

Moldflow Material Testing Report

MAT2215

ISOGLASS H 30 FVL C NAT

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25 August, 2004

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Summary

Description

Family name	POLYPROPYLENES (PP)
Trade name	ISOGLASS H 30 FVL C NAT
Manufacturer	SIRMAX SpA
Family abbreviation	PP
Material structure	Crystalline
Data source	Moldflow Plastics Labs : pvT-Measured : mech-Supplemental
Date last modified	25-Aug-04
Date tested	18-Aug-04
Data status	Non-Confidential
Material ID	20506
Grade code	MAT2215
Supplier code	SIRMAX
Fibers/fillers	30% Glass Filled

Recommended Processing

Mold surface temperature	40	°C
Melt temperature	228	°C

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

Melt temperature range (recommended)		
Minimum	220	°C
Maximum	235	°C

Absolute maximum melt temperature	275	°C
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Ejection temperature	111	°C
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Rheological Properties

Cross WLF Viscosity Model		
n	0.3113	
Tau	8735.07	Pa
D1	5.14252e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	30.000	
A2	51.600	K

Juncture loss method coefficients		
C1	0.99	Pa ^(1-c2)
C2	1.29	

Transition temperature		
Ttrans	123	°C

Moldflow Viscosity Index	VI(240)72	
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Melt mass-flow rate (MFR)		
Temperature	230	°C
Load	2.16	Kg
Measured MFR	6.0	g/10min

Thermal Properties

Specific heat data		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
225	3461.0	-0.33
127	3348.0	-0.33
124	3646.0	-0.33
123	4057.0	-0.33
119	9017.0	-0.33
116	10889.0	-0.33
113	7361.0	-0.33
108	3933.0	-0.33
104	3496.0	-0.33
97	3303.0	-0.33
85	3149.0	-0.33
50	2273.0	-0.33

Thermal conductivity data		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
242.5	0.195	0.0
221.2	0.186	0.0
200.4	0.189	0.0
179.8	0.185	0.0
159.4	0.186	0.0
142.6	0.232	0.0
118.2	0.213	0.0
98.7	0.220	0.0
77.5	0.210	0.0
58.2	0.214	0.0
38.6	0.234	0.0

PVT Properties

Melt density	0.9373	g/cm ³
Solid density	1.1176	g/cm ³

2-domain Tait PVT model coefficients		
b5	433.15	K
b6	6.500e-008	K/Pa
b1m	0.001014	m ³ /Kg
b2m	7.740e-007	m ³ /Kg-K
b3m	9.68283e+007	Pa
b4m	0.005482	1/K
b1s	0.000929	m ³ /Kg
b2s	2.538e-007	m ³ /Kg-K
b3s	1.93166e+008	Pa
b4s	0.004682	1/K
b7	0.000085	m ³ /Kg
b8	0.08227	1/K
b9	8.313e-009	1/Pa

Mechanical Properties

Mechanical properties data		
Elastic modulus, 1 st principal direction [E1]	5157.67	MPa
Elastic modulus, 2 nd principal direction [E2]	2737.29	MPa
Poissons ratio [v12]	0.4371	
Poissons ratio [v23]	0.4615	
Shear modulus [G12]	1218.98	MPa

Transversely isotropic coefficient of thermal expansion [CTE] data		
Alpha1	3.040e-005	1/C
Alpha2	5.810e-005	1/C

Mechanical and CTE data have not been tested for this material. The data has been supplemented with generic estimates for 30% Glass filled PP.

Shrinkage Properties

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.348641
A2	-0.011852
A3	0.001193
A4	0.793762
A5	-0.263921
A6	0.006323

Residual strain model coefficients		
	Parallel	Perpendicular
A1	0.012061	0.13476
A2	0.000452	-0.000907
A3	6.3552e-006	-1.6839e-006
A4	-1.1942e-008	5.0223e-007
A5	0.001115	0.003109

These shrinkage models are valid for Moldflow Plastics Insight™ 5 only. Shrinkage models for previous software versions are available upon request.

Filler Properties

Filler data	
Description	Weight %
Glass	30

Viscosity

Method:

MPL Viscosity Test Method (QOP-14-M)

Instrument:

Arburg Allrounder 270S Injection Molding Machine

Test Specifications:

Sample Form:	Granules
Pre-Processing:	Not required
Moisture Level:	Not measured
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 Tested:	12-Aug-04

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 ⁻¹)	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
207.1	64350	9.97	2	16
207.6	255	335.53	2	16
207.6	318	304.74	2	16
207.8	6494	38.56	2	16
208.3	815	158.34	2	16
208.3	2636	71.89	2	16
208.3	25643	16.25	2	16
209.6	12732	24.7	2	16
210.7	1375	111.55	2	16
215.8	64019	8.86	2	16
217.1	25554	14.69	2	16
217.7	369	247.48	2	16
217.8	6494	36.32	2	16
218	242	329.3	2	16
218.3	815	147.22	2	16
218.7	2648	67.65	2	16
218.9	12707	22.88	2	16
219.1	1375	103.6	2	16
226.5	255	294.43	2	16
226.6	63980	8.09	2	16
227.4	6494	34.57	2	16
227.8	25618	13.53	2	16
228	369	231.4	2	16
228.2	815	138.78	2	16
228.3	2636	63.42	2	16
228.4	12720	21.7	2	16
229.2	1413	96.27	2	16
235	64286	7.35	2	16
236.6	242	284.75	2	16
237.2	2636	60.45	2	16
237.3	25630	12.69	2	16
237.6	6481	32.73	2	16
237.7	357	222.14	2	16
237.8	12732	20.48	2	16
238.2	815	130.54	2	16
239.7	1375	93.71	2	16
216.2	64350	21.61	2	3.98
217.4	25643	34.38	2	3.98
217.5	12732	50.66	2	3.98
217.6	255	630.78	2	3.98
218.3	2636	139.27	2	3.98
218.8	6494	76.91	2	3.98
219.3	318	577.56	2	3.98
221	815	290.29	2	3.98
223.3	1375	193.92	2	3.98
227.6	2648	130.78	2	3.98
227.7	242	609.51	2	3.98
227.9	12707	47.3	2	3.98

Temperature (°C)	Apparent Shear Rate (sec ⁻¹)	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
228.1	25554	31.28	2	3.98
228.1	64019	20.04	2	3.98
229.1	6494	72.37	2	3.98
229.3	369	467.31	2	3.98
229.8	815	274.89	2	3.98
233.4	1375	188.9	2	3.98
237.9	63980	17.78	2	3.98
238.3	25618	28.8	2	3.98
238.5	2636	123.56	2	3.98
239	6494	68.22	2	3.98
239.4	12720	43.75	2	3.98
239.6	369	426.52	2	3.98
239.8	255	542.08	2	3.98
240.6	815	258.72	2	3.98
243.7	1413	173.59	2	3.98
248.5	6481	65.16	2	3.98
249.1	64286	16.42	2	3.98
249.2	2636	118.56	2	3.98
249.3	242	547.26	2	3.98
249.3	25630	26.83	2	3.98
249.8	357	420.64	2	3.98
250	12732	41.3	2	3.98
250.1	815	245.63	2	3.98
252	1375	172.02	2	3.98

Calculated Viscosity Data

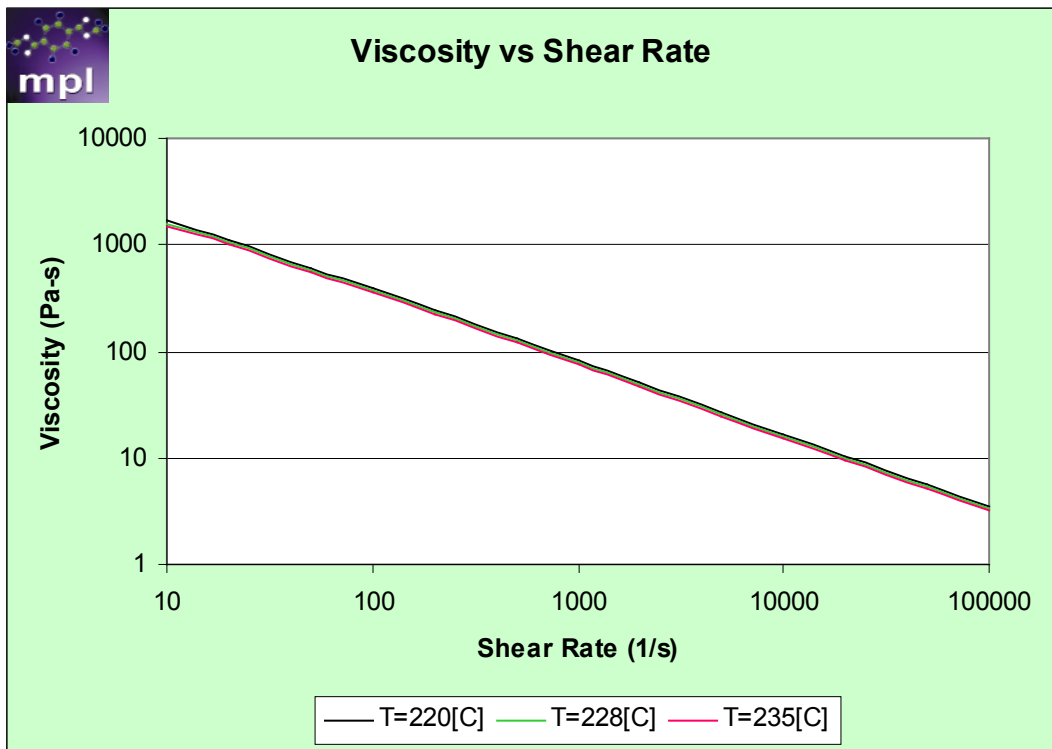
Temperature (°C)	Shear Rate (sec ⁻¹)	Calculated Viscosity (Pa-s)
207.1	64350	5.07
207.6	255	224.70
207.6	318	193.41
207.8	6494	24.46
208.3	815	101.30
208.3	25643	9.48
208.3	2636	45.30
209.6	12732	15.21
210.7	1375	69.69
215.8	64019	4.81
216.2	64350	4.78
217.1	25554	8.98
217.4	25643	8.94
217.5	12732	14.47
217.6	255	210.27
217.7	369	163.55
217.8	6494	22.94
218	242	217.29
218.3	815	94.94
218.3	2636	42.49
218.7	2648	42.25
218.8	6494	22.80
218.9	12707	14.36
219.1	1375	66.05
219.3	318	179.10
221	815	93.36
223.3	1375	64.38
226.5	255	198.93
226.6	63980	4.51
227.4	6494	21.66
227.6	2648	40.05
227.7	242	204.59
227.8	25618	8.41
227.9	12707	13.61
228	369	153.52
228.1	25554	8.41
228.1	64019	4.47
228.2	815	89.42
228.3	2636	40.02
228.4	12720	13.56
229.1	6494	21.45
229.2	1413	61.03
229.3	369	152.34
229.8	815	88.59
233.4	1375	60.71
235	64286	4.29
236.6	242	194.22
237.2	2636	38.07
237.3	25630	7.97
237.6	6481	20.48

Temperature (°C)	Shear Rate (sec ⁻¹)	Calculated Viscosity (Pa-s)
237.7	357	148.46
237.8	12732	12.86
237.9	63980	4.23
238.2	815	84.50
238.3	25618	7.93
238.5	2636	37.80
239	6494	20.30
239.4	12720	12.76
239.6	369	143.65
239.7	1375	58.64
239.8	255	184.15
240.6	815	83.40
243.7	1413	56.34
248.5	6481	19.35
249.1	64286	3.98
249.2	2636	35.74
249.3	25630	7.49
249.3	242	181.17
249.8	357	139.10
250	12732	12.08
250.1	815	79.35
252	1375	55.02

Rheological Data

Cross WLF Viscosity Model		
n	0.3113	
Tau	8735.07	Pa
D1	5.14252e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	30.000	
A2	51.600	K

Juncture loss method coefficients		
C1	0.99	Pa ^(1-c2)
C2	1.29	



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

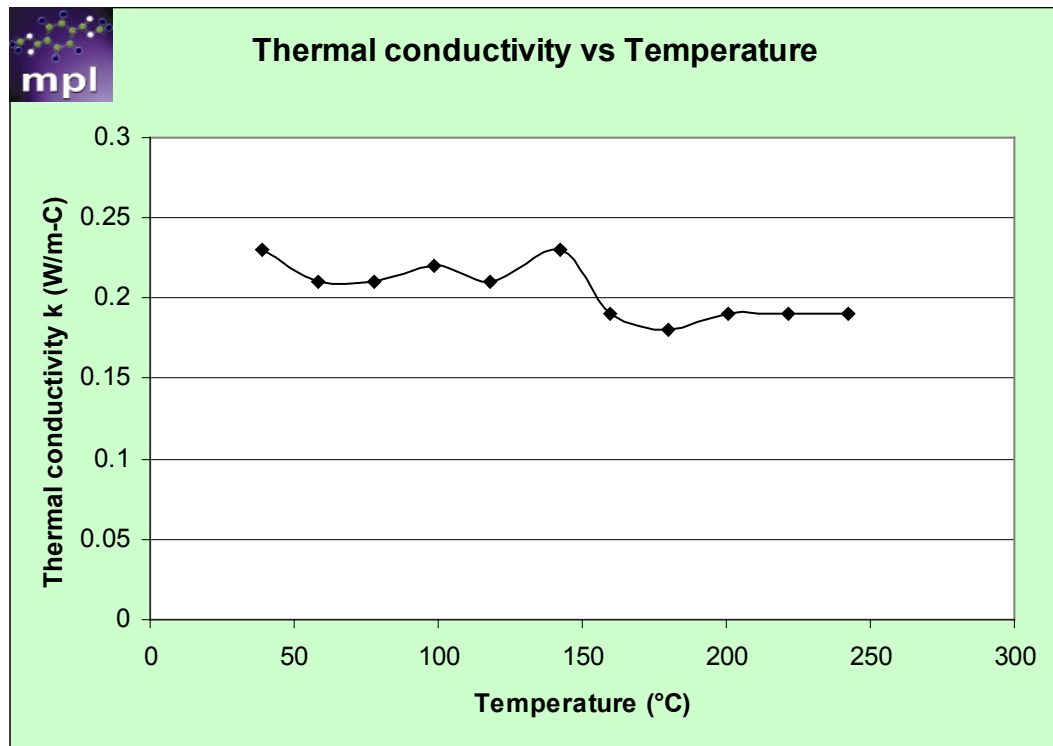
Test Specifications:

Sample Form:	Granules
Pre-Processing:	Not required
Moisture Level:	Not measured
Probe Constant:	0.831
Probe Length:	50 mm
Data acquisition time:	45 sec
Probe Voltage:	3.0 V
Date Tested:	12-Aug-04

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
242.5	0.195	0.0
221.2	0.186	0.0
200.4	0.189	0.0
179.8	0.185	0.0
159.4	0.186	0.0
142.6	0.232	0.0
118.2	0.213	0.0
98.7	0.220	0.0
77.5	0.210	0.0
58.2	0.214	0.0
38.6	0.234	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 of Polymers by Differential Scanning Calorimetry

ASTM D 3417, Standard Test Method for Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry (DSC)

Instrument:

Perkin Elmer DSC-7 Differential Scanning Calorimeter

Test Specifications:

Sample Form:	Granules
Pre-Processing:	Not required
Moisture Level:	Not measured
Initial Temperature:	240°C
Final Temperature:	50°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 ³ /sec
Date Tested:	12-Aug-04

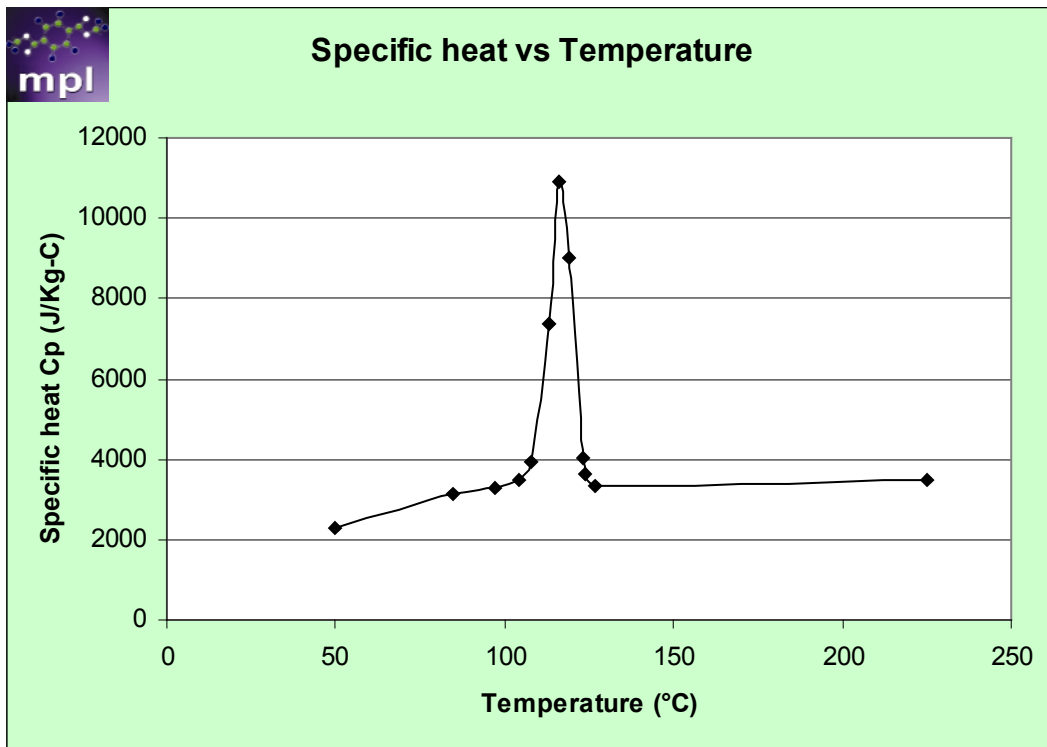
Operator's Notes:

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
225	3461.0	-0.33
127	3348.0	-0.33
124	3646.0	-0.33
123	4057.0	-0.33
119	9017.0	-0.33
116	10889.0	-0.33
113	7361.0	-0.33
108	3933.0	-0.33
104	3496.0	-0.33
97	3303.0	-0.33
85	3149.0	-0.33
50	2273.0	-0.33

Ttrans	123	°C
Ejection temperature	111	°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 Tested:	18-Aug-04

Operator's Notes:

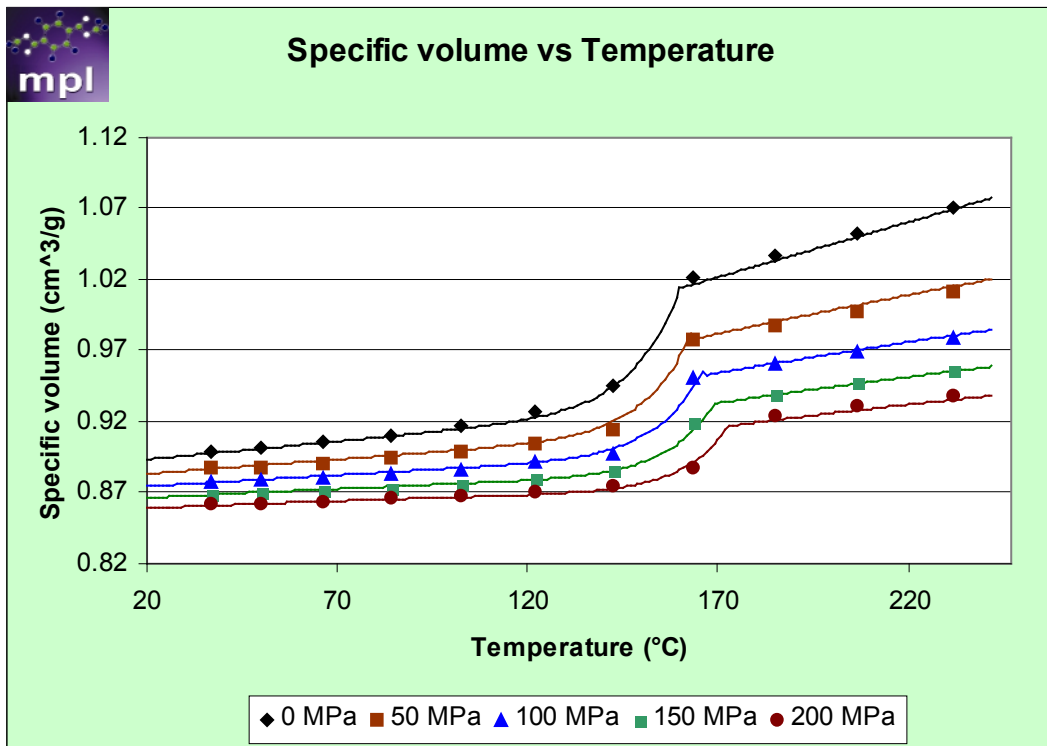
Testing was performed per standard testing procedures.
No anomalies were noted during the course of testing.

pvT Experimental Data

Temperature (°C)	Pressure (MPa)				
	0 MPa	50 MPa	100 MPa	150 MPa	200 MPa
36.61	0.8990	0.8872	0.8774	0.8694	0.8622
50.1	0.9014	0.8883	0.8785	0.8704	0.8627
66.25	0.9055	0.8910	0.8807	0.8721	0.8642
83.99	0.9108	0.8944	0.8831	0.8742	0.8659
102.7	0.9176	0.8987	0.8864	0.8769	0.8681
122.2	0.9275	0.9049	0.8912	0.8805	0.8712
142.5	0.9451	0.9150	0.8980	0.8856	0.8752
163.6	1.0210	0.9771	0.9506	0.9200	0.8875
185.1	1.0370	0.9878	0.9602	0.9401	0.9236
206.7	1.0530	0.9979	0.9688	0.9477	0.9306
231.5	1.0710	1.0120	0.9798	0.9566	0.9379

Melt density	0.9373	g/cm ³
Solid density	1.1176	g/cm ³

2-domain Tait PVT model coefficients		
b5	433.15	K
b6	6.500e-008	K/Pa
b1m	0.001014	m ³ /Kg
b2m	7.740e-007	m ³ /Kg-K
b3m	9.68283e+007	Pa
b4m	0.005482	1/K
b1s	0.000929	m ³ /Kg
b2s	2.538e-007	m ³ /Kg-K
b3s	1.93166e+008	Pa
b4s	0.004682	1/K
b7	0.000085	m ³ /Kg
b8	0.08227	1/K
b9	8.313e-009	1/Pa



Shrinkage

Method:

MPL 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:	Not required
Moisture Level:	Not measured
Date Molded:	12-AUG-04
Post-Processing:	Conditioned at 23°C / 50% relative humidity for 7 days
Date Measured:	19-AUG-04
Shrinkage Data Correlated With:	Moldflow Plastics Insight™ 5
Default Model:	Residual Stress (CRIMS)

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.

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	230.6	43.6	46.6	2	11.5	10	15
2	230.1	43.1	60.2	2	11.6	10	15
3	229.7	43.1	78.7	2	11.6	10	15
4	228.8	43.1	24.8	2	11.6	10	15
5	229.2	43.6	12.6	2	11.6	10	15
6	230.1	43.9	46.8	2	11.6	10	22.5
7	229.7	42.3	46.8	2	11.6	10	30
8	229.7	43.1	46.0	2	36.9	10	15
9	231.0	43.6	46.5	2	61.7	10	15
10	229.2	43.1	46.8	2	89.3	10	15
11	230.1	43.6	60.2	2	89.5	10	15
12	230.1	43.6	84.3	2	89.4	10	15
13	231.0	43.6	24.8	2	88.5	10	15
14	229.7	43.6	11.4	2	89.5	10	15
15	230.1	43.1	42.1	2	89.6	10	22.5
16	229.7	43.6	46.8	2	89.6	10	30
17	219.2	43.1	46.8	2	89.4	10	15
18	221.0	43.9	46.8	2	11.7	10	15
19	236.5	43.6	46.8	2	11.9	10	15
20	237.9	44.4	46.8	2	11.9	10	15
21	231.0	58.7	46.8	2	89.9	10	15
22	229.2	58.3	46.8	2	12.1	10	15
23	230.6	44.4	25.7	1.1	91.3	5	15
24	230.6	43.9	25.7	1.1	15.5	5	15
25	229.7	45.6	58.8	3	91.2	20	15
26	230.6	45.2	51.4	3	12.2	20	15
27	226.9	43.9	61.2	5	90.1	35	15
28	227.9	43.6	69.8	5	11.1	35	15

Part Shrinkage

Process Condition	Average Measured Parallel	Average Measured Perpendicular	Maximum Predicted Volumetric
1	0.19%	1.33%	7.79%
2	0.18%	1.33%	7.77%
3	0.18%	1.26%	7.79%
4	0.19%	1.41%	7.77%
5	0.19%	1.49%	7.63%
6	0.20%	1.35%	7.77%
7	0.19%	1.34%	7.80%
8	0.18%	1.14%	4.52%
9	0.17%	0.95%	3.32%
10	0.12%	0.76%	1.97%
11	0.13%	0.74%	1.95%
12	0.12%	0.73%	1.95%
13	0.13%	0.83%	1.94%
14	0.14%	0.85%	1.79%
15	0.12%	0.75%	1.94%
16	0.11%	0.74%	1.92%
17	0.13%	0.75%	1.96%
18	0.18%	1.31%	7.84%
19	0.17%	1.31%	7.52%
20	0.19%	1.34%	7.52%
21	0.12%	0.75%	2.03%
22	0.21%	1.36%	7.36%
23	0.12%	0.90%	3.80%
24	0.17%	1.23%	8.86%
25	0.12%	0.73%	3.89%
26	0.19%	1.32%	5.62%
27	0.13%	0.97%	3.69%
28	0.21%	1.55%	8.03%

Residual Stress Coefficients

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.348641
A2	-0.011852
A3	0.001193
A4	0.793762
A5	-0.263921
A6	0.006323

Residual Strain Coefficients

Parallel				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.012061	0.008018	0.088617	0.043118
2	0.000452	0.043473	0.53199	0.4137
3	6.3552e-006	3.1066	22.073	10.245
4	-1.1942e-008	4635.60	61147.00	22649.00
5	0.001115	0	0	0

Perpendicular				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.13476	0.008018	0.080267	0.042504
2	-0.000907	0.043473	0.53199	0.4241
3	-1.6839e-006	3.1066	21.096	10.186
4	5.0223e-007	1426.50	9281.10	5143.80
5	0.003109	0	0	0

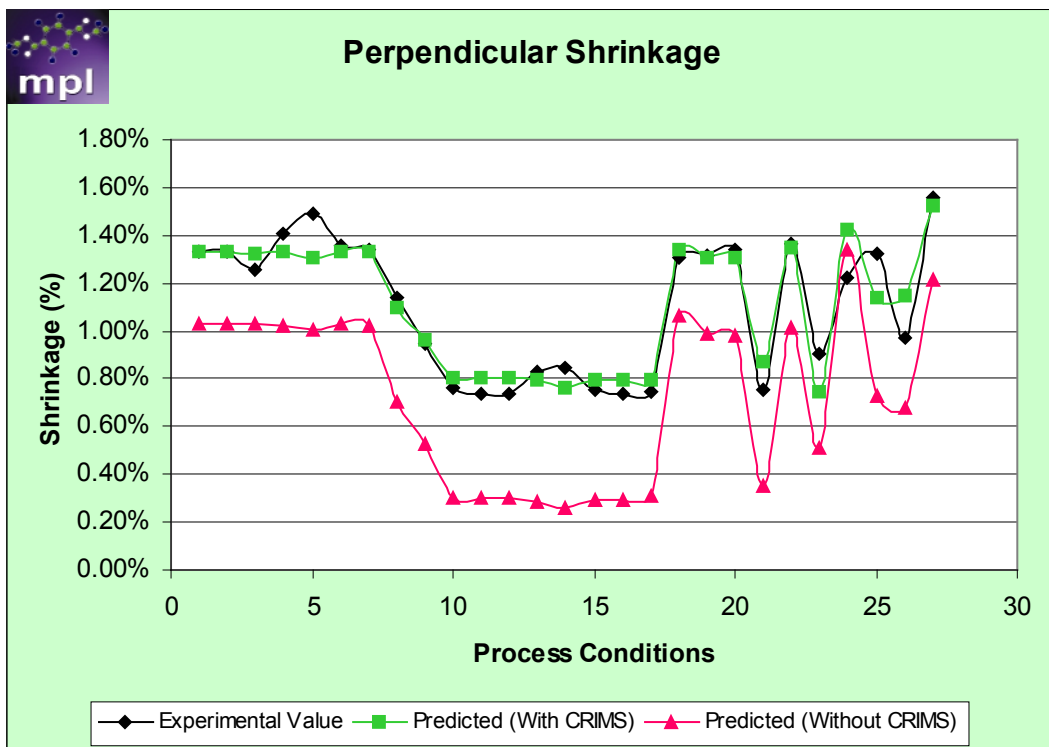
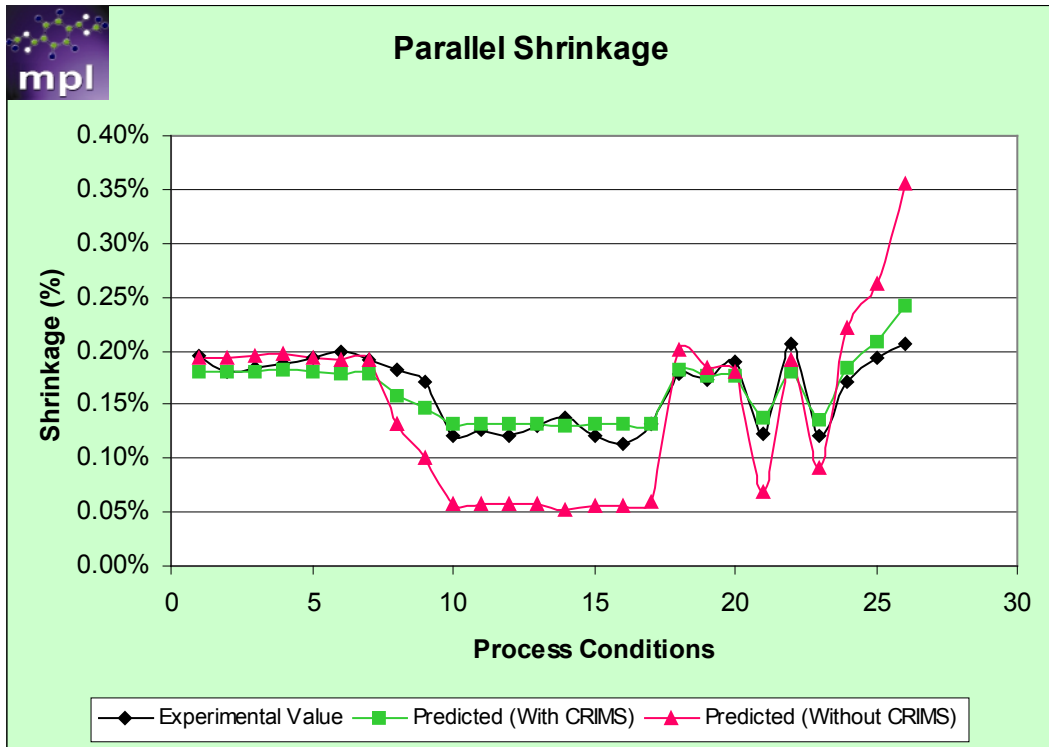
These shrinkage models are valid for Moldflow Plastics Insight™ 5 only. Shrinkage models for previous software versions are available upon request.

Observed Shrinkage

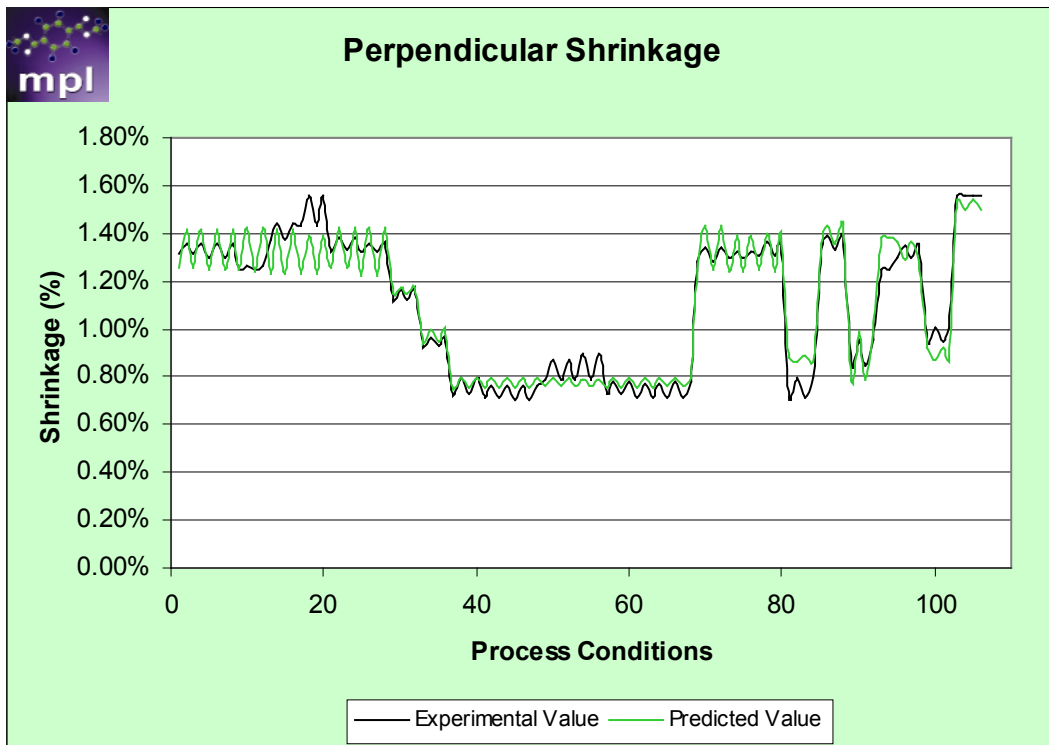
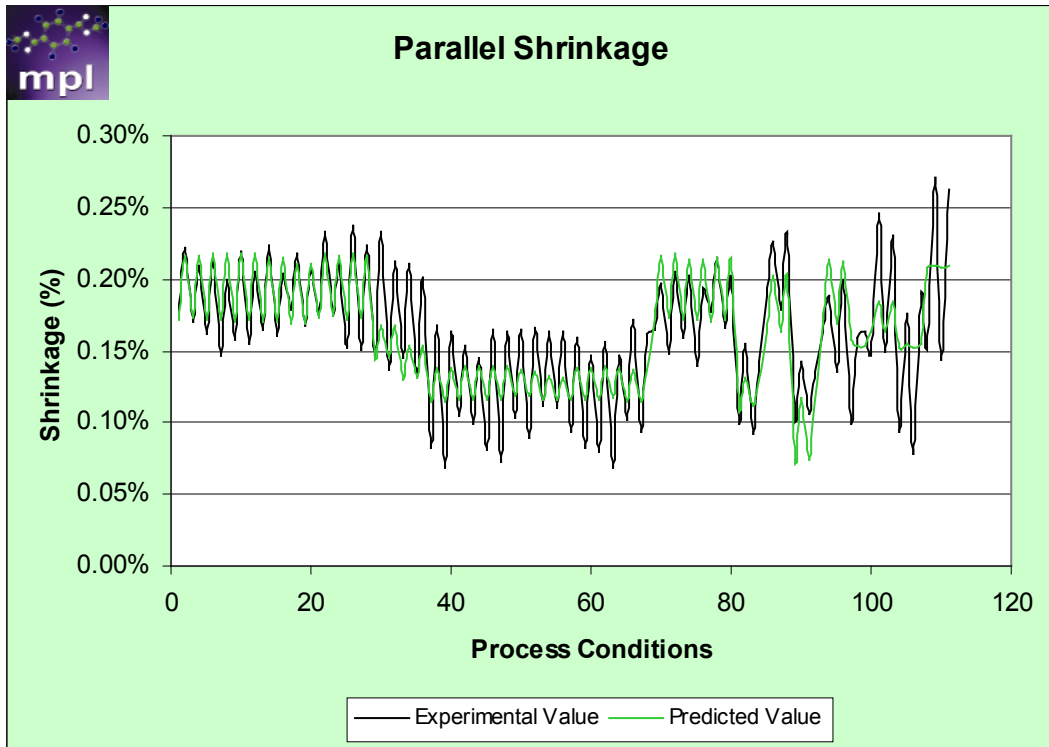
Observed nominal shrinkage	
Parallel	0.161%
Perpendicular	1.057%

Observed shrinkage	
Minimum Parallel	0.113%
Maximum Parallel	0.207%
Minimum Perpendicular	0.730%
Maximum Perpendicular	1.407%

Residual Stress Plots



Residual Strain Plots



Mold verification

Method:

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

Instrument:

Battenfeld BK-T 1500/400 Injection Molding Machine

Test Specifications:

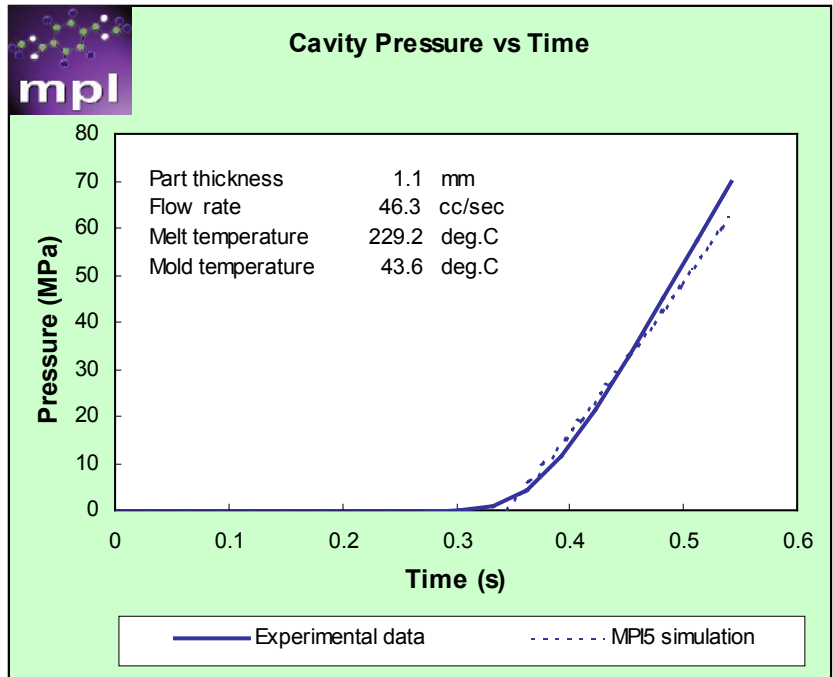
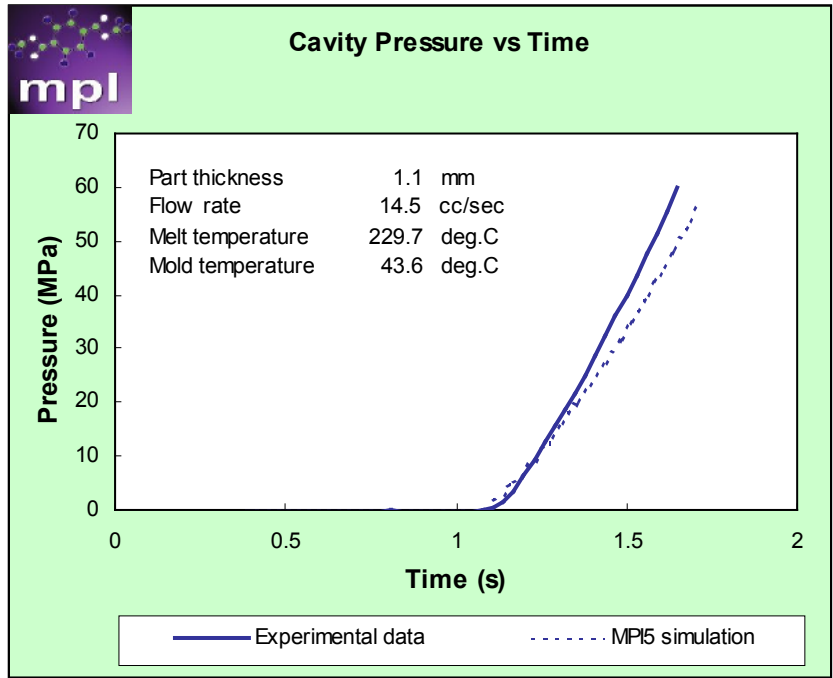
Sample Form:	Granules
Pre-Processing:	Not required
Moisture Level:	Not measured
Date Tested:	12-AUG-04

Operator's Notes:

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

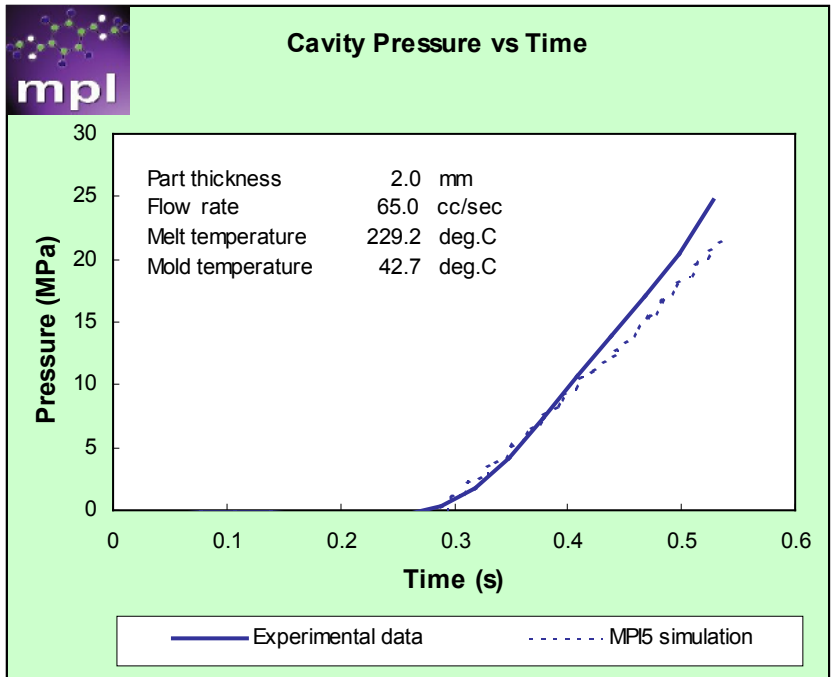
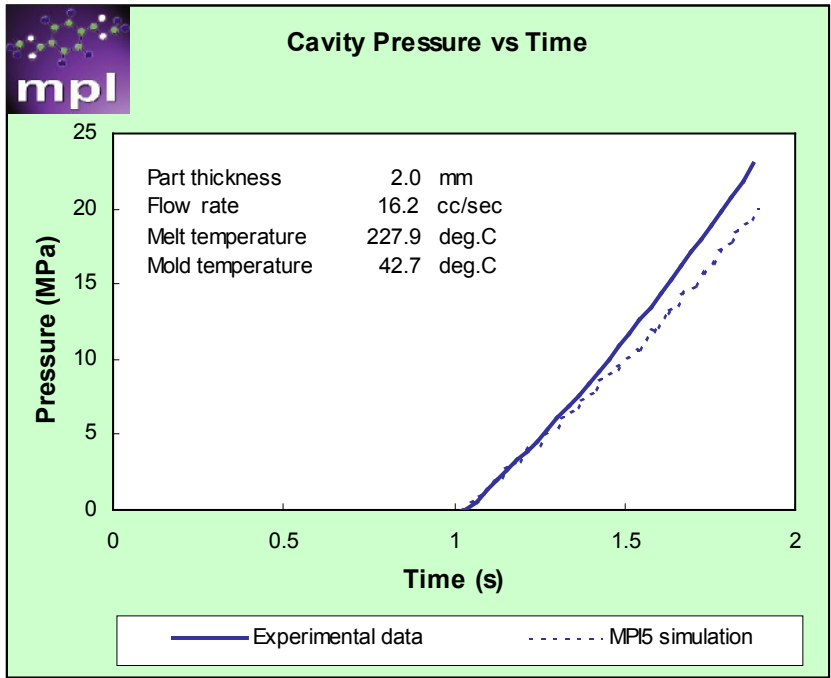
1.1mm tag die

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
cyc1198	14.5	229.7	43.6
cyc1204	46.3	229.2	43.6



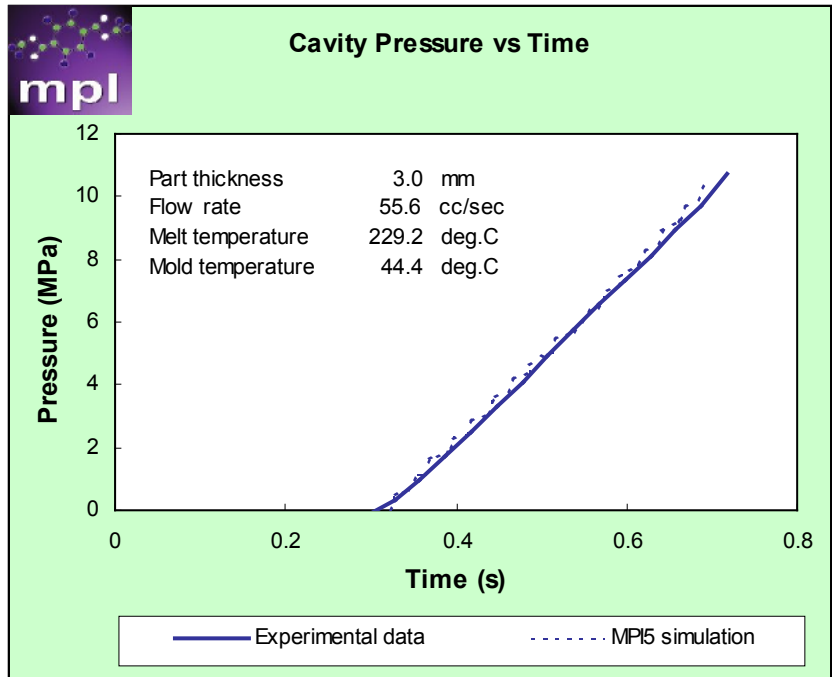
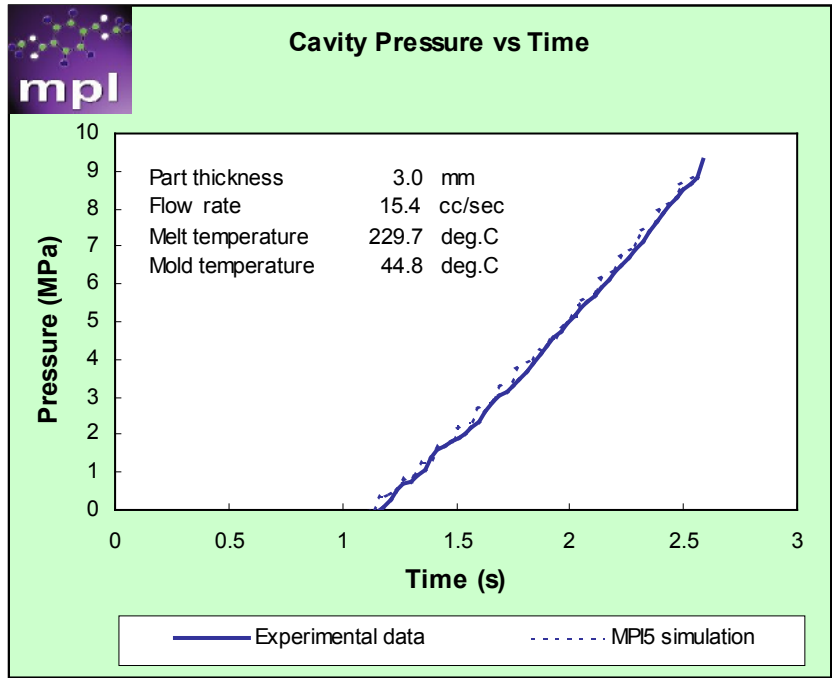
2mm tag die

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
cyc1025	16.2	227.9	42.7
cyc1031	65	229.2	42.7



3mm tag die

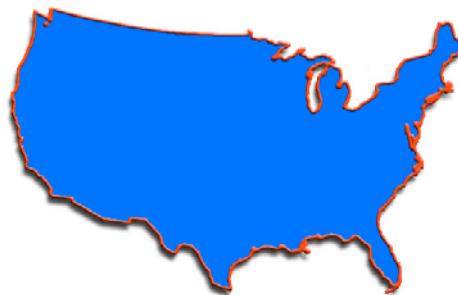
Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
cyc1232	15.4	229.7	44.8
cyc1238	55.6	229.2	44.4



Contact details

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For data fitting and database enquiries please email datafitting@moldflow.com

Find out more about Moldflow's testing service on www.plasticszone.com

Moldflow's corporate website: www.moldflow.com


Selecting material data from the User database

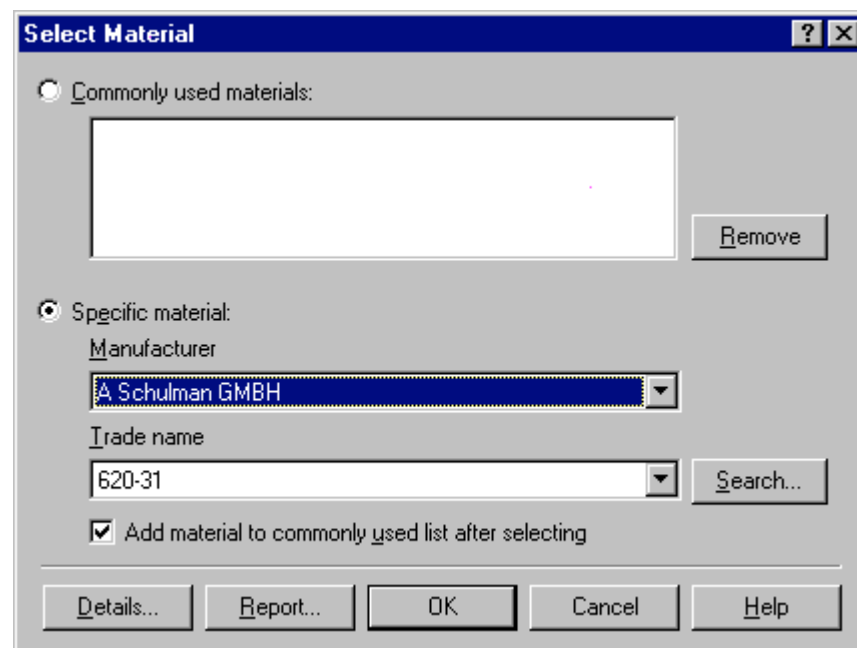
In order to use material data supplied by MPL, the 21000.udb file must be added to the User database.

A standard **PC** installation will have created a directory drive:\My MPI Projects\udb. Add the material data file to this directory.

A standard **Unix** installation will have created a directory <home directory>/mpi???-files/udb (where ??? is the version of MPI installed on the system). Add the material data file to this directory.

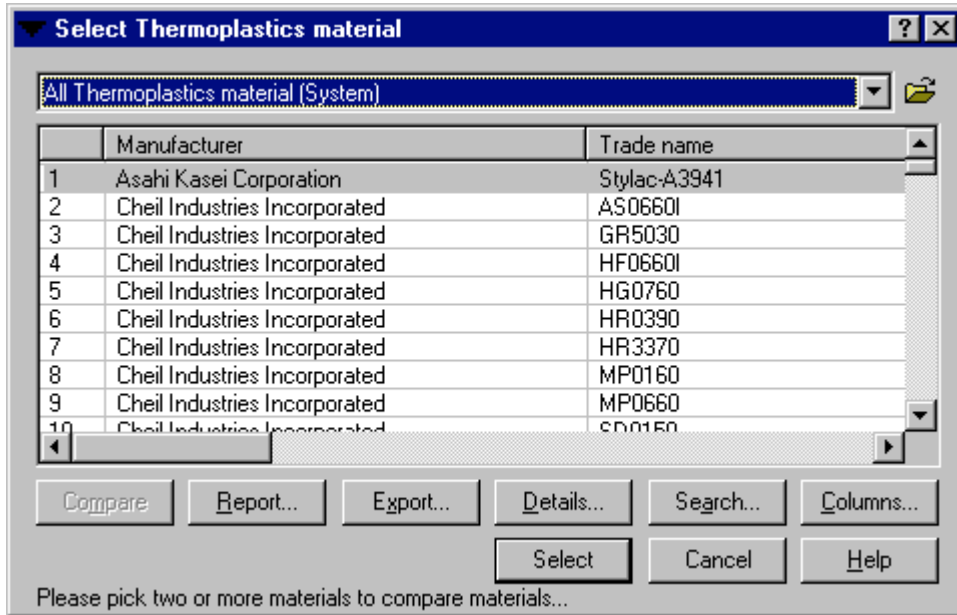
Once the material data file has been added to the appropriate directory, the material can be selected from the User database by following these steps:

- Start Moldflow Plastics Insight™.
- Open an existing project or create a new project.
- Open an existing study or create a new study. This will bring up the material icon  in the 'Study Tasks' window.
- Double click on the material icon to bring up the 'Select Material' dialog box.

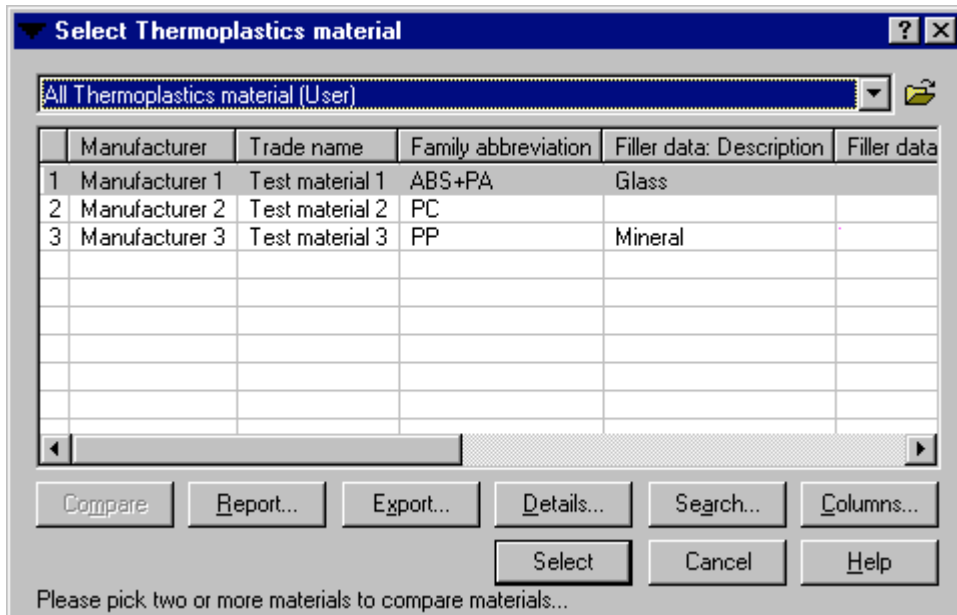


- Click **Search**.
- Click **Clear Filters** before clicking **OK**.

- From the drop down menu select 'All Thermoplastics material (User)'.



- Highlight the desired material and click **Select** or **OK** (depending on the version of MPI that is installed).



- Click **OK** to use this material in an analysis or **Details** to view the material data.