INSIGNIA™ 10,000 HOUR HYDRATION-DEHYDRATION TEST

10,000 Hour Hydration-Dehydration Test conducted on the Insignia™ Hydrophilic Gasket Seals to establish performance of the seals in simulated sewer conditions

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Report Summary

The Insignia™ Hydrophilic Gasket Seals were developed by the Research & Development Team at LMK Technologies as a solution to the problem of water tracking in the annular space that exists between a CIPP liner and the host pipe. This space exists due to the shrinkage of resins as they undergo polymerization during the process of curing. This water drains back into the sewer collection system affecting the capacity of the sewer system and consequently the capacity of any waste treatment services that the collection system utilizes.

The Insignia™ Sealing System consists of three construction types of Gasket Seals: O-Rings, Lateral Connection Hats, and Mainline End Seals for the purpose of eliminating infiltration from the known sources in a collection system. Neoprene formerly known as Duprene is the backbone of the chemical makeup of the Insignia™ Seals. Neoprene is known for its properties of chemical inertness and maintaining flexibility over a wide range of temperatures. LMK's proprietary neoprene compound further has hydrophilic properties that allow it to absorb water and expand when left unconstrained. In a pipe, when the seal is constrained between the host pipe and the CIPP liner, the seal swells to close the annular gap between the liner and the pipe thus creating a compression gasket and effectively sealing the system by preventing water from infiltrating into the collection system.

Since the Insignia™ Seals are hydrophilic; a concern to the engineering society that collaborates with LMK Technologies was the performance of the seals when dehydrated or deprived of water. It was this concern that led to the development of the 10,000 hour alternate hydration/dehydration testing of the Insignia™ Seals. The test comprised of 6 samples of the Insignia™ Gasket Seals subjected to various cycles of hydration and dehydration ranging from 2 days to 6 months. The seals were tested for gain in weight and size when hydrated and the subsequent loss in weight and thickness when dehydrated.

Conclusion:

An Insignia™ Gasket Seals expands to about 800% of its original size when hydrated for prolonged periods of time. When the seals were dehydrated, they did not exhibit any degradation or loss of materials and maintained their original surface properties, which is a significant find for long term sealing.

The seals maintained their flexibility and expansion properties while undergoing continuous hydration and dehydration cycles. The seals also exhibited their expansion properties when subjected to dehydration. After a number of hydration and dehydration cycles, the gasket seals were able to retain almost up to 75% of their expansion over shorter periods of dehydration.

The results obtained by the means of this test (further detailed in the report) establish that the Insignia™ Gasket Seals are able to maintain their water sealing properties when subjected to simulated sewer and ground water conditions of hydration and dehydration.

Test Procedure

Focus: To determine the change in physical properties of an Insignia™ Hydrophilic Seals after they have been subjected to varying durations of hydration and dehydration cycles.

Apparatus: The following equipment and materials are to be used for conducting the test

1. Insignia™ O-Rings
2. Scale
3. Vernier Calipers

Methodology: The following procedure is to be followed for conducting the test

1. 5 specimens of Insignia™ O-rings will be weighed to determine the initial weight and thickness and then will be labeled beginning with Sample A up to Sample F
2. Sample A will remain submerged for 48 hours and then will be allowed to dry for 48 hours and will be measured for weight and thickness upon removal and after drying
3. Step 2 of the test procedure is to be repeated on Samples B to E; at 1 week, 1 month, and 6 months respectively
4. Sample F will be the control sample and will remain submerged for the entire duration of the test

Documentation: The test will be documented using the following techniques

1. Photographs of the Hydrophilic Seals during various stages of the tests including the seal formed in the pipe after dehydration
2. Observations of the weight changes of the O-rings
3. Observation of sealing properties of the O-rings after being subjected to the Hydration/Dehydration/Hydration Cycle
4. Observation of surface properties of the O-rings to check for loss of material, loss of flexibility, etc.

Observations: Please refer to the appendix for the observations

Observations for Sample A – 2 Day Cycle

Sample A of the Insignia™ Gasket Seals was subjected to a 2-day cycle of alternate hydration or dehydration. A total of 208 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample A – 2 Day Cycle

Maximum increase in thickness (Dry to Wet):
= [(5.66 – 4.56)/4.56]*100
= 24.12%

Maximum increase in weight (Dry to Wet):
= [(8.6 – 4.7)/4.7]*100
= 82.97%

Thickness increase over a period of 10,000 Hours (Dry to Dry):
= [(5.66 – 3.94)/3.94]*100
= 43.65%

Thickness increase over a period of 10,000 Hours (Wet to Wet):
= [(5.97 – 4.56)/4.56]*100
= 30.92%

Weight increase over a period of 10,000 Hours (Dry to Dry):
= [(7.6 – 4.7)/4.7]*100
= 61.70%

Weight increase over a period of 10,000 Hours (Wet to Wet):
= [(9.5 – 8.6)/8.6]*100
= 10.46%

Observation Charts for Sample A – 2 Day Cycle

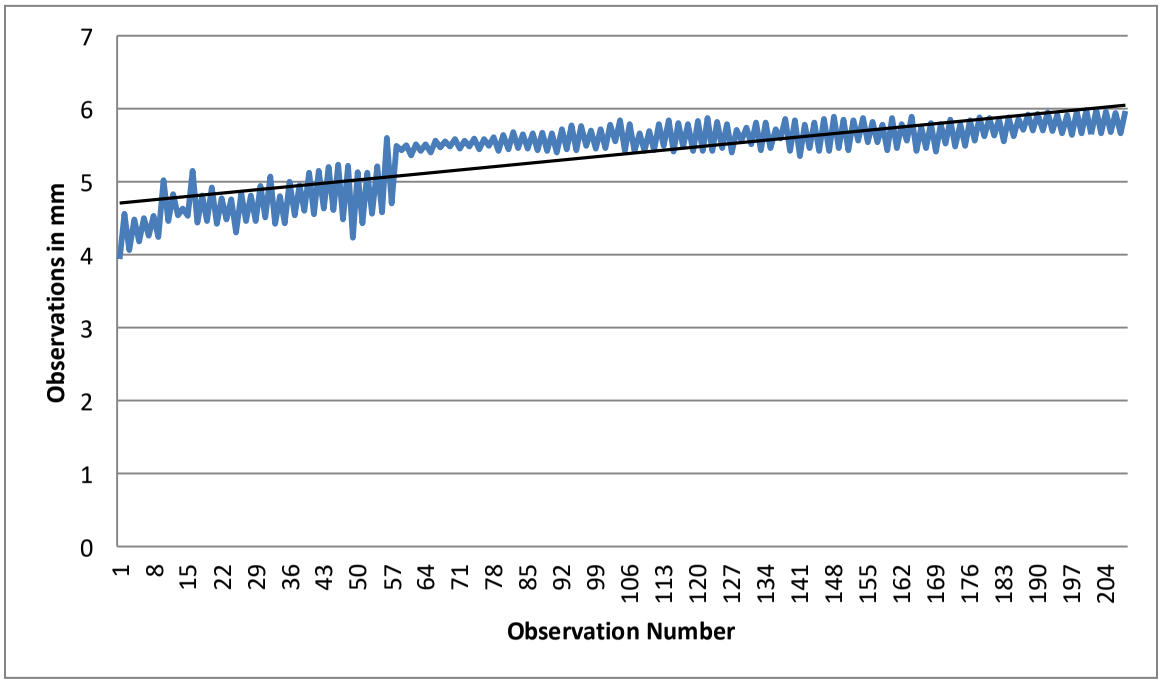

Figure 1: Thickness Observation Chart for Sample A

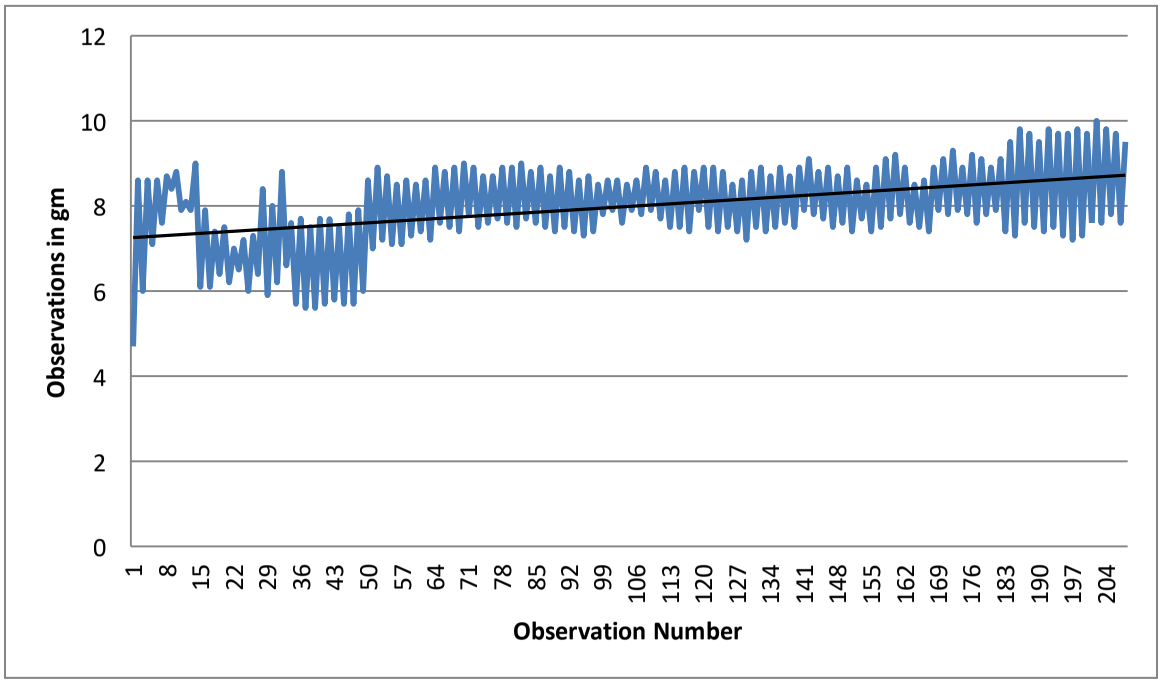

Figure 2: Weight Observations Chart for Sample A

Observations for Sample B – 7 Day Cycle

Sample B of the Insignia™ Gasket Seals was subjected to a 7-day cycle of alternate hydration or dehydration. A total of 58 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample B – 7 Day Cycle

Maximum increase in thickness (Dry to Wet):
= [(6.58 – 4.49)/4.49]*100
= 46.54%

Maximum increase in weight (Dry to Wet):
= [(11.8 – 5.2)/5.2]*100
= 126.92%

Thickness increase over a period of 10,000 Hours (Dry to Dry):
= [(4.53 – 4.23)/4.23]*100
= 7.09%

Thickness increase over a period of 10,000 Hours (Wet to Wet):
= [(6.58 – 4.69)/4.69]*100
= 40.29%

Weight increase over a period of 10,000 Hours (Dry to Dry):
= [(6.4 – 4.5)/4.5]*100
= 42.22%

Weight increase over a period of 10,000 Hours (Wet to Wet):
= [(10.4 – 7.2)/7.2]*100
= 44.44%

Observation Charts for Sample B – 7 Day Cycle

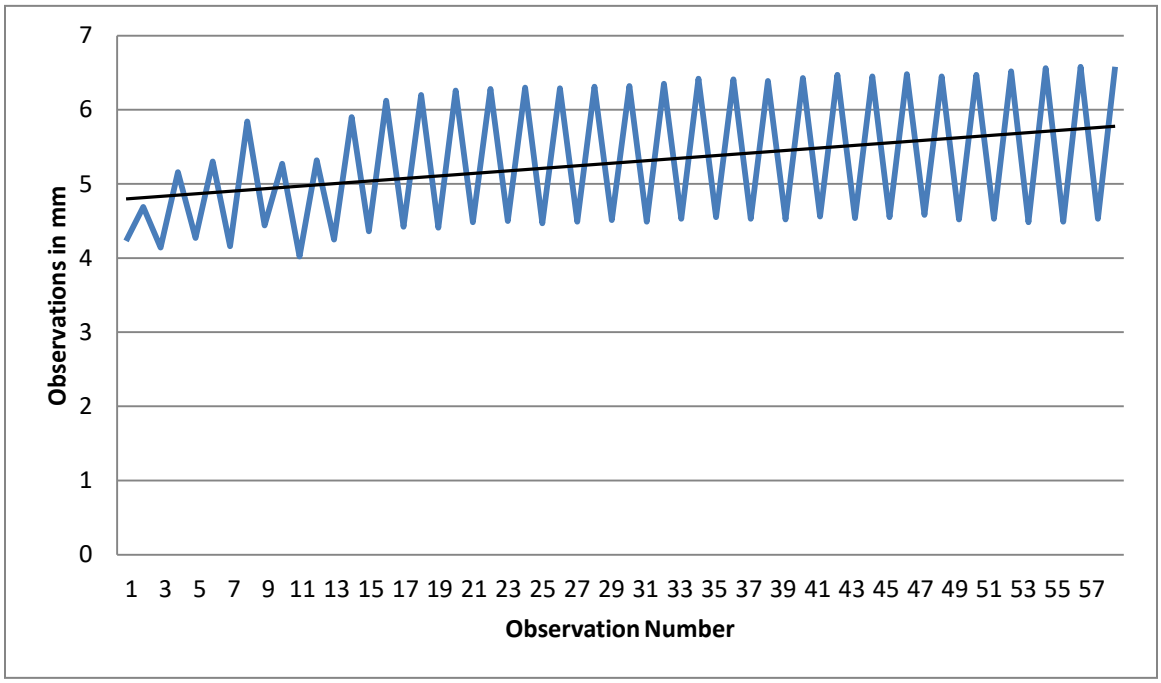

Figure 3: Thickness Observation Chart for Sample B

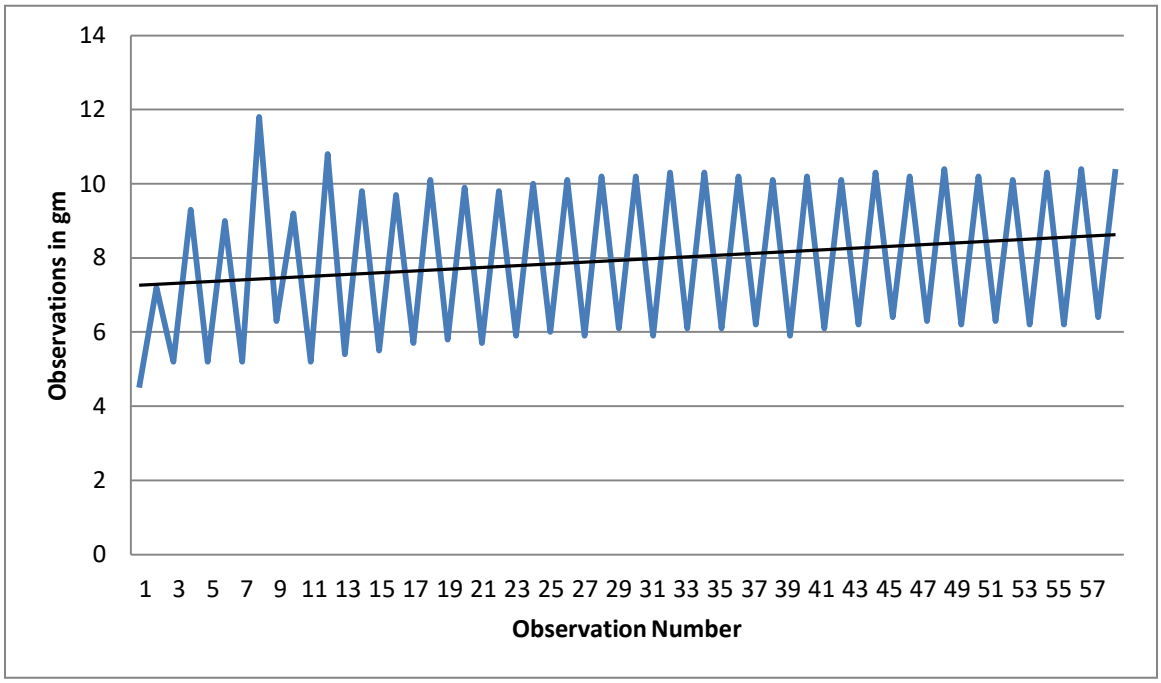

Figure 4: Weight Observations Chart for Sample B

Observations for Sample C – 30 Day Cycle

Sample B of the Insignia™ Gasket Seals was subjected to a 30 day cycle of alternate hydration or dehydration. A total of 14 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample C – 30 Day Cycle

Maximum increase in thickness (Dry to Wet):
= [(6.56 – 4.23)/4.23]*100
= 55.08%

Maximum increase in weight (Dry to Wet):
= [(17.3 – 5.1)/5.1]*100
= 239.21%

Thickness increase over a period of 10,000 Hours (Dry to Dry):
= [(4.28 – 3.98)/3.98]*100
= 7.53%

Thickness increase over a period of 10,000 Hours (Wet to Wet):
= [(4.28 – 3.98)/3.98]*100
= 7.70%

Weight increase over a period of 10,000 Hours (Dry to Dry):
= [(5.1 – 4.5)/4.5]*100
= 13.33%

Weight increase over a period of 10,000 Hours (Wet to Wet):
= [(17.3 – 16.3)/16.3]*100
= 6.13%

Observation Charts for Sample C – 30 Day Cycle

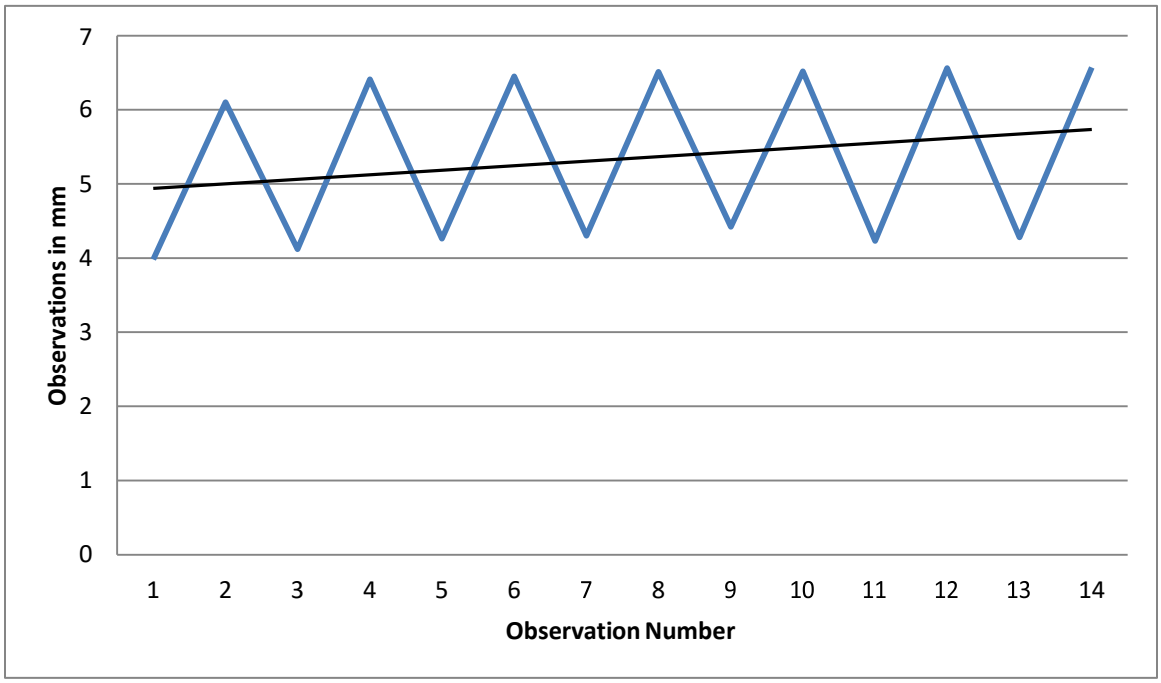

Figure 5: Thickness Observation Chart for Sample C

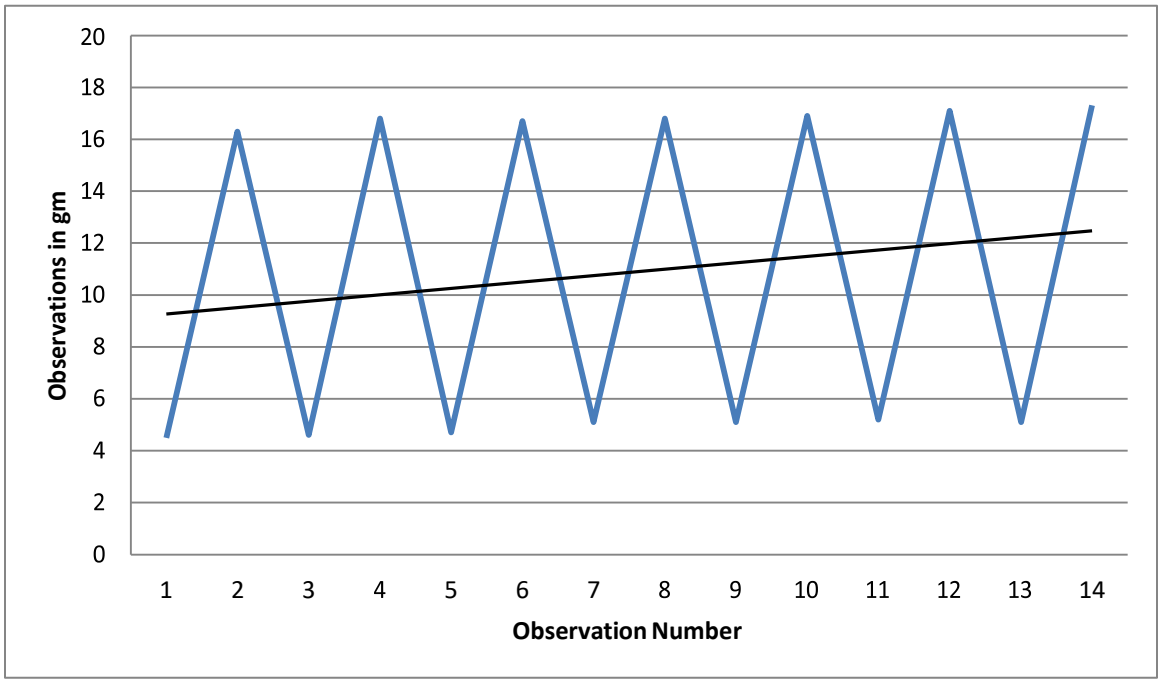

Figure 6: Weight Observations Chart for Sample C

Observations for Sample D – 90 Day Cycle

Sample D of the Insignia™ Gasket Seals was subjected to a 90 day cycle of alternate hydration or dehydration. A total of 6 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample D – 90 Day Cycle

Maximum increase in thickness (Dry to Wet):
= [(9.11 – 4.1)/4.1]*100
= 122.19%

Maximum increase in weight (Dry to Wet):
= [(32.3 – 8.3)/8.3]*100
= 289.15%

Thickness increase over a period of 10,000 Hours (Dry to Dry):
= [(4.11 – 3.96)/3.96]*100
= 3.78%

Thickness increase over a period of 10,000 Hours (Wet to Wet):
= [(9.10 – 7.67)/7.67]*100
= 18.64%

Weight increase over a period of 10,000 Hours (Dry to Dry):
= [(8.3 – 4.5)/4.5]*100
= 84.44%

Weight increase over a period of 10,000 Hours (Wet to Wet):
= [(32.3 – 28.7)/28.7]*100
= 12.54%

Observation Charts for Sample D – 30 Day Cycle

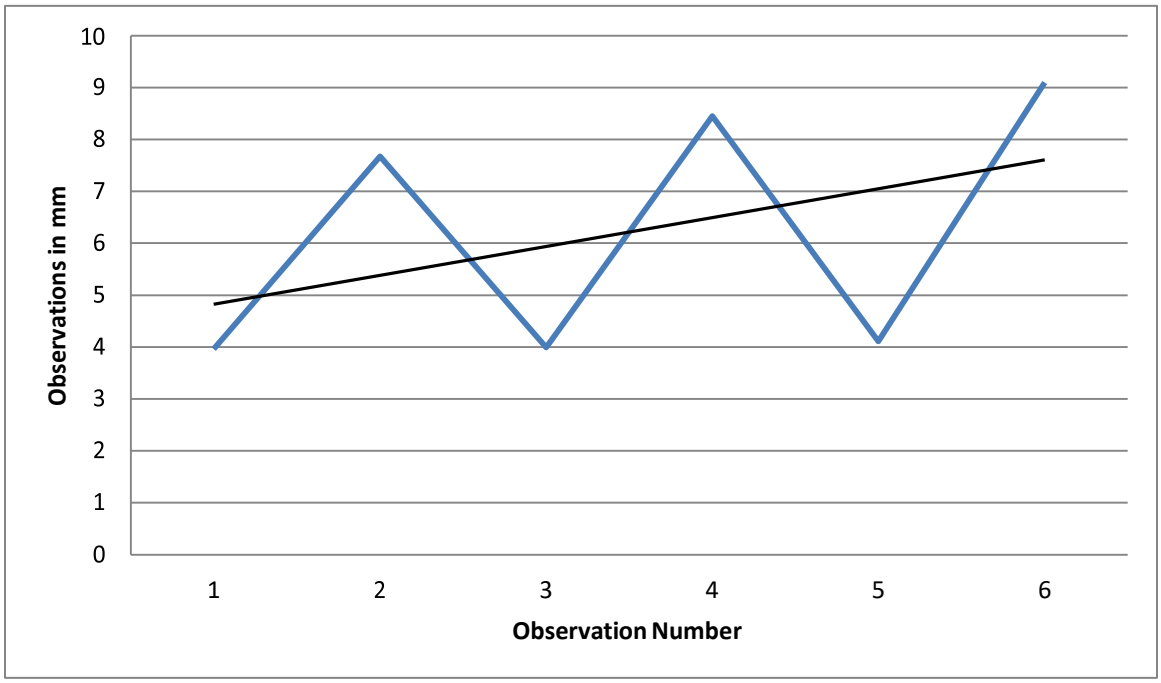

Figure 7: Thickness Observation Chart for Sample D

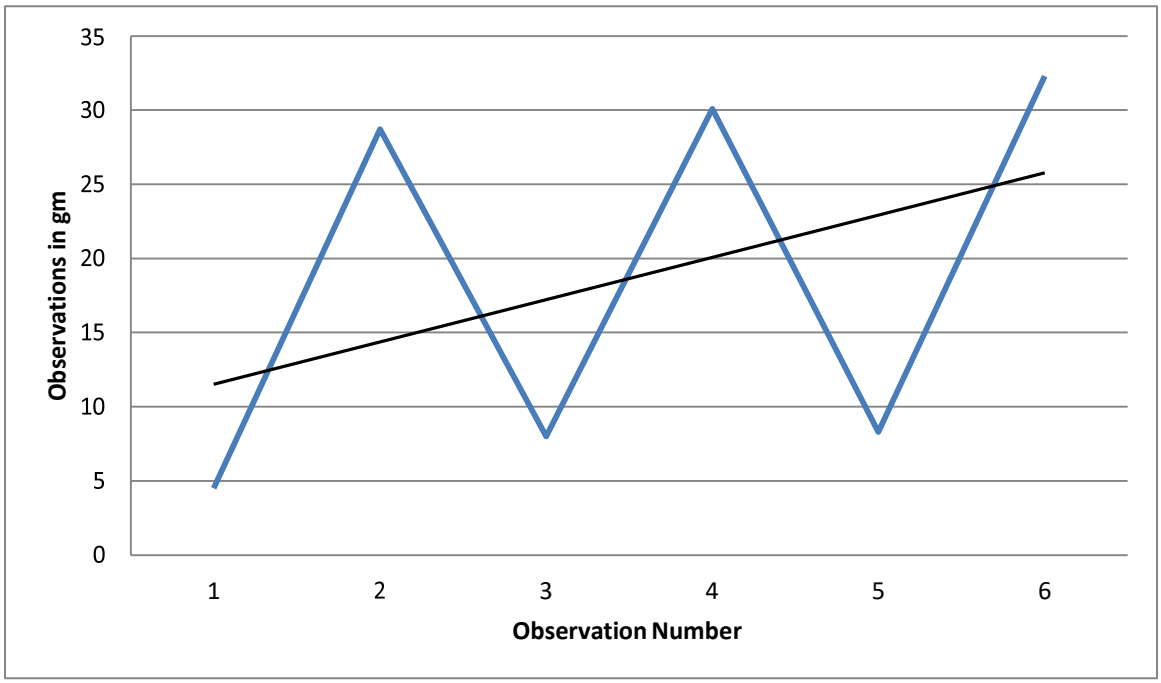

Figure 8: Weight Observations Chart for Sample D

Observations for Sample E – 180 Day Cycle

Sample D of the Insignia™ Gasket Seals was subjected to a 180 day cycle of alternate hydration or dehydration. A total of 4 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample E – 180 Day Cycle

Maximum increase in thickness (Dry to Wet):
= [(11.96 – 4.36)/4.36]*100
= 174.31%

Maximum increase in weight (Dry to Wet):
= [(53.2 – 8.4)/8.4]*100
= 533.33%

Thickness increase over a period of 10,000 Hours (Dry to Dry):
= [(4.36 – 3.94)/3.94]*100
= 10.65%

Thickness increase over a period of 10,000 Hours (Wet to Wet):
= [(11.96 – 9.42)/9.42]*100
= 26.32%

Weight increase over a period of 10,000 Hours (Dry to Dry):
= [(8.4 – 4.7)/4.7]*100
= 78.72%

Weight increase over a period of 10,000 Hours (Wet to Wet):
= [(53.2 – 41.7)/41.7]*100
= 27.57%

Observation Charts for Sample E – 180 Day Cycle

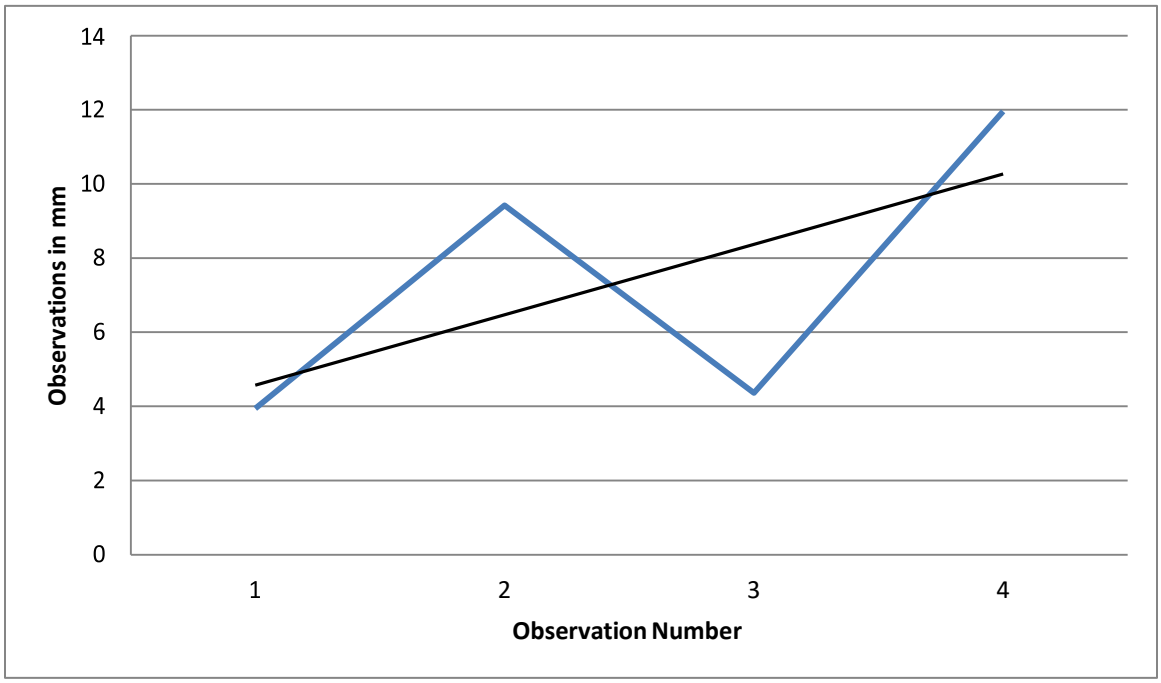

Figure 9: Thickness Observation Chart for Sample E

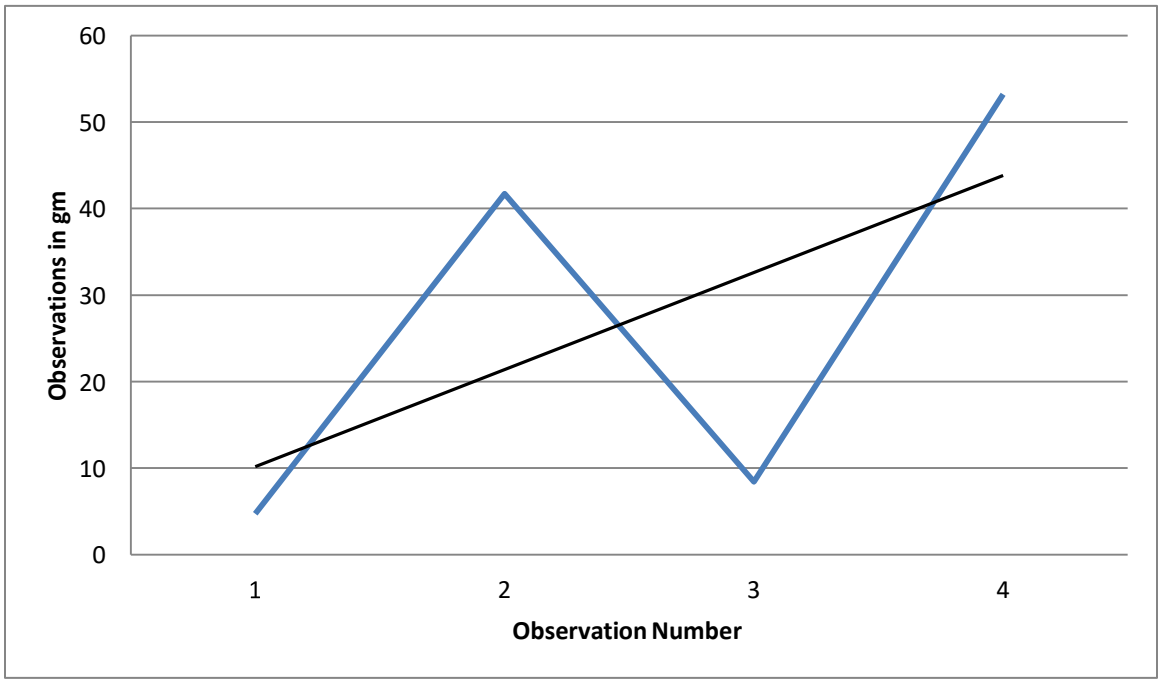

Figure 10: Weight Observations Chart for Sample E

Observations for Sample F – 416 Day Cycle

Sample F of the Insignia™ Gasket Seals was subjected to a 416 day hydration. A total of 2 observations were recorded of which half were in the dry state while the other half were in the wet state. The observations were further studied for the gain/loss in thickness and weight as the samples underwent multiple hydration and dehydration cycle.

Calculations for Sample F – 416 Day Cycle

Increase in thickness (Dry to Wet):
= [(11.46 – 3.94)/3.94]*100
= 190.86%

Maximum increase in weight (Dry to Wet):
= [(52.3 – 4.7)/4.7]*100
= 1012.16%

Summary & Conclusions

The data can be summarized as below

Sample	Increase in Thickness (mm)	Increase in Weight (gm)
A – 2 days	24.12%	82.97%
B – 7 days	46.54%	126.92%
C – 30 days	55.08%	239.21%
D – 90 days	122.19%	289.15%
E – 180 days	174.31%	533.33%
F – 416 days	190.86%	1012.16%

The following conclusions can be drawn from the data reported above:

- The trend line of each observation chart indicates that not only do the seals maintain their expansion properties when subjected to alternate hydration and dehydration data but also progressively increase the amount of water they take on and consequently their expansion.
- The gasket seals are able to retain an expansion of at least 4% or higher even when subjected to dehydration thus ensuring that a seal will be maintained between the liner and the host pipe even when the seals face dehydration in the sewer.
- The seals retain moisture even when dehydrated over periods as long as 3 months.

Visual observations further confirm the following facts:

- The seals do not show any degradation or loss of material when dehydrated
- The seals maintain their flexibility even after being subjected to multiple hydration and dehydration cycles

Appendix

Table 1: 2 Day Cycle Observations for Sample A

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample B (mm)	State	Test Sample B (mm)	State
1	3.94	Dry	4.7	Dry
2	4.56	Wet	8.6	Wet
3	4.06	Dry	6.0	Dry
4	4.48	Wet	8.6	Wet
5	4.18	Dry	7.1	Dry
6	4.5	Wet	8.6	Wet
7	4.26	Dry	7.6	Dry
8	4.53	Wet	8.7	Wet
9	4.24	Dry	8.4	Dry
10	5.02	Wet	8.8	Wet
11	4.46	Dry	7.9	Dry
12	4.83	Wet	8.1	Wet
13	4.54	Dry	7.9	Dry
14	4.63	Wet	9	Wet
15	4.53	Dry	6.1	Dry
16	5.15	Wet	7.9	Wet
17	4.44	Dry	6.1	Dry
18	4.81	Wet	7.4	Wet
19	4.46	Dry	6.4	Dry
20	4.92	Wet	7.5	Wet
21	4.42	Dry	6.2	Dry
22	4.77	Wet	7	Wet
23	4.48	Dry	6.5	Dry
24	4.76	Wet	7.2	Wet
25	4.3	Dry	6	Dry
26	4.84	Wet	7.3	Wet
27	4.46	Dry	6.4	Dry
28	4.81	Wet	8.4	Wet
29	4.46	Dry	5.9	Dry
30	4.94	Wet	8	Wet
31	4.51	Dry	6.2	Dry
32	5.07	Wet	8.8	Wet
33	4.42	Dry	6.6	Dry
34	4.8	Wet	7.6	Wet
35	4.43	Dry	5.7	Dry

36	5	Wet	7.7	Wet
37	4.54	Dry	5.6	Dry
38	4.95	Wet	7.5	Wet
39	4.6	Dry	5.6	Dry
40	5.12	Wet	7.7	Wet
41	4.55	Dry	5.7	Dry
42	5.15	Wet	7.69	Wet
43	4.63	Dry	5.8	Dry
44	5.2	Wet	7.5	Wet
45	4.61	Dry	5.7	Dry
46	5.23	Wet	7.8	Wet
47	4.48	Dry	5.7	Dry
48	5.22	Wet	7.9	Wet
49	4.23	Dry	6	Dry
50	5.13	Wet	8.6	Wet
51	4.43	Dry	7	Dry
52	5.12	Wet	8.9	Wet
53	4.56	Dry	7.2	Dry
54	5.21	Wet	8.7	Wet
55	4.58	Dry	7.1	Dry
56	5.6	Wet	8.5	Wet
57	4.7	Dry	7.1	Dry
58	5.49	Wet	8.6	Wet
59	5.43	Dry	7.3	Dry
60	5.5	Wet	8.5	Wet
61	5.36	Dry	7.4	Dry
62	5.51	Wet	8.6	Wet
63	5.42	Dry	7.2	Dry
64	5.51	Wet	8.9	Wet
65	5.4	Dry	7.6	Dry
66	5.56	Wet	8.8	Wet
67	5.47	Dry	7.5	Dry
68	5.55	Wet	8.9	Wet
69	5.48	Dry	7.4	Dry
70	5.58	Wet	9	Wet
71	5.45	Dry	7.8	Dry
72	5.56	Wet	8.9	Wet
73	5.48	Dry	7.5	Dry
74	5.59	Wet	8.7	Wet
75	5.44	Dry	7.6	Dry

76	5.58	Wet	8.7	Wet
77	5.49	Dry	7.7	Dry
78	5.61	Wet	8.9	Wet
79	5.42	Dry	7.6	Dry
80	5.64	Wet	8.9	Wet
81	5.44	Dry	7.5	Dry
82	5.68	Wet	9	Wet
83	5.46	Dry	7.7	Dry
84	5.65	Wet	8.8	Wet
85	5.45	Dry	7.6	Dry
86	5.66	Wet	8.9	Wet
87	5.43	Dry	7.5	Dry
88	5.67	Wet	8.7	Wet
89	5.42	Dry	7.4	Dry
90	5.66	Wet	8.9	Wet
91	5.4	Dry	7.5	Dry
92	5.72	Wet	8.8	Wet
93	5.44	Dry	7.4	Dry
94	5.77	Wet	8.6	Wet
95	5.43	Dry	7.3	Dry
96	5.76	Wet	8.7	Wet
97	5.49	Dry	7.4	Dry
98	5.7	Wet	8.5	Wet
99	5.45	Dry	7.8	Dry
100	5.72	Wet	8.6	Wet
101	5.46	Dry	7.9	Dry
102	5.78	Wet	8.6	Wet
103	5.55	Dry	7.6	Dry
104	5.84	Wet	8.5	Wet
105	5.42	Dry	7.9	Dry
106	5.79	Wet	8.6	Wet
107	5.42	Dry	7.8	Dry
108	5.66	Wet	8.9	Wet
109	5.42	Dry	7.9	Dry
110	5.69	Wet	8.8	Wet
111	5.43	Dry	7.7	Dry
112	5.79	Wet	8.6	Wet
113	5.49	Dry	7.5	Dry
114	5.84	Wet	8.8	Wet
115	5.41	Dry	7.5	Dry

116	5.8	Wet	8.9	Wet
117	5.48	Dry	7.4	Dry
118	5.79	Wet	8.8	Wet
119	5.42	Dry	7.9	Dry
120	5.83	Wet	8.9	Wet
121	5.42	Dry	7.5	Dry
122	5.87	Wet	8.9	Wet
123	5.42	Dry	7.4	Dry
124	5.82	Wet	8.8	Wet
125	5.46	Dry	7.5	Dry
126	5.79	Wet	8.5	Wet
127	5.4	Dry	7.4	Dry
128	5.71	Wet	8.6	Wet
129	5.56	Dry	7.2	Dry
130	5.74	Wet	8.8	Wet
131	5.51	Dry	7.5	Dry
132	5.81	Wet	8.9	Wet
133	5.43	Dry	7.4	Dry
134	5.81	Wet	8.7	Wet
135	5.46	Dry	7.5	Dry
136	5.72	Wet	8.9	Wet
137	5.59	Dry	7.6	Dry
138	5.86	Wet	8.7	Wet
139	5.42	Dry	7.5	Dry
140	5.84	Wet	8.9	Wet
141	5.35	Dry	7.9	Dry
142	5.78	Wet	9.1	Wet
143	5.46	Dry	7.8	Dry
144	5.81	Wet	8.8	Wet
145	5.42	Dry	7.7	Dry
146	5.86	Wet	8.9	Wet
147	5.42	Dry	7.5	Dry
148	5.89	Wet	8.7	Wet
149	5.46	Dry	7.6	Dry
150	5.85	Wet	8.9	Wet
151	5.43	Dry	7.4	Dry
152	5.84	Wet	8.6	Wet
153	5.56	Dry	7.7	Dry
154	5.87	Wet	8.5	Wet
155	5.54	Dry	7.4	Dry

156	5.82	Wet	8.9	Wet
157	5.54	Dry	7.5	Dry
158	5.78	Wet	9.1	Wet
159	5.43	Dry	7.7	Dry
160	5.87	Wet	9.2	Wet
161	5.46	Dry	7.8	Dry
162	5.79	Wet	8.9	Wet
163	5.56	Dry	7.6	Dry
164	5.89	Wet	8.5	Wet
165	5.42	Dry	7.5	Dry
166	5.75	Wet	8.6	Wet
167	5.46	Dry	7.4	Dry
168	5.8	Wet	8.9	Wet
169	5.41	Dry	7.9	Dry
170	5.79	Wet	9.1	Wet
171	5.52	Dry	7.8	Dry
172	5.85	Wet	9.3	Wet
173	5.48	Dry	7.9	Dry
174	5.79	Wet	8.9	Wet
175	5.49	Dry	7.8	Dry
176	5.84	Wet	9.2	Wet
177	5.56	Dry	7.6	Dry
178	5.88	Wet	9.1	Wet
179	5.62	Dry	7.8	Dry
180	5.87	Wet	8.9	Wet
181	5.63	Dry	7.9	Dry
182	5.86	Wet	9.1	Wet
183	5.55	Dry	7.4	Dry
184	5.88	Wet	9.5	Wet
185	5.62	Dry	7.3	Dry
186	5.86	Wet	9.8	Wet
187	5.71	Dry	7.6	Dry
188	5.92	Wet	9.7	Wet
189	5.70	Dry	7.5	Dry
190	5.93	Wet	9.5	Wet
191	5.70	Dry	7.4	Dry
192	5.95	Wet	9.8	Wet
193	5.69	Dry	7.5	Dry
194	5.92	Wet	9.7	Wet
195	5.66	Dry	7.3	Dry

196	5.91	Wet	9.7	Wet
197	5.64	Dry	7.2	Dry
198	5.96	Wet	9.8	Wet
199	5.66	Dry	7.3	Dry
200	5.98	Wet	9.7	Wet
201	5.65	Dry	7.6	Dry
202	5.98	Wet	10.0	Wet
203	5.66	Dry	7.6	Dry
204	5.96	Wet	9.8	Wet
205	5.68	Dry	7.8	Dry
206	5.94	Wet	9.7	Wet
207	5.66	Dry	7.6	Dry
208	5.97	Wet	9.5	Wet

Table 2: 7 Day Cycle Observations for Sample B

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample C (mm)	State	Test Sample C (gm)	State
1	4.23	Dry	4.5	Dry
2	4.69	Wet	7.2	Wet
3	4.14	Dry	5.2	Dry
4	5.16	Wet	9.3	Wet
5	4.27	Dry	5.2	Dry
6	5.3	Wet	9	Wet
7	4.16	Dry	5.2	Dry
8	5.84	Wet	11.8	Wet
9	4.44	Dry	6.3	Dry
10	5.27	Wet	9.2	Wet
11	4.02	Dry	5.2	Dry
12	5.32	Wet	10.8	Wet
13	4.25	Dry	5.4	Dry
14	5.9	Wet	9.8	Wet
15	4.36	Dry	5.5	Dry
16	6.12	Wet	9.7	Wet
17	4.42	Dry	5.7	Dry
18	6.2	Wet	10.1	Wet
19	4.41	Dry	5.8	Dry
20	6.26	Wet	9.9	Wet
21	4.48	Dry	5.7	Dry
22	6.28	Wet	9.8	Wet
23	4.5	Dry	5.9	Dry
24	6.3	Wet	10	Wet
25	4.47	Dry	6	Dry
26	6.29	Wet	10.1	Wet
27	4.49	Dry	5.9	Dry
28	6.31	Wet	10.2	Wet
29	4.51	Dry	6.1	Dry
30	6.32	Wet	10.2	Wet
31	4.49	Dry	5.9	Dry
32	6.35	Wet	10.3	Wet
33	4.53	Dry	6.1	Dry
34	6.42	Wet	10.3	Wet
35	4.55	Dry	6.1	Dry
36	6.41	Wet	10.2	Wet
37	4.53	Dry	6.2	Dry

38	6.39	Wet	10.1	Wet
39	4.52	Dry	5.9	Dry
40	6.43	Wet	10.2	Wet
41	4.56	Dry	6.1	Dry
42	6.47	Wet	10.1	Wet
43	4.54	Dry	6.2	Dry
44	6.45	Wet	10.3	Wet
45	4.55	Dry	6.4	Dry
46	6.48	Wet	10.2	Wet
47	4.58	Dry	6.3	Dry
48	6.45	Wet	10.4	Wet
49	4.52	Dry	6.2	Dry
50	6.47	Wet	10.2	Wet
51	4.53	Dry	6.3	Dry
52	6.52	Wet	10.1	Wet
53	4.48	Dry	6.2	Dry
54	6.56	Wet	10.3	Wet
55	4.49	Dry	6.2	Dry
56	6.58	Wet	10.4	Wet
57	4.53	Dry	6.4	Dry
58	6.58	Wet	10.4	Wet

Table 3: 30 Day Cycle Observations for Sample C

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample D (mm)	State	Test Sample D (gm)	State
1	3.98	Dry	4.5	Dry
2	6.1	Wet	16.3	Wet
3	4.12	Dry	4.6	Dry
4	6.41	Wet	16.8	Wet
5	4.26	Dry	4.7	Dry
6	6.45	Wet	16.7	Wet
7	4.3	Dry	5.1	Dry
8	6.51	Wet	16.8	Wet
9	4.42	Dry	5.1	Dry
10	6.52	Wet	16.9	Wet
11	4.23	Dry	5.2	Dry
12	6.56	Wet	17.1	Wet
13	4.28	Dry	5.1	Dry
14	6.57	Wet	17.3	Wet

Table 4: 90 Day Cycle Observations for Sample D

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample E (mm)	State	Test Sample E (gm)	State
1	3.96	Dry	4.5	Dry
2	7.67	Wet	28.7	Wet
3	3.99	Dry	8	Dry
4	8.45	Wet	30.1	Wet
5	4.11	Dry	8.3	Dry
6	9.10	Wet	32.3	Wet

Table 5: 180 Day Cycle Observations for Sample E

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample F (mm)	State	Test Sample F (gm)	State
1	3.94	Dry	4.7	Dry
2	9.42	Wet	41.7	Wet
3	4.36	Dry	8.4	Dry
4	11.96	Wet	53.2	Wet

Table 6: 416 Day Cycle Observations for Sample F

Obs. No.	Thickness Observations		Weight Observations	
	Test Sample F (mm)	State	Test Sample F (gm)	State
1	3.94	Dry	4.7	Dry
2	11.46	Wet	52.3	Wet