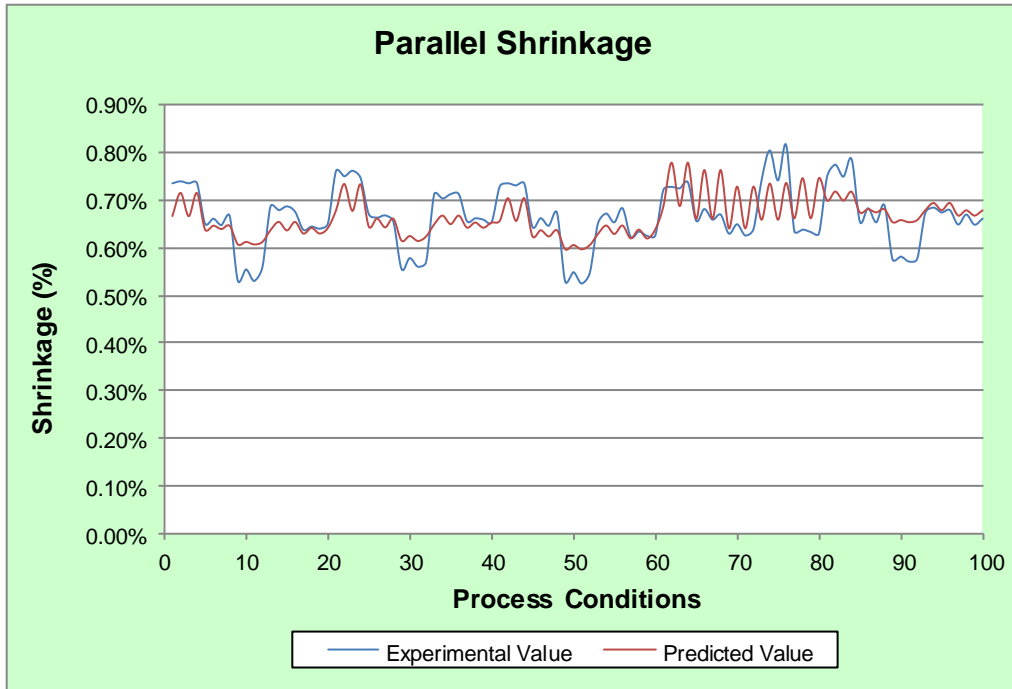
Observed nominal shrinkage	
Parallel	0.664%
Perpendicular	0.917%

Observed shrinkage	
Minimum Parallel	0.537%
Maximum Parallel	0.775%
Minimum Perpendicular	0.734%
Maximum Perpendicular	1.194%

### 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.  
 Isotropic behavior was assumed therefore the value for v12 was used for v23.

Elastic modulus		
Elastic modulus, 1 <sup>st</sup> principal direction [E1]	2710.18	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	2524.06	MPa

Poisson's ratio		
Poisson's ratio [v12]	0.3270	
Poisson's ratio [v23]	0.3270	

## 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]	962.200	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:	14-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	6.570e-005	1/°C
Alpha 2	7.210e-005	1/°C

# Mold verification

**Method:**

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

**Instrument:**

Battenfeld BK-T 1500/400 Injection Molding Machine

**Test Specifications:**

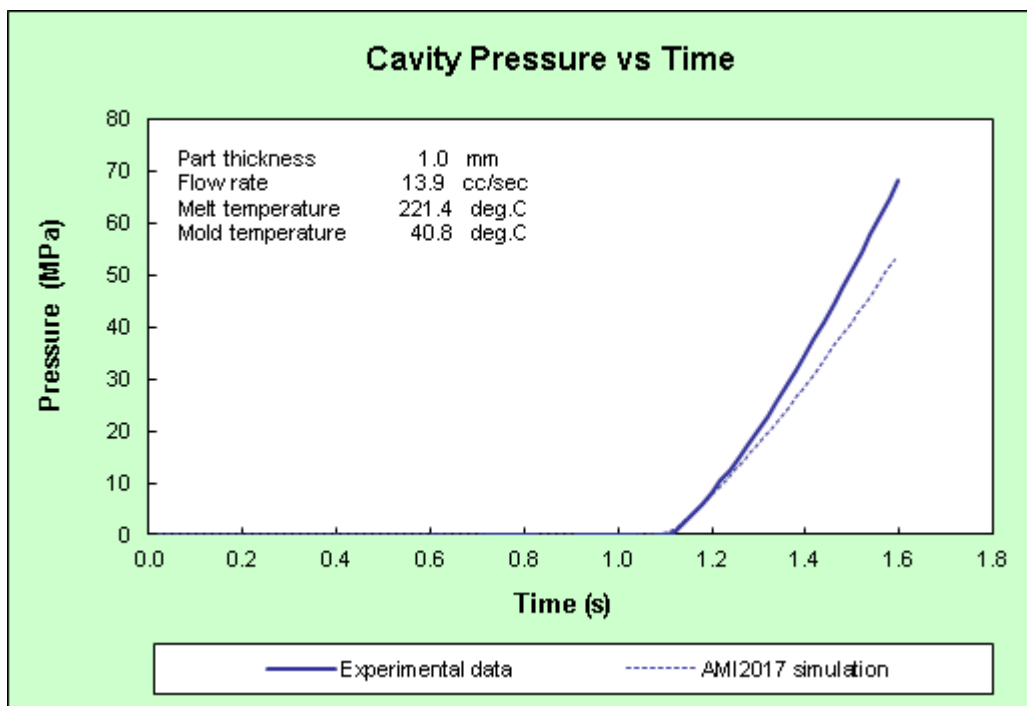
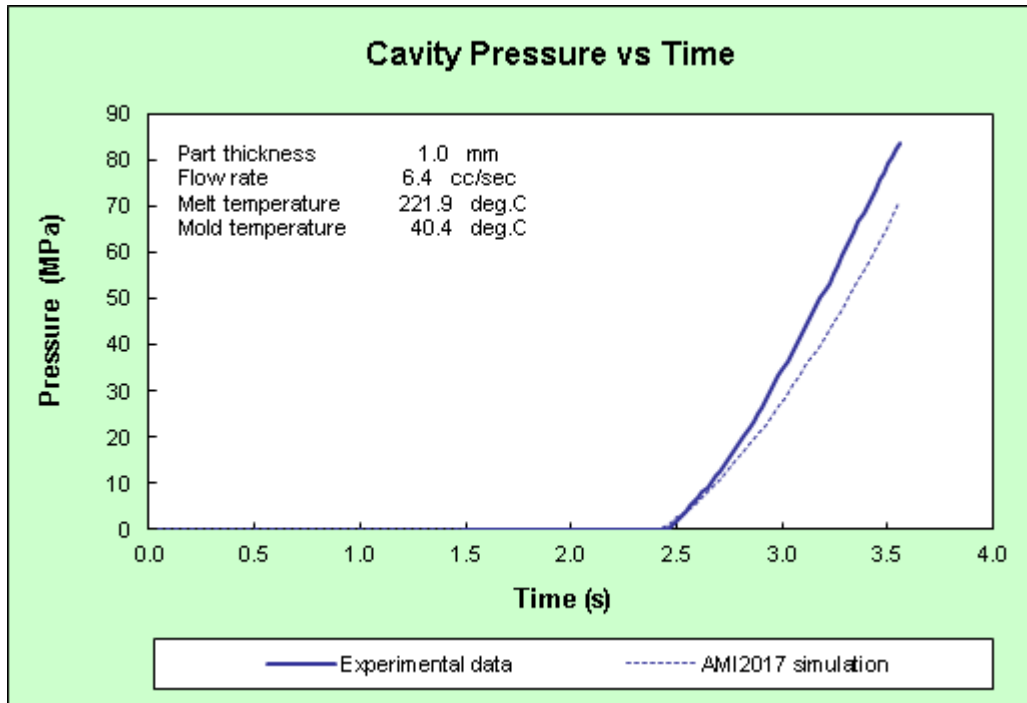
Sample Form:	Granules
Pre-Processing:	Dried at 65°C for 1 hours in a hopper dryer
Moisture Level:	0.023 %
Date Received:	01-FEB-16
Date Tested:	01-APR-16

**Operator's Notes:**

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

**1mm tag die**

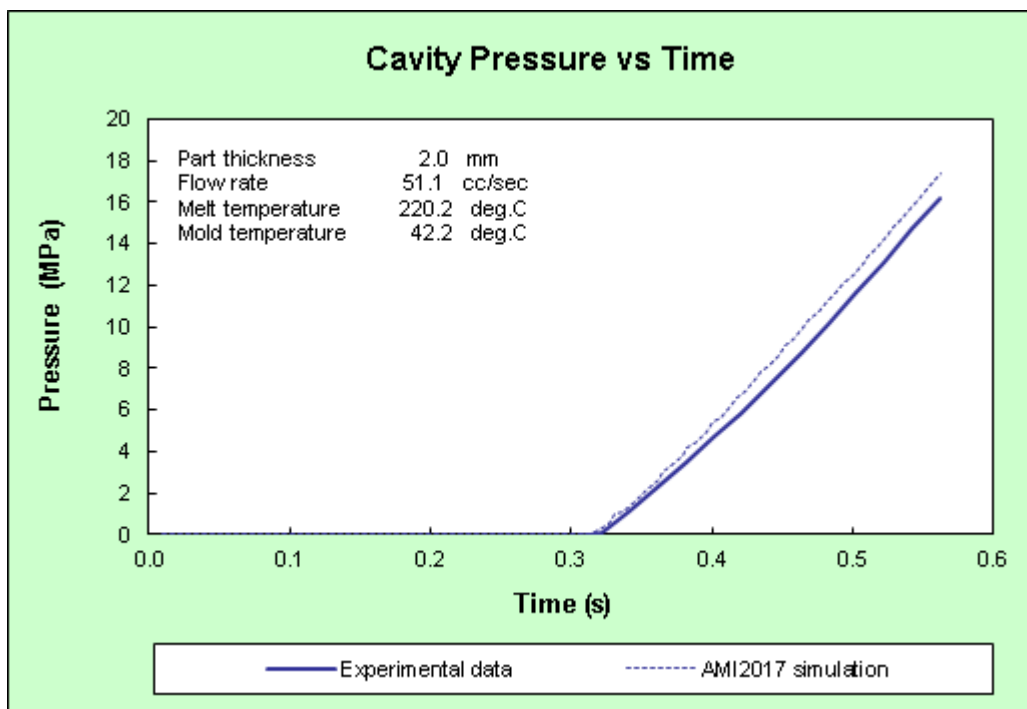
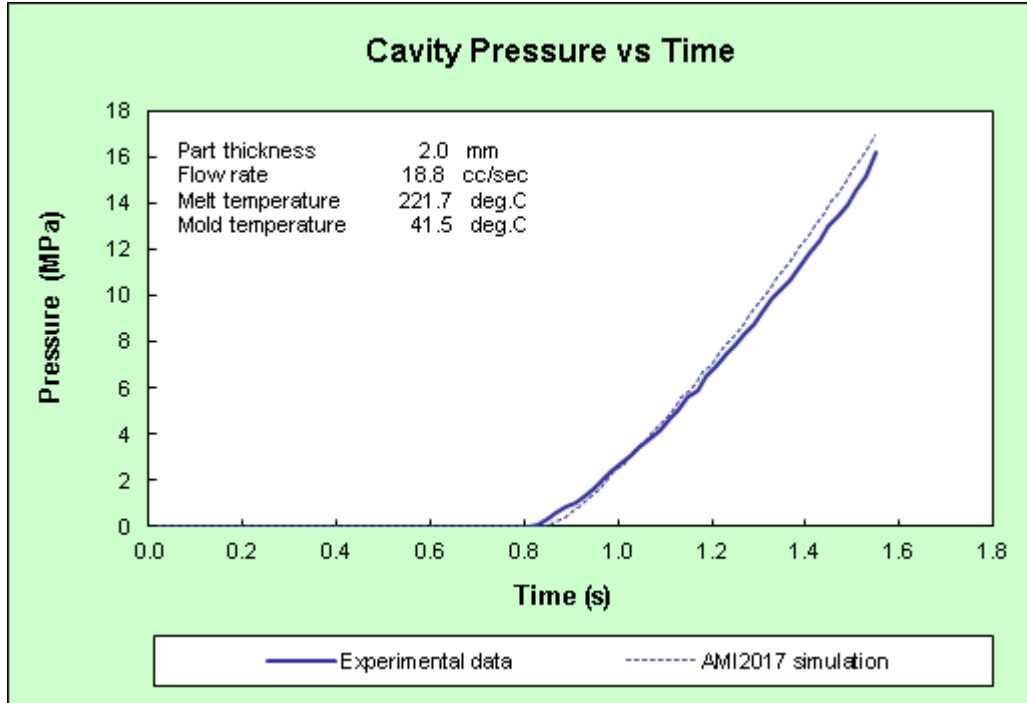
Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0108	6.4	221.9	40.4
Cyc0117	13.9	221.4	40.8





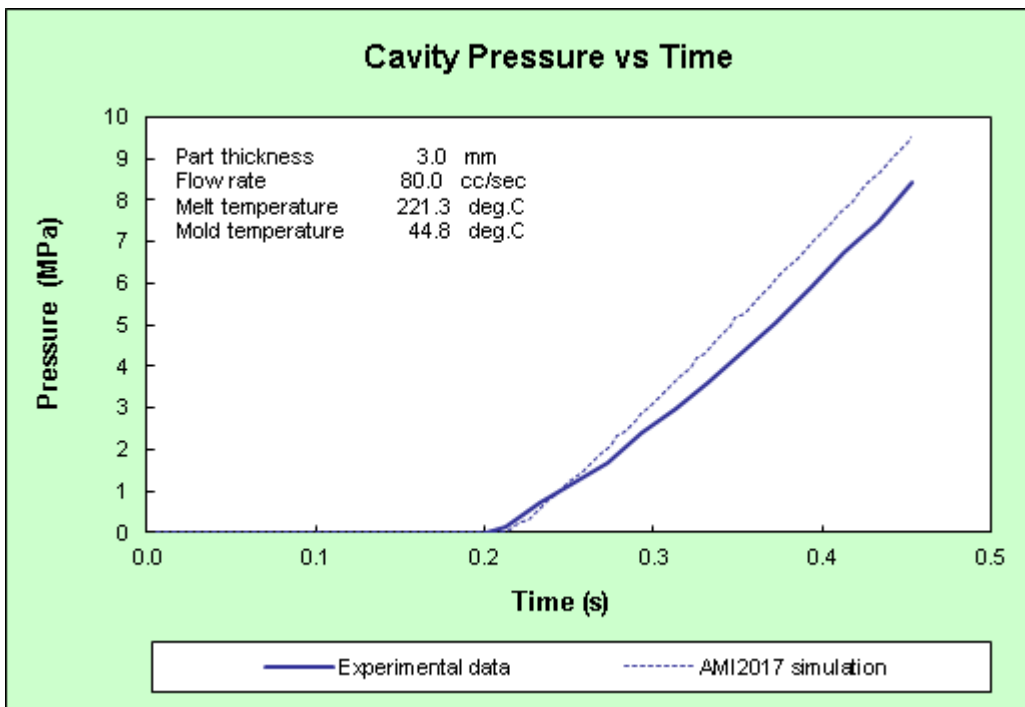
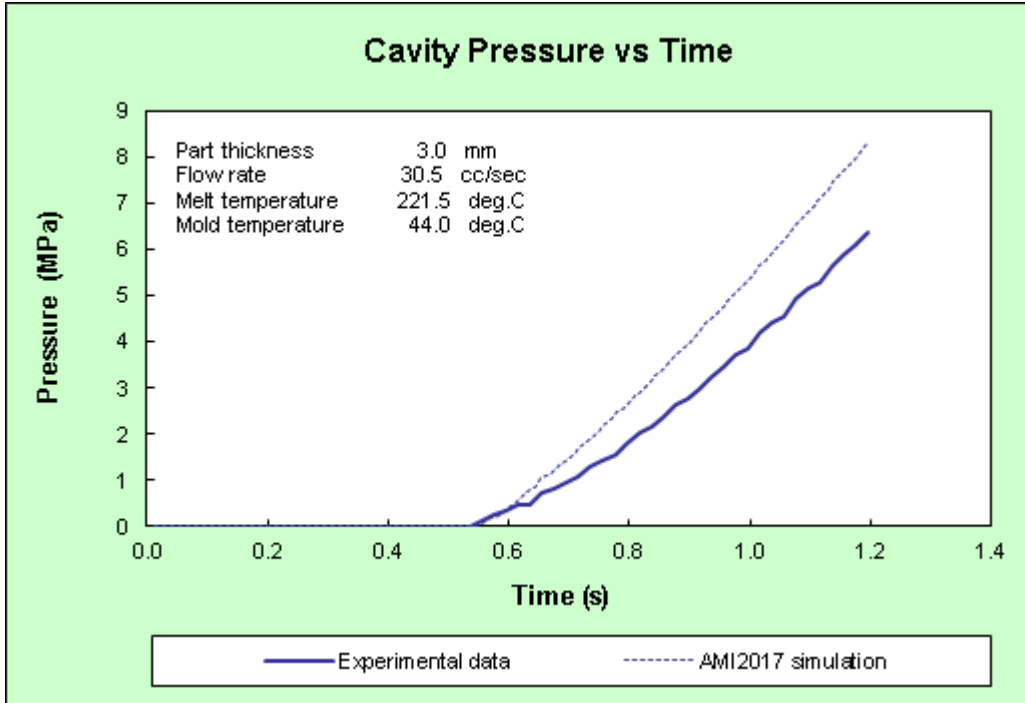
**2mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0014	18.8	221.7	41.5
Cyc0023	51.1	220.2	42.2



**3mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0163	30.5	221.5	44
Cyc0172	80	221.3	44.8



## Contact details

### United States of America

Autodesk Inc.

2353 North Triphammer Road

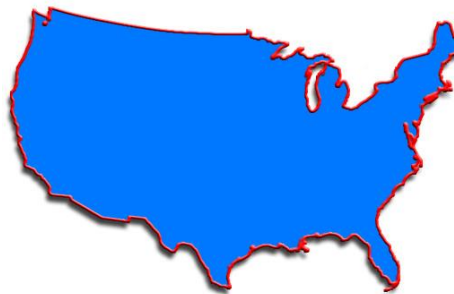
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