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Date
April 27. 2005

Our reference
TC-BRF-05-11873/mso

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Project number
007.83033/01.54.01

Subject
Compression test BENEFIL polymer

Note: this report replaces TNO-report 11/03.008572/sec

Dear Mister Mol,

at the request of Verheijen Resins B.V. TNO Science and Industry has performed compression tests on five samples of BENEFIL polymer with different densities. The samples were received from Verheijen Resins B.V. on September 24, 2003 and registered under the TNO-sample code 03.0548.

The compression test was performed in accordance with the method described in ISO 844; 2001, under the following conditions:

Specimen dimensions : approx. 100 x 100 x 50 mm (for actual dimensions see table 1)
Number of specimen : 5 per density
Densities : >BENEFIL 3000, >BENEFIL 4000, >BENEFIL 5000,
>BENEFIL 6000 and >BENEFIL 7000
Test speed : 5mm/min
Conditions : (23±2) C° and (50±5)% R.H.

The Standard Conditions for Research Instructions given to TNO, as filed at the Registry of the District Court and the Chamber of Commerce in The Hague shall apply to all instructions given to TNO the Standard Conditions will be sent on request.

Prior to testing the density of each specimen was calculated from the actual dimensions and the weight of specimens. The results are given in table 1.

Table 1: Dimensions and density of five samples of BENEFIL polymer (dimensions (l x w x h) in mm and density ρ in kg/m³)

>BENEFIL 3000				>BENEFIL 4000				>BENEFIL 5000			
l	b	h	ρ	l	b	h	ρ	l	b	h	ρ
85.8	85.7	44.7	32.2	91.9	90.9	41.3	42.2	91.9	94.2	41.5	52.3
85.6	85.8	44.9	33.2	89.9	88.7	41.3	43.9	91.1	90.6	41.0	46.9
86.0	85.7	47.2	33.2	90.2	89.1	41.1	43.9	91.7	90.0	46.3	46.4
85.8	85.9	47.1	32.7	90.3	89.4	40.4	44.7	90.8	93.0	47.0	44.0
85.9	85.6	45.1	34.8	90.1	91.7	40.8	44.0	91.1	91.2	45.8	45.1



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Table 1: Continued

>BENEFIL 6000				>BENEFIL 7000			
l	b	h	ρ	l	b	h	ρ
91.7	93.4	44.0	55.4	92.4	92.6	46.2	62.1
93.3	91.7	47.7	49.3	92.4	93.7	44.8	61.0
92.9	91.4	46.8	50.0	90.3	91.4	44.0	66.1
90.8	92.7	46.8	51.0	92.7	91.2	43.6	62.6
91.4	90.0	44.8	58.5	93.1	93.1	42.4	67.1

The results of the compression test are summarised in table 2.

The compressive stress σ_{10} in N/mm^2 ($1 \text{ kPa} = 0,001 \text{ N/mm}^2 = 102 \text{ kg/m}^2$) is the ratio of the compressive force F_{10} at 10% relative deformation to the initial cross-sectional area of the test specimen.

In the tables 2a, 2b, 2c and 2d the compressive properties are given in respectively kPa, N/mm^2 , kN/m^2 and kg/m^2 .

Table 2a: Compressive properties of five samples of BENEFIL polymer in kPa.

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	143	168	214	243	337
2	156	189	203	201	300
3	156	176	210	225	279
4	145	209	190	206	268
5	135	178	194	240	254
average	147	184	202	223	288
s.d.	9	16	10	19	32

Table 2b: Compressive properties of five samples of BENEFIL polymer in N/mm^2 .

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	0.143	0.168	0.214	0.243	0.337
2	0.156	0.189	0.203	0.201	0.300
3	0.156	0.176	0.210	0.225	0.279
4	0.145	0.209	0.190	0.206	0.268
5	0.135	0.178	0.194	0.240	0.254
average	0.147	0.184	0.202	0.223	0.288
s.d.	0.009	0.016	0.010	0.019	0.032



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Table 2c: Compressive properties of five samples of BENEFIL polymer in kN/m².

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	143	168	214	243	337
2	156	189	203	201	300
3	156	176	210	225	279
4	145	209	190	206	268
5	135	178	194	240	254
average	147	184	202	223	288
s.d.	9	16	10	19	32

Table 2d: Compressive properties of five samples of BENEFIL polymer in kg/m².

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	14586	17136	21828	24786	34374
2	15912	19278	20706	20502	30600
3	15912	17952	21420	22950	28458
4	14790	21318	19380	21012	27336
5	13770	18156	19788	24480	25908
average	14990	18770	20600	22750	29380
s.d.	920	1630	1020	1940	3260

With this report we consider the order to be finished.

Yours faithfully,

P.C.G. Langeveld. B.Sc.
Project Manager

K. Pahnke. M.Sc.
Head of department

Onderwerp: Druktest Benefil Polymeer Hardschuim

Opmerking: dit rapport vervangt TNO - rapport 11/03.008572/sec

Geachte heer Mol,

Op verzoek van Verheijen Resins BV heeft TNO Science and Industry druktesten uitgevoerd op vijf monsters Benefil Polymeer Hardschuim met verschillende dichtheden. De monsters zijn ontvangen van Verheijen Resins B.V op 24 september 2003, en geregistreerd onder TNO - monstercode 03.0548

De druktest is uitgevoerd conform de methode zoals omschreven in ISO 844:2001 onder volgende condities:

Afmetingen van de monsters: ongeveer 100x100x50 mm (voor de actuele maatvoering verwijzen wij naar de tabellen)

Aantal monsters per dichtheid : 5 stuks

Dichtheden:: Benefil 3000, 4000, 5000,6000 en Benefil 7000

Snelheid van druktest: 5mm/min

Conditie tijdens testen: (23 + / - 2°)C en bij (50 +/- 5) % luchtvochtigheid

Voorafgaand aan de test is de dichtheid van ieder individueel monster bepaald uitgaande van de actuele afmetingen in combinatie met het gewicht van de monsters. De resultaten zijn weergegeven in tabel 1.

Tabel 1: Afmetingen en dichtheden van vijf monsters Benefil Polymeer Hardschuim (afmetingen(lxlwh) in mm and dichtheid ρ in kg/m³)

>BENEFIL 3000				>BENEFIL 4000				>BENEFIL 5000			
l	b	h	ρ	l	b	h	ρ	l	b	h	ρ
85.8	85.7	44.7	32.2	91.9	90.9	41.3	42.2	91.9	94.2	41.5	52.3
85.6	85.8	44.9	33.2	89.9	88.7	41.3	43.9	91.1	90.6	41.0	46.9
86.0	85.7	47.2	33.2	90.2	89.1	41.1	43.9	91.7	90.0	46.3	46.4
85.8	85.9	47.1	32.7	90.3	89.4	40.4	44.7	90.8	93.0	47.0	44.0
85.9	85.6	45.1	34.8	90.1	91.7	40.8	44.0	91.1	91.2	45.8	45.1

Table 1: Continued

>BENEFIL 6000				>BENEFIL 7000			
l	b	h	ρ	l	b	h	ρ
91.7	93.4	44.0	55.4	92.4	92.6	46.2	62.1
93.3	91.7	47.7	49.3	92.4	93.7	44.8	61.0
92.9	91.4	46.8	50.0	90.3	91.4	44.0	66.1
90.8	92.7	46.8	51.0	92.7	91.2	43.6	62.6
91.4	90.0	44.8	58.5	93.1	93.1	42.4	67.1

De resultaten van de druktest zijn samengevat in tabel 2.

De drukspanning σ_{10} in N/mm² (1 kPa = 0,001 N/mm² = 102 kg/m²) is de verhouding tussen de drukkracht F₁₀ bij 10% relatieve vervorming ten opzichte van het uitgangsmateriaal, diagonaal gemeten.

In tabellen 2a,2b,2c en 2d zijn de druktest waarden weergegeven in respectievelijk kPa, N/mm², kN/m² en kg/m².

Table 2a: Compressive properties of five samples of BENEFIL polymer in kPa.

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	143	168	214	243	337
2	156	189	203	201	300
3	156	176	210	225	279
4	145	209	190	206	268
5	135	178	194	240	254
average	147	184	202	223	288
s.d.	9	16	10	19	32

Table 2b: Compressive properties of five samples of BENEFIL polymer in N/mm².

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	0.143	0.168	0.214	0.243	0.337
2	0.156	0.189	0.203	0.201	0.300
3	0.156	0.176	0.210	0.225	0.279
4	0.145	0.209	0.190	0.206	0.268
5	0.135	0.178	0.194	0.240	0.254
average	0.147	0.184	0.202	0.223	0.288
s.d.	0.009	0.016	0.010	0.019	0.032

Table 2c: Compressive properties of five samples of BENEFIL polymer in kN/m².

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	143	168	214	243	337
2	156	189	203	201	300
3	156	176	210	225	279
4	145	209	190	206	268
5	135	178	194	240	254
average	147	184	202	223	288
s.d.	9	16	10	19	32

Table 2d: Compressive properties of five samples of BENEFIL polymer in kg/m².

specimen	> BENEFIL 3000 σ_{10}	> BENEFIL 4000 σ_{10}	> BENEFIL 5000 σ_{10}	> BENEFIL 6000 σ_{10}	> BENEFIL 7000 σ_{10}
1	14586	17136	21828	24786	34374
2	15912	19278	20706	20502	30600
3	15912	17952	21420	22950	28458
4	14790	21318	19380	21012	27336
5	13770	18156	19788	24480	25908
average	14990	18770	20600	22750	29380
s.d.	920	1630	1020	1940	3260

Opmerking: de originele Engelse tekst van het rapport is leidend bij de interpretatie van dit TNO rapport. De Nederlandse vertaling is uitsluitend bedoeld als ondersteuning van het Engelstalige rapport en er kunnen geen rechten ontleend worden aan de Nederlandse vertaling.