

Cariflex™

Polyisoprene Products

Wet-Gel Strength Improvement

June 2013

Lennert Dik, Bert Krutzer, and Nico van Dijk
Kraton Innovation Center Amsterdam

Wet-Gel Strength Improvement

We define wet-gel strength as the strength of a dipped film from a latex compound before curing.

Films from Natural Rubber Latex have good wet-gel strength. Many synthetic rubber latices have inferior wet-gel strength¹⁾. This can lead to problems in processing the synthetic-latex compound into dipped goods, as the uncured film has limited film integrity yet.

We have developed a method to quantitatively measure wet-gel strength to monitor wet-gel improvement.

We have identified a way to significantly improve the wet-gel strength of Cariflex IR-401 based compound.

¹⁾ Blackley, Polymer Latices Science and technology, volume 3

Wet-Gel Strength Improvement

Method to measure wet-gel strength

The following steps were taken to measure wet-gel strength:

1. Metal plates were first dipped in a coagulant solution and - after drying- in the latex compound.*)
2. The wet film was dried for 60 minutes at 50°C on the plates. Subsequently the film was carefully removed from the two sides of the plate and put on a thick polyester film (0.19 mm).
3. The film was covered with polyester to make it possible to cut dumbbells (type C, ISO 37) without damaging the film.
4. After clamping the sandwiched dumbbell, the two polyester films were cut and the tensile properties of the wet film were measured using an Instron tensile machine at a speed of 500 mm/min.
5. As it was difficult to measure the thickness due to the water inside the film, we correlated the wet-gel strength in Newton.

*) IR-401 + 5 phr Bostex 862 + 0.75 phr Manawet 172

Bostex™ is a trademark of Akron Dispersions
Manawet™ is a trademark of Manufacturers Chemicals



Wet-Gel Strength Improvement

Based on this method we have investigated ways to improve wet-gel strength of synthetic Cariflex™ IR-401 latex:

1. Several additives were tested: wet-gel improver (Styrene Maleic Anhydride), fillers
2. Alternative compounding formulations
3. Pre-curing of the dipped film at 130°C up to 3 minutes
4. Longer maturation times, up to 5 days at ambient temperature

These approaches have not led to significant improvement of the wet-gel strength. Only a minor increase could be achieved (from 0.4 to 0.5 N).

Subsequently, we have matured the compound at elevated temperatures (50°C). This appears to have a significant positive effect on the wet-gel strength.

Wet-Gel Strength Improvement

Effect of maturation conditions on wet-gel strength

Maturation (hour at 50°C)	Cariflex IR-401		Natural Rubber Latex	
	Wet Gel strength (N)	sd	Wet Gel strength	sd
0	0.42	0.01	5.54	1.27
3	0.5	0.37	5.48	1.75
6	0.95	0.03	7.98	1.30
9	1.68	0.08	12.05	2.74
12	2.04	0.15	12.22	0.96
15	2.27	0.05	11.04	1.60
18	2.48	0.03	9.75	1.93

The wet-gel strength is presented after maturation at 50° C for 0 to 18 hours. Wet-gel strength continuously increases in time.

The wet-gel strength of Natural Rubber Latex based films starts at a significantly higher level and seems to reach a maximum after 12 hours.

Although for IR0401 the wet-gel strength still does not reach the levels for Natural Rubber Latex, this increase may be sufficient to improve film integrity such that issues in processing are alleviated.

It should be noted that maturation at elevated temperatures may negatively affect the stability of the compound. We also found that the tensile strength of the film gradually decreased from 21-22 MPas to 16 MPas after 21 hours at 50° C

Wet-Gel Strength Improvement

Summarized:

Wet-gel strength of Cariflex IR-401 based films could be significantly improved by maturation of the compound at 50°C

Maturation at elevated temperatures may negatively affect the stability of the compound. Also, the final product properties may decline.

We recommend to carefully seek the balance between increased wet-gel strength on the one hand and compound stability and mechanical properties on the other hand. This may be different for different compound variations and processing conditions.

Kraton, the Kraton logo and design, the Cariflex logo and Cariflex are trademarks of Kraton Performance Polymers, Inc. Giving Innovators Their Edge is a service mark of Kraton Performance Polymers, Inc.

Publication Disclaimer:

We believe the information set forth above to be true and accurate, but any findings, recommendations or suggestions that may be made in the foregoing text are without any warranty or guarantee whatsoever, and shall establish no legal duty or responsibility on the part of the authors or any Kraton Polymers entity. Furthermore, nothing set forth above shall be construed as a recommendation to use any product in conflict with any existing patent rights. All Kraton Polymers entities expressly disclaim any and all liability for any damages or injuries arising out of any activities relating in any way to this publication or the information set forth herein.

©2013 Kraton Performance Polymers, Inc. All rights reserved.