National Institute of Standards and Technology
U.S. Department of Commerce

Date of Issue:
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Standard Reference Material® 2492
Bingham Paste Mixture for Rheological Measurements
CERTIFICATE

Purpose: The certified values delivered by this Standard Reference Material (SRM) are intended for use in calibrating rheometers for measuring the rheological properties of cement and concrete.

Description: A unit of SRM 2492 consists of three containers, one glass bottle of corn syrup (500 g) and two plastic jars of limestone powder (600 g each).

Certified Values: A NIST certified value is a value for which NIST has the highest confidence in its accuracy and that all known or suspected sources of bias have been investigated or taken into account. Certified values are traceable to International System of Units (SI) [1]. The certified Bingham yield stress and plastic viscosity values are given in Table 1 and are based on measurements from analyses made using a parallel serrated plate rheometer performed at NIST by a single operator. The full curves of the viscosity vs. shear rate are shown in Tables 2 through 4 and on Figure 1. Bingham parameters were extracted from these curves and are shown in Table 5. The expanded uncertainties of the certified values are consistent with the NIST uncertainty policy described in the NIST Technical Note 1297 [2], but were computed using a Bayesian statistical analysis. All expanded uncertainties are reported at the 95 % confidence level. The certified yield stress and plastic viscosity values are given in Table 1. In Table 1, the measurands are the parameters listed and the certified values are metrologically traceable to the indicated coherent SI units.

Table 1. Certified Yield Stress and Plastic Viscosity Values[(a)]

Parameter	Age (days)	Certified Value (Pa)	Standard Uncertainty (Pa)	Coverage Factor, k	Expanded Uncertainty (Pa)
Yield Stress	1	25.61	1.69	2.05	3.47
	3	24.93	1.69	2.03	3.44
	7	23.53	1.73	2.04	3.54
Plastic Viscosity	Age (days)	Certified Value (Pa·s)	Standard Uncertainty (Pa·s)	Coverage Factor, k	Expanded Uncertainty (Pa·s)
	1	7.74	0.74	2.00	1.47
	3	7.89	0.74	2.01	1.49
	7	8.13	0.74	2.00	1.49

[(a)] The flow curves obtained by measuring 20 points distributed on a linear scale between 0.1 s^{-1} to 37 s^{-1}.

Non-Certified Values: Non-certified values are provided in the Appendix A.

Additional Information: Additional information is provided in Appendix B

Period of Validity: The certified values delivered by **SRM 2492** are valid within the measurement uncertainty specified until **30 December 2025**. The certified values are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Certified Values: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm) and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

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Table 2. Certified Values for Viscosity versus Shear Rate at One Day[(a)]

Shear Rate (s^{-1})	Viscosity Certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	168.527	11.924	2.015	24.024
0.103	163.838	11.734	2.035	23.877
0.107	159.082	11.595	2.027	23.502
0.110	154.122	11.100	2.003	22.228
0.114	149.277	10.891	2.010	21.895
0.119	144.355	10.569	2.022	21.367
0.123	139.263	10.168	2.032	20.661
0.129	134.355	9.843	2.052	20.198
0.134	129.328	9.458	2.022	19.124
0.140	124.294	8.993	2.043	18.374
0.147	119.303	8.653	2.031	17.571
0.154	114.252	8.293	2.023	16.780
0.162	109.060	7.965	2.042	16.265
0.171	103.957	7.549	2.032	15.343
0.181	98.739	7.162	2.032	14.551
0.192	93.497	6.794	2.014	13.685
0.205	88.390	6.428	2.011	12.929
0.219	83.193	6.054	2.021	12.234
0.235	78.004	5.660	2.024	11.457
0.255	72.871	5.345	2.025	10.827
0.277	67.720	4.904	2.013	9.870
0.305	62.549	4.536	2.029	9.203
0.338	57.373	4.157	2.026	8.421
0.379	52.333	3.731	2.027	7.564
0.431	47.235	3.326	2.040	6.783
0.500	42.127	2.946	2.057	6.060
0.596	37.011	2.536	2.058	5.219
0.737	31.881	2.139	2.023	4.326
0.966	26.782	1.730	2.076	3.592
1.402	21.659	1.357	2.069	2.808
2.550	16.554	1.104	2.055	2.268
5.000	13.353	0.944	2.050	1.936
10.000	10.966	0.777	2.049	1.591
15.000	9.972	0.722	2.038	1.471
20.000	9.349	0.676	2.045	1.382
25.000	8.925	0.655	2.042	1.338
30.000	8.601	0.620	2.023	1.255
35.000	8.354	0.617	2.056	1.268

[(a)] Obtained from a flow curves by measuring points distributed on a logarithmic scale between 0.1 s^{-1} to 35 s^{-1}.

Table 3. Certified Values for Viscosity Versus Shear Rate at Three Days[a]

Shear Rate (s^{-1})	Viscosity Certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	164.967	11.933	2.011	23.995
0.103	160.319	11.475	2.027	23.258
0.107	155.767	11.355	2.004	22.758
0.110	150.844	10.979	2.013	22.102
0.114	146.085	10.817	2.020	21.851
0.119	141.245	10.509	2.037	21.412
0.123	136.273	10.174	2.025	20.603
0.129	131.649	9.702	2.041	19.798
0.134	126.632	9.453	2.047	19.347
0.140	121.713	9.042	2.044	18.478
0.147	116.715	8.631	2.031	17.527
0.154	111.808	8.231	2.048	16.854
0.162	106.675	7.877	2.032	16.006
0.171	101.709	7.541	2.028	15.294
0.181	96.699	7.199	2.028	14.597
0.192	91.558	6.698	2.026	13.572
0.205	86.586	6.386	2.038	13.011
0.219	81.426	6.068	2.042	12.391
0.235	76.356	5.609	2.035	11.417
0.255	71.390	5.274	2.021	10.657
0.277	66.370	4.854	2.019	9.801
0.305	61.330	4.497	2.027	9.116
0.338	56.339	4.113	2.017	8.299
0.379	51.337	3.723	2.019	7.518
0.431	46.342	3.333	2.026	6.752
0.500	41.343	2.969	2.035	6.041
0.596	36.361	2.525	2.031	5.130
0.737	31.384	2.133	2.027	4.324
0.966	26.409	1.720	2.051	3.528
1.402	21.411	1.362	2.067	2.814
2.550	16.428	1.070	2.047	2.191
5.000	13.315	0.924	2.059	1.902
10.000	10.993	0.765	2.041	1.561
15.000	10.012	0.714	2.054	1.467
20.000	9.403	0.680	2.042	1.389
25.000	8.985	0.649	2.039	1.322
30.000	8.659	0.628	2.043	1.284
35.000	8.422	0.615	2.047	1.258

[a] Obtained from a flow curves by measuring points distributed on a logarithmic scale between 0.1 s^{-1} to 35 s^{-1}.

Table 4. Certified Values for Viscosity Versus Shear Rate at Seven Days[(a)]

Shear Rate (s^{-1})	Viscosity Certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	157.841	12.043	2.011	24.221
0.103	153.249	11.682	2.025	23.659
0.107	148.870	11.540	2.029	23.418
0.110	144.284	11.068	2.010	22.246
0.114	139.791	10.887	2.011	21.888
0.119	135.040	10.512	2.011	21.144
0.123	130.382	10.089	2.014	20.325
0.129	125.832	9.968	2.016	20.095
0.134	121.049	9.520	2.034	19.366
0.140	116.447	9.092	2.018	18.350
0.147	111.688	8.741	2.034	17.779
0.154	106.895	8.334	2.022	16.855
0.162	102.161	7.974	2.032	16.203
0.171	97.312	7.590	2.011	15.264
0.181	92.469	7.190	2.035	14.631
0.192	87.671	6.849	2.036	13.946
0.205	82.793	6.442	2.034	13.104
0.219	78.028	6.078	2.030	12.335
0.235	73.183	5.713	2.024	11.564
0.255	68.460	5.284	2.023	10.692
0.277	63.689	4.888	2.043	9.984
0.305	58.860	4.516	2.024	9.142
0.338	54.159	4.138	2.019	8.353
0.379	49.409	3.763	2.028	7.631
0.431	44.646	3.362	2.045	6.878
0.500	39.900	2.950	2.020	5.961
0.596	35.121	2.564	2.044	5.239
0.737	30.350	2.139	2.051	4.386
0.966	25.634	1.730	2.063	3.570
1.402	20.873	1.374	2.055	2.823
2.550	16.185	1.090	2.066	2.252
5.000	13.252	0.938	2.037	1.911
10.000	11.032	0.789	2.052	1.619
15.000	10.103	0.720	2.040	1.468
20.000	9.514	0.688	2.029	1.396
25.000	9.105	0.650	2.045	1.330
30.000	8.793	0.629	2.054	1.292
35.000	8.553	0.624	2.055	1.283

[(a)] Obtained from a flow curves by measuring points distributed on a logarithmic scale between 0.1 s^{-1} to 35 s^{-1}.

Table 5 has the certified Bingham yield stress and plastic viscosity values obtained from the viscosity curves (Table 2 to Table 4). In Table 5, the measurands are the parameters listed and the certified values are metrologically traceable to the indicated coherent SI units. The data in Table 5 have a lower uncertainty and are not identical to the values in Table 1 because they were generated using 38 data points distributed on a logarithmic scale between 0.1 s^{-1} and 35 s^{-1} while Table 1 used 20 points linear distributed. Read the report for more details [5].

Table 5. Certified Bingham Yield Stress and Plastic Viscosity Values[(a)]

Bingham Parameter	Age (days)	Certified Value (Pa)	Standard Uncertainty (Pa)	Coverage Factor, *k*	Expanded Uncertainty (Pa)
Yield Stress	1	17.48	0.52	1.96	1.02
	3	17.07	0.51	1.96	1.00
	7	16.26	0.52	1.96	1.02
	Age (days)	Certified Value (Pa·s)	Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Expanded Uncertainty (Pa·s)
Plastic Viscosity	1	8.15	0.32	1.96	0.63
	3	8.23	0.32	1.96	0.63
	7	8.38	0.33	1.96	0.65

[(a)] The flow curves obtained by measuring 38 points distributed on a logarithmic scale between 0.1 s^{-1} to 35 s^{-1}.

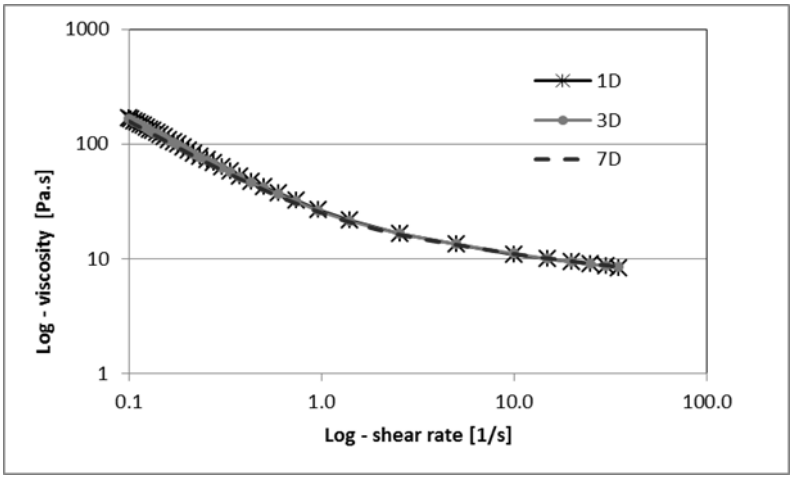

Figure 1. Log of viscosity versus log of the shear rate. The curves indicate no significant changes in values when measurements were taken on the different days

Safety: Please consult the Safety Data Sheet provided with this material.

Storage: Store the bulk, unmixed material at room temperature. Once the two components are mixed as described below, the SRM should be stored at 23 °C ± 2 °C in a sealed plastic jar and used within 7 d.

Use: The SRM batch needs to be prepared by the operator before it can be used.
Follow the instructions below. The mixture's composition is:

- Corn syrup: 200 g
- Distilled water: 63.16 g
- Limestone: 458.1 g

The equipment and the method are described in ASTM C1738 [3], with the following sequence to introduce the ingredients. Pour the correct amount of distilled water in a jar that already contains the correct mass of corn syrup, and mix with a spatula until homogeneous. On average it will take 5 min to dilute the visible glucose chains in the corn syrup. Assuring the syrup is diluted prior to adding it into the high shear blender results in a more effective transfer of the corn syrup into the mixture. Then add the mixture into the high shear blender and proceed as described

in ASTM C1738 to introduce the limestone. The water bath of the high shear blender and the rheometer should be maintained at 23 °C ± 1 °C. It is recommended to use a plunger mixer (rotation speed of 300 rpm) for 30 s to remix the prepared SRM before each use, especially after a few days of rest.

REFERENCES

[1] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Molloy, J.; Nelson, M.A.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sander, L.C.; Schiel, J.E.; Sharpless, K.E.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136, 2021 edition; U.S. Government Printing Office: Washington, DC (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Nov 2022).

[2] Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at https://www.nist.gov/pml/nist-technical-note-1297 (accessed Nov 2022).

[3] ASTM C1738/C1738M-14 *Standard Practice for High-Shear Mixing of Hydraulic Cement Paste*; Annual Book of ASTM Standards, Vol. 04.01.

[4] Ferraris, C.F., Stutzman, P., Winpigler, J., Guthrie, W.; *Certification of SRM 2492: Bingham Paste Mixture for Rheological Measurements*, NIST Special Publication SP-260-174 Rev. 2012; U.S. Government Printing Office: Washington, DC, (2012); available at https://www.nist.gov/srm/publications-sp260s (accessed Nov 2022).

[5] Olivas, A, Ferraris, C. F., Guthrie, W.; *Re-Certification of SRM 2492: Bingham Paste Mixture for Rheological Measurements*, NIST Special Publication SP-260-182; U.S. Government Printing Office: Washington, DC (2015); available at https://pages.nist.gov/NIST-Tech-Pubs/SP260.html (accessed Nov 2022).

If you use this SRM in published work, please reference:

Ferraris CF, Stutzman P, Winpigler J, Guthrie W (2012) Certification of SRM 2492: Bingham Paste Mixture for Rheological Measurements. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 260-174. https://doi.org/10.6028/NIST.SP.260-174

Olivas A, Ferraris CF Guthrie W (2015) Re-Certification of SRM 2492: Bingham Paste Mixture for Rheological Measurements. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 260-182. https://doi.org/10.6028/NIST.SP.260-182

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Certain commercial equipment, instruments, or materials may be identified in this Certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

APPENDIX A

Non-Certified Values: Non-certified values have been interpolated for the days in between physical measurements and are listed in Tables A1 to A6. A NIST non-certified value is a noncertified value that is the best estimate of the true value based on available data; however, the value does not meet the NIST criteria for certification [1] and is provided with associated uncertainties that may reflect only measurement reproducibility, may not include all sources of uncertainty, or may reflect a lack of sufficient statistical agreement among multiple analytical methods. Table A1 is complementary to Table 1. Table A2 through Table A5 show the viscosity vs. shear rate for days that were not measured, but were interpolated from certified curves (complementary to Tables 2 through 4). Table A6 (complementary to Table 5) shows the Bingham parameters extracted from the expanded curves shown in Tables A2 through A5.

Maintenance of Non-Certified Values: NIST will monitor this material to the end of its period of validity. If substantive technical changes occur that affect the non-certified values during this period, NIST will update this Reference Material Information Sheet and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Table A1. Non-certified Yield Stress and Plastic Viscosity Values (Interpolated from Certified Values) – Complimentary to Table 1

Parameter	Age (days)	Non-certified Value (Pa)	Standard Uncertainty (Pa)	Coverage Factor, *k*	Expanded Uncertainty (Pa)
Yield Stress	2	25.28	1.70	2.04	3.48
	4	24.58	1.67	2.05	3.43
	5	24.23	1.68	2.04	3.43
	6	23.88	1.73	2.06	3.55
Plastic Viscosity	Age (days)	Non-certified Value (Pa·s)	Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Expanded Uncertainty (Pa·s)
	2	7.81	0.75	2.00	1.50
	4	7.94	0.74	2.01	1.49
	5	8.00	0.74	2.00	1.48
	6	8.08	0.74	2.01	1.49

Table A2. Non-Certified Values for Viscosity versus Shear Rate at Two Days (Interpolated from Certified Values)

Shear Rate (s^{-1})	Viscosity Non-Certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	166.603	11.927	2.032	24.238
0.103	161.871	11.616	2.031	23.587
0.107	157.618	11.450	2.016	23.081
0.110	152.548	11.065	2.013	22.270
0.114	147.772	10.819	2.031	21.970
0.119	142.790	10.463	2.013	21.063
0.123	137.920	10.047	2.019	20.283
0.129	133.031	9.795	2.024	19.826
0.134	127.990	9.404	2.029	19.076
0.140	123.006	9.034	2.049	18.514
0.147	118.075	8.619	2.056	17.716
0.154	113.019	8.268	2.043	16.892
0.162	107.912	7.959	2.038	16.220
0.171	102.809	7.482	2.037	15.242
0.181	97.700	7.200	2.037	14.668
0.192	92.525	6.724	2.016	13.554
0.205	87.492	6.486	2.029	13.156
0.219	82.256	6.017	2.029	12.209
0.235	77.159	5.690	2.024	11.516
0.255	72.169	5.275	2.017	10.642
0.277	67.036	4.879	2.029	9.900
0.305	61.977	4.534	2.025	9.181
0.338	56.924	4.126	2.019	8.330
0.379	51.800	3.743	2.016	7.545
0.431	46.754	3.384	2.009	6.797
0.500	41.710	2.940	2.039	5.994
0.596	36.691	2.530	2.036	5.151
0.737	31.634	2.140	2.064	4.416
0.966	26.603	1.729	2.052	3.546
1.402	21.538	1.357	2.071	2.811
2.550	16.496	1.092	2.040	2.228
5.000	13.348	0.938	2.059	1.930
10.000	10.981	0.776	2.046	1.588
15.000	9.997	0.713	2.039	1.455
20.000	9.371	0.682	2.048	1.397
25.000	8.956	0.645	2.040	1.317
30.000	8.624	0.623	2.049	1.276
35.000	8.383	0.610	2.046	1.247

Table A3. Non-Certified Values for Viscosity versus Shear Rate at Four Days (Interpolated from Certified Values)

Shear Rate (s^{-1})	Viscosity Non-certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.1000	163.0821	11.8218	2.0345	24.0510
0.1032	158.4471	11.5844	2.0075	23.2552
0.1065	154.0894	11.4604	2.0417	23.3982
0.1103	149.3031	11.0238	2.0200	22.2685
0.1143	144.4133	10.7745	2.0269	21.8385
0.1187	139.6814	10.5158	2.0445	21.4997
0.1234	134.8451	10.1903	2.0394	20.7820
0.1285	130.0087	9.7303	2.0402	19.8516
0.1341	125.1284	9.4205	2.0385	19.2039
0.1401	120.4082	9.0122	2.0343	18.3339
0.1467	115.4065	8.6446	2.0417	17.6493
0.1539	110.5026	8.2081	2.0275	16.6418
0.1619	105.6063	7.9176	2.0390	16.1443
0.1709	100.5740	7.5487	2.0269	15.3005
0.1808	95.5844	7.1098	2.0334	14.4570
0.1919	90.5623	6.7396	2.0321	13.6955
0.2045	85.6299	6.3052	2.0435	12.8846
0.2189	80.5662	6.0081	2.0220	12.1484
0.2355	75.6022	5.6686	2.0288	11.5006
0.2547	70.6604	5.2661	2.0402	10.7437
0.2774	65.6387	4.8871	2.0232	9.8876
0.3046	60.7592	4.5402	2.0152	9.1497
0.3376	55.7926	4.0776	2.0357	8.3007
0.3787	50.8628	3.7702	2.0160	7.6006
0.4311	45.9177	3.3183	2.0229	6.7125
0.5004	40.9998	2.9376	2.0440	6.0044
0.5962	36.0336	2.5413	2.0346	5.1705
0.7375	31.1489	2.1401	2.0492	4.3854
0.9665	26.2159	1.7240	2.0542	3.5416
1.4016	21.2571	1.3418	2.0747	2.7838
2.5496	16.3623	1.0935	2.0645	2.2576
5.0000	13.3131	0.9283	2.0510	1.9039
10.0000	11.0018	0.7786	2.0471	1.5938
15.0000	10.0377	0.7039	2.0528	1.4449
20.0000	9.4316	0.6762	2.0605	1.3932
25.0000	9.0242	0.6532	2.0362	1.3300
30.0000	8.6960	0.6263	2.0516	1.2849
35.0000	8.4582	0.6147	2.0351	1.2510

Table A4. Non-Certified Values for Viscosity versus Shear Rate at Five Days (Interpolated from Certified Values)

Shear Rate (s^{-1})	Viscosity Non-certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	161.248	11.919	2.023	24.109
0.103	156.813	11.696	2.021	23.642
0.107	152.271	11.479	2.034	23.349
0.110	147.644	11.090	2.009	22.278
0.114	142.944	10.746	2.033	21.845
0.119	138.146	10.481	2.020	21.167
0.123	133.337	10.163	2.037	20.703
0.129	128.732	9.759	2.022	19.735
0.134	123.716	9.395	2.030	19.075
0.140	118.990	8.931	2.037	18.193
0.147	114.157	8.740	2.037	17.807
0.154	109.345	8.230	2.029	16.702
0.162	104.381	7.932	2.036	16.152
0.171	99.486	7.494	2.023	15.162
0.181	94.566	7.160	2.033	14.560
0.192	89.708	6.719	2.044	13.731
0.205	84.744	6.445	2.039	13.142
0.219	79.741	6.055	2.031	12.294
0.235	74.833	5.670	2.023	11.468
0.255	69.901	5.285	2.016	10.654
0.277	65.090	4.881	2.008	9.802
0.305	60.091	4.485	2.008	9.006
0.338	55.240	4.137	2.032	8.407
0.379	50.342	3.712	2.039	7.569
0.431	45.480	3.348	2.040	6.829
0.500	40.620	2.931	2.045	5.993
0.596	35.738	2.532	2.040	5.164
0.737	30.873	2.110	2.048	4.323
0.966	26.024	1.734	2.052	3.557
1.402	21.150	1.361	2.091	2.847
2.550	16.307	1.088	2.050	2.231
5.000	13.290	0.930	2.050	1.907
10.000	11.003	0.776	2.074	1.609
15.000	10.053	0.717	2.058	1.476
20.000	9.454	0.682	2.059	1.404
25.000	9.049	0.652	2.040	1.330
30.000	8.720	0.625	2.055	1.284
35.000	8.490	0.612	2.020	1.237

Table A5. Non-Certified Values for Viscosity versus Shear Rate at Six Days (Interpolated from Certified Values)

Shear Rate (s^{-1})	Viscosity Non-certified Value (Pa·s)	Viscosity Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Viscosity Expanded Uncertainty (Pa·s)
0.100	159.498	11.984	2.023	24.238
0.103	155.021	11.693	2.039	23.845
0.107	150.612	11.396	2.022	23.046
0.110	145.979	10.981	2.022	22.207
0.114	141.379	10.845	2.016	21.866
0.119	136.665	10.497	2.039	21.404
0.123	131.899	10.189	2.034	20.725
0.129	127.277	9.721	2.051	19.935
0.134	122.516	9.513	2.030	19.312
0.140	117.715	9.091	2.039	18.541
0.147	112.997	8.648	2.026	17.519
0.154	108.074	8.332	2.058	17.149
0.162	103.286	7.922	2.035	16.125
0.171	98.362	7.484	2.034	15.222
0.181	93.455	7.119	2.032	14.466
0.192	88.588	6.792	2.033	13.808
0.205	83.717	6.454	2.035	13.136
0.219	78.848	6.059	2.018	12.226
0.235	74.041	5.722	2.012	11.511
0.255	69.160	5.297	2.038	10.795
0.277	64.363	4.853	2.020	9.802
0.305	59.573	4.543	2.035	9.246
0.338	54.725	4.119	2.009	8.277
0.379	49.832	3.776	2.014	7.604
0.431	45.078	3.339	2.016	6.731
0.500	40.258	2.963	2.023	5.995
0.596	35.440	2.539	2.030	5.154
0.737	30.637	2.124	2.024	4.298
0.966	25.828	1.727	2.037	3.519
1.402	21.023	1.372	2.063	2.832
2.550	16.236	1.094	2.056	2.249
5.000	13.265	0.934	2.034	1.899
10.000	11.026	0.784	2.057	1.612
15.000	10.071	0.722	2.058	1.486
20.000	9.482	0.684	2.040	1.395
25.000	9.078	0.657	2.050	1.347
30.000	8.754	0.631	2.044	1.289
35.000	8.522	0.618	2.059	1.273

Table A6. Bingham Yield Stress and Plastic Viscosity Non-Certified Values[(a)] (Complimentary to Table 5)

Bingham Parameter	Age (days)	Non-certified Value (Pa)	Standard Uncertainty (Pa)	Coverage Factor, *k*	Expanded Uncertainty (Pa)
Yield Stress	2	17.29	0.51	1.96	1.00
	4	16.87	0.51	1.96	1.00
	5	16.67	0.52	1.96	1.02
	6	16.47	0.52	1.96	1.02
Plastic Viscosity	Age (days)	Non-certified Value (Pa·s)	Standard Uncertainty (Pa·s)	Coverage Factor, *k*	Expanded Uncertainty (Pa·s)
	2	8.18	0.32	1.96	0.63
	4	8.27	0.32	1.96	0.63
	5	8.30	0.32	1.96	0.63
	6	8.34	0.33	1.96	0.65

[(a)] These values were obtained from data in Table A2 to Table A5.

* * * * * * * * * * End of Appendix A * * * * * * * * * *

APPENDIX B

Material Selection and Packaging: The limestone was purchased in bulk and the corn syrup was purchased in 1 gallon bottles. The packaging contains enough material to prepare two batches of material for testing. There is enough limestone in each jar for one batch and the glass bottle contains enough corn syrup for two batches.

Homogeneity Assessment and Certification Analyses: Certification analyses for Bingham parameters were performed at NIST on 12 randomly selected units of the SRM. The uncertainty reported for the certified values include allowances for random measurement variability, day-to-day variability, and material heterogeneity between units.

Viscosity Curves: The values for the viscosity and shear rate measured on the different days are provided in Table 2 to 4 and Figure 1. The viscosity (not the Bingham plastic viscosity) represents the ratio between the shear stress and the shear rate at a given shear rate. Table 5 shows the Bingham parameters extracted from the curves shown in Tables 2 through 4. Read the report for more details [5].

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