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Vytex™ Natural Rubber Latex (NRL): Specialty Adhesives Using Eco-Friendly, Ultra-Low Protein NRL

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VYSTAR[™]
CORPORATION
www.vytex.com



Vystar Milestones

▶ 2000	• Vystar Founded
▶ 2005	• 1st Patent Issued
▶ 2006	• Production Scale-up Work Begins • 2 nd Patent Issued
▶ 2007	• Vytex SOP & Repeatability Study Completed
▶ 2008	• Global Trials Begin (45) • ASTM: New Category of Ultra-Low <i>Hevea</i> Protein NRL Proposed
▶ 2009	• 3 rd Patent Filed Vytex NRL adhesives enter market





Ultra-Low Protein NRL Adhesives Address Growing Concerns

**Standard NRL contains 2 – 5% by weight protein –
approximately 200 dissimilar proteins.**

13 known allergens

- Consumer groups call for warning labels on food packaging containing NRL: poses a potential threat to people with allergic sensitivities.

<http://www.sciencedaily.com/releases/2006/08/060809083433.htm>

- Researchers conclude that latex allergy may play a role in autism.

<http://iospress.metapress.com/content/w6820728082nu597/>





Ultra-low Protein NRL Adhesives Address Growing Concerns

- Thomas H. Moore, Commissioner of the U.S. Consumer Product Safety Commission

“it would behoove manufacturers of NRL to take steps to reduce the level of proteins that consumers can come into contact with, whether or not the end product is a medical device.”

<http://www.cpsc.gov/library/foia/foia04/petition/rubberla.pdf>

- Citizen’s Petition filed: U.S. EPA, Office of Pollution Prevention and Toxics, March 6th, 2008

Establish regulations requiring total protein content thresholds

<http://www.epa.gov/EPA-TOX/2008/April/Day-25/t9041.htm>





Synthetics: Health, Safety & Environmental Impact

- Petroleum Based
 - Styrene
 - Butadiene
- Risk of carcinogenesis and acute toxicity
- Can contain VOCs
- Non-biodegradable



Natural Rubber Latex: The Eco-Friendly Solution



- Derived from *Hevea brasiliensis* rubber tree
- Free of known or suspected carcinogens
- Non-toxic
- No VOCs
- Biodegradable
- Natural, renewable resource

Ultra Low Protein Vytex NRL makes adhesives “greener”





Vytex NRL Technology

**A new standardized source material
for the production of natural rubber products,
using green chemistry, to significantly reduce total
protein content**





Insoluble Aluminum Hydroxide in Vytex NRL

Vytex NRL Process

- Acts on the known affinity protein has for powder
- Uses insoluble aluminum hydroxide $\text{Al}(\text{OH})_3$ for the effective exchange/complexing of proteins from the field latex sap emulsion to/with $\text{Al}(\text{OH})_3$

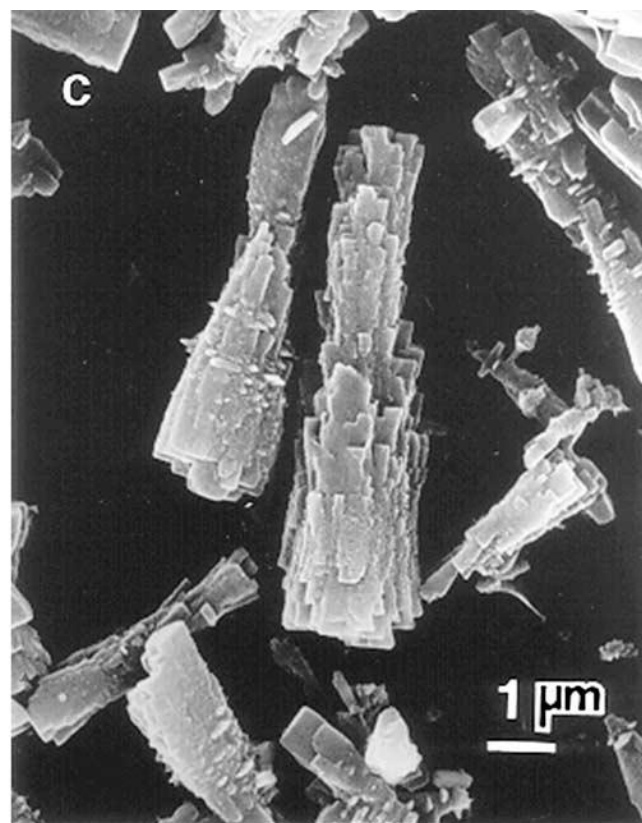
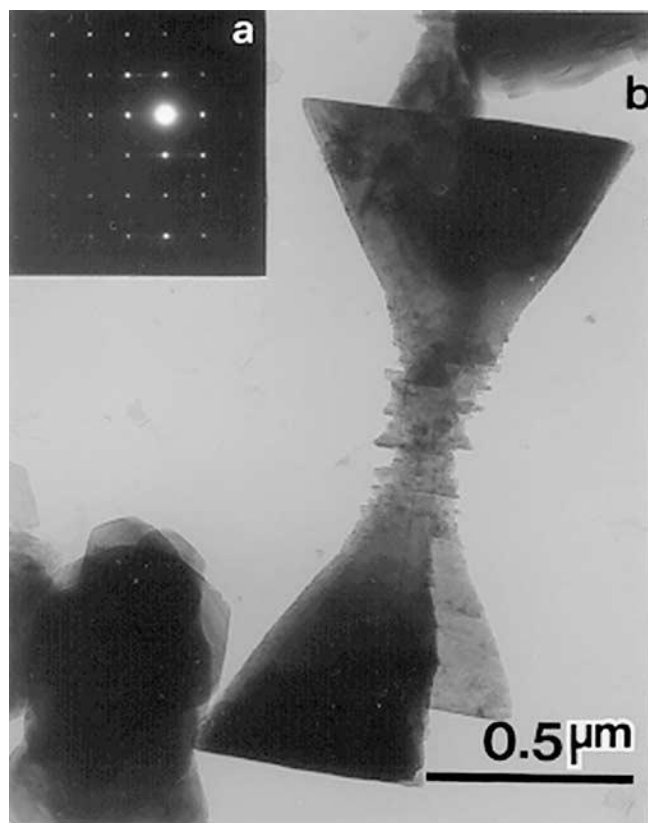
The Results

- Effectively removes total and antigenic proteins without diminishing the important physical properties of NRL
- Provides equal or improved chemical and physical properties to NRL
- Demonstrates excellent resistance to aging
- Improves stability





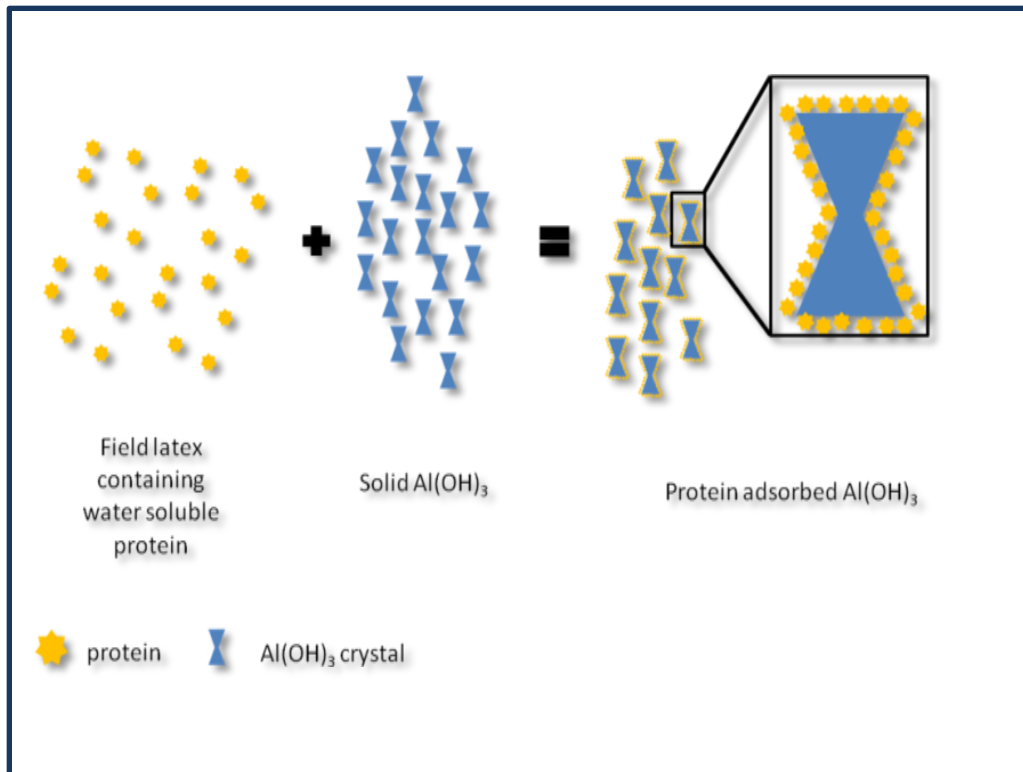
$\text{Al}(\text{OH})_3$ Crystals Generated in Distilled Water



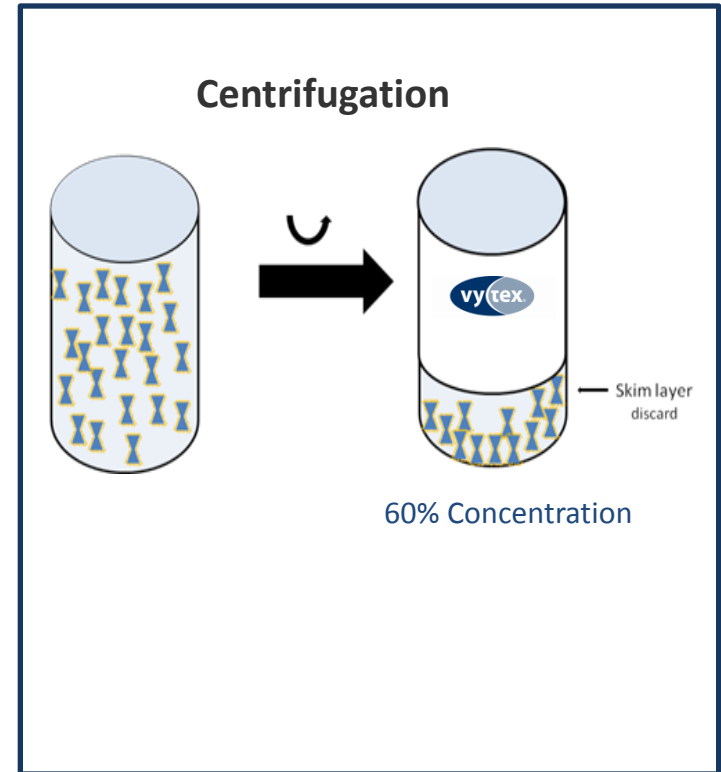
Antunes et al. 2002 Mat Chem Phys 76:243-249



Vytex NRL Process



Protein Adsorption



Protein Removal





Typical Vytex NRL Protein Behavior Upon Aging

Sample ID	% Reduction Compared to Non-Vytex NRL Sample	ELISA ASTM D-6499-07 µg/g
Vytex NRL fresh sample	28%	2.3
Vytex NRL 21-day aging	89%	4.9
Vytex NRL 6-month aging	89%	6.4
Vytex NRL 1-year aging	n/a	4.7
Non-Vytex NRL fresh sample	n/a	3.2
Non-Vytex NRL 21- day aging	n/a	56.3
Non-Vytex NRL 6-month aging	n/a	58.7

* Well over 500 samples have been tested for protein

Source: Independent test results from Donald Guthrie Foundation, Sayre, PA. www.guthrie.org



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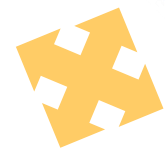


Colloidal Properties Vytex NRL & Vytex LA

Property	Specifications (HA)	Typical Vytex NRL	Specifications (LA)	Typical Vytex LA	ISO Standard
Viscosity cps (sp 2/60)	20 – 100	81	20 – 100	92	1652
TSC (%)	60.0 – 61.5	60.88	60.0 – 61.5	60.34	124
Alkalinity (%)	0.65 -0.8	0.71	0.20 - 0.29	0.24	125
VFA no.	0.07 max.	0.018	0.07 max.	0.019	506
Mechanical Stability	650 Seconds min.	1860	650 Seconds min.	1870	35
Coagulum (mesh# 80) ppm	100 max.	23	100 max.	19	706
pH	10.5 – 11.5	10.87	9.5 – 10.5	9.89	976



Vytex NRL: From Tree to Product



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Cold Seal & Pressure Sensitive Adhesives

Chemical & Physical Properties

Test Parameter	Cold Seal Non-Vytex NRL	Cold Seal Vytex NRL	PSA Non-Vytex NRL	PSA Vytex NRL
Brookfield Viscosity centipoise (cps)	1,200	1,400	2,600	2,400
pH	10	10	9	9
Storage Modulus @ 120°C (Mpa)	2,175	2,085	2,683	2,959
Onset Tg°C	-71.82	-73.66	-64.41	-64.06
Peak Tg°C	-66.20	-65.37	-53.09	-58.07

Source: Independent testing provided by National Polymer Laboratories, Akron, OH
www.nationalpolymerlabs.com



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Cold Seal & Pressure Sensitive Adhesives

Physical Properties

Test Parameter	Cold Seal Non-Vytex NRL	Cold Seal Vytex NRL	PSA Non-Vytex NRL	PSA Vytex NRL
T-Peel (Avg) units: (# / lineal in.) ASTM D1876	1.0	0.9	n/a	n/a
Peel Adhesion (Avg) units: (# / lineal in.) ASTM D3330	n/a	n/a	3.3	4.0
Loop Tack (Avg) units: (# / in ² .) ASTM D6195	2.7	3.3	37.5	36.8
Shear (minutes) (Avg) units: ASTM D6195	n/a	n/a	>10,080	>10,080

Source: Independent testing provided by National Polymer Laboratories, Akron, OH
www.nationalpolymerlabs.com



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Unformulated Cold Seal Characteristics

Test Parameter	Vytex NRL	Non-Vytex NRL
T-Peel	0.88 lbs/in	0.88 lbs/in
PAFT	185	204
SAFT	218	252
TOTAL PROTEIN	<200 ug/dm ²	~600 ug/dm ²
ANTIGENIC PROTEIN	<10 ug/dm ²	>55 ug/dm ²

Test Conditions:

1. 100 lb/ream Kraft liner board
2. 20-25 g/m² coat weight
3. 8-lb roller
4. 100 gram static load (ASTM D4498)
5. Total protein content (ASTM D 5712-05)
6. Antigenic protein content (ASTM D 6499-07)

Source: Testing provided by Adherent Laboratories Inc., an independent laboratory and ASC member- www.adherentlabs.com





Vytex NRL Formulated Cold Seal Adhesive Characteristics

ASTM D6499-07 (Antigenic Protein)	<10 ug/dm²
ASTM D5712-05 (Total Protein)	<200 ug/dm²

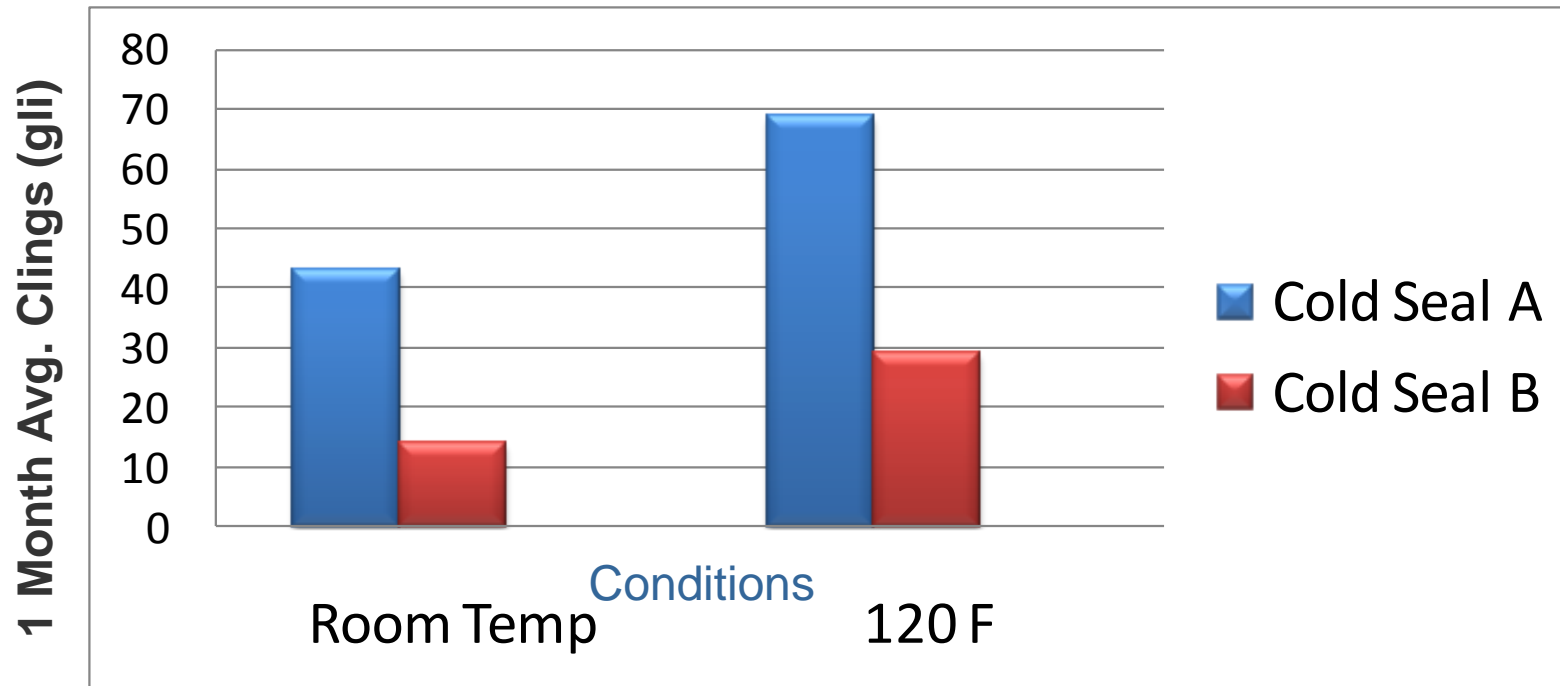
- Tested 2 cold seal formulations substituting Vytex NRL for non-Vytex NRL.
- Coat weight used was 3.0 lbs/ream
- Cling and Bond data gathered after 1 month block
- Sitting at room temperature and 120°F

Source: Testing provided by a leading adhesive manufacturer and ASC member





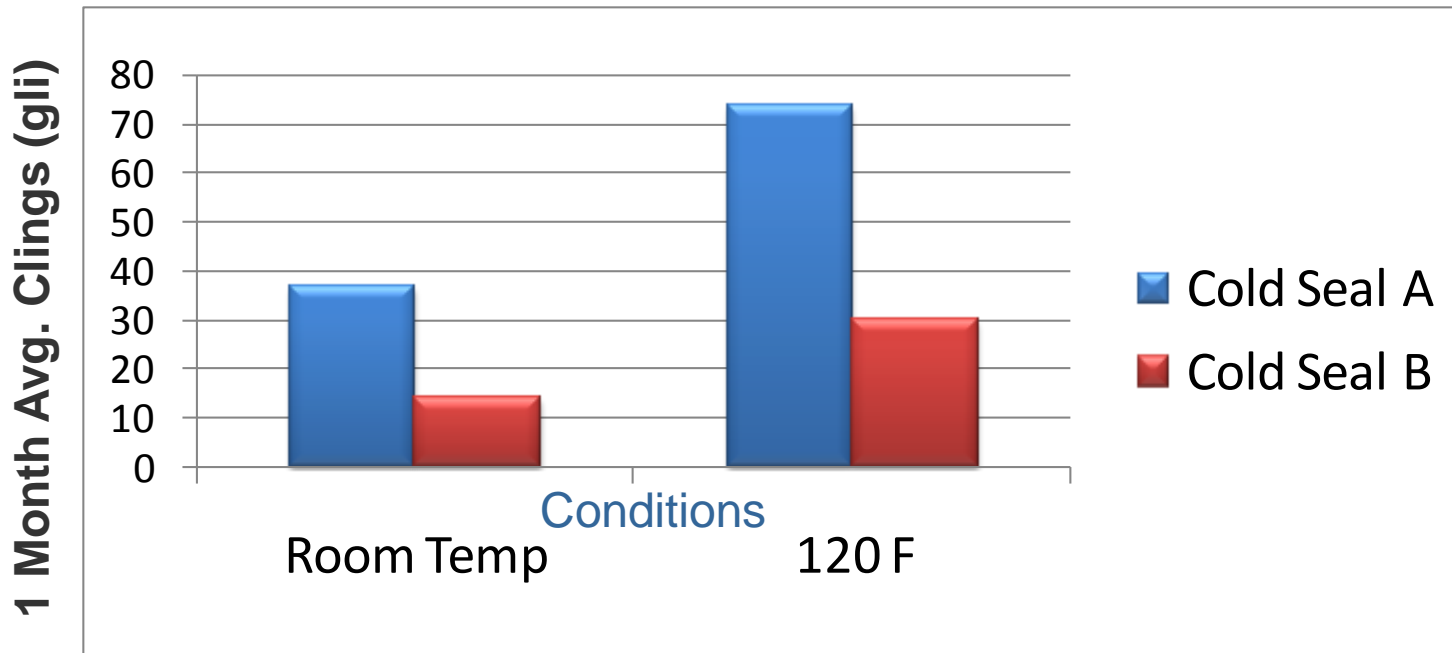
Release Film/Cavitated OPP



Source: Testing provided by a leading adhesive manufacturer and ASC member



Release Film/Met-OPP



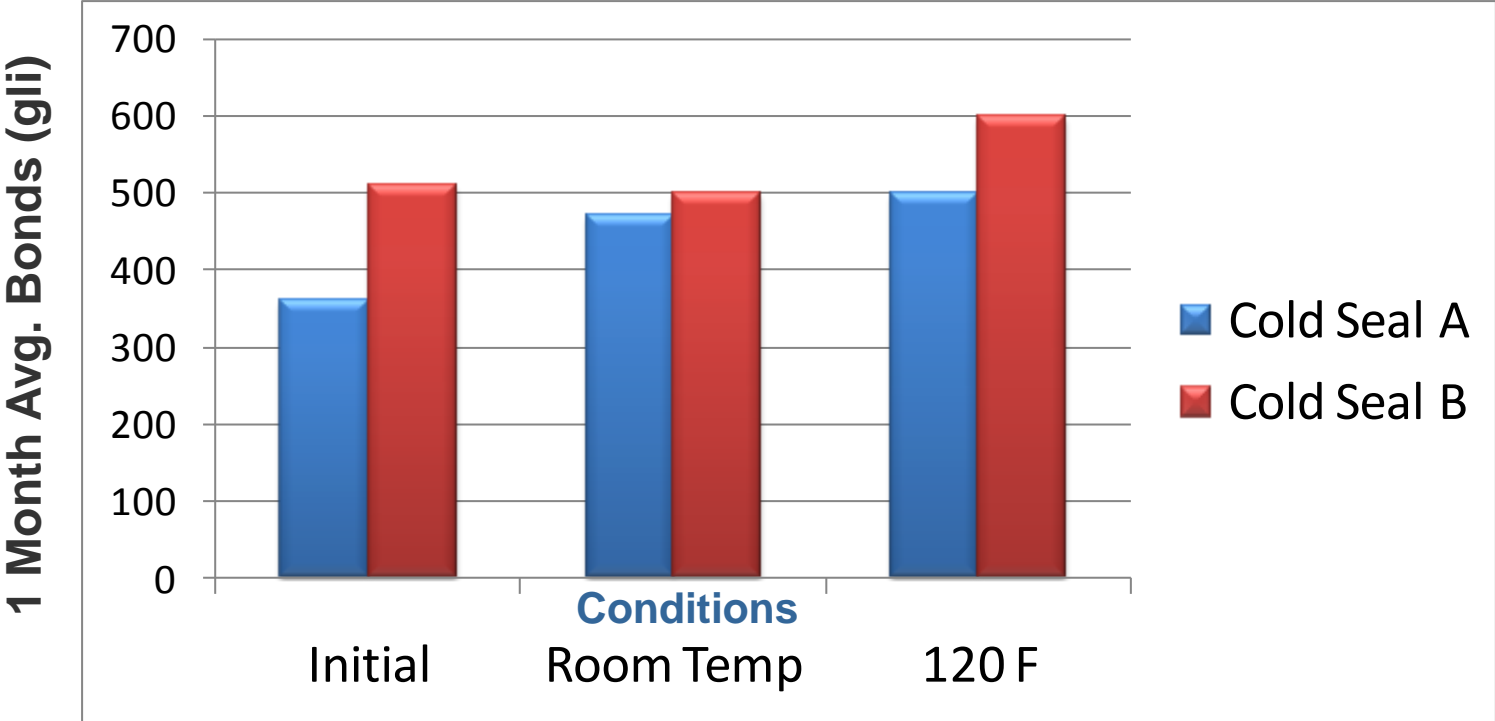
Source: Testing provided by a leading adhesive manufacturer and ASC member



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Release Film/Cavitated OPP



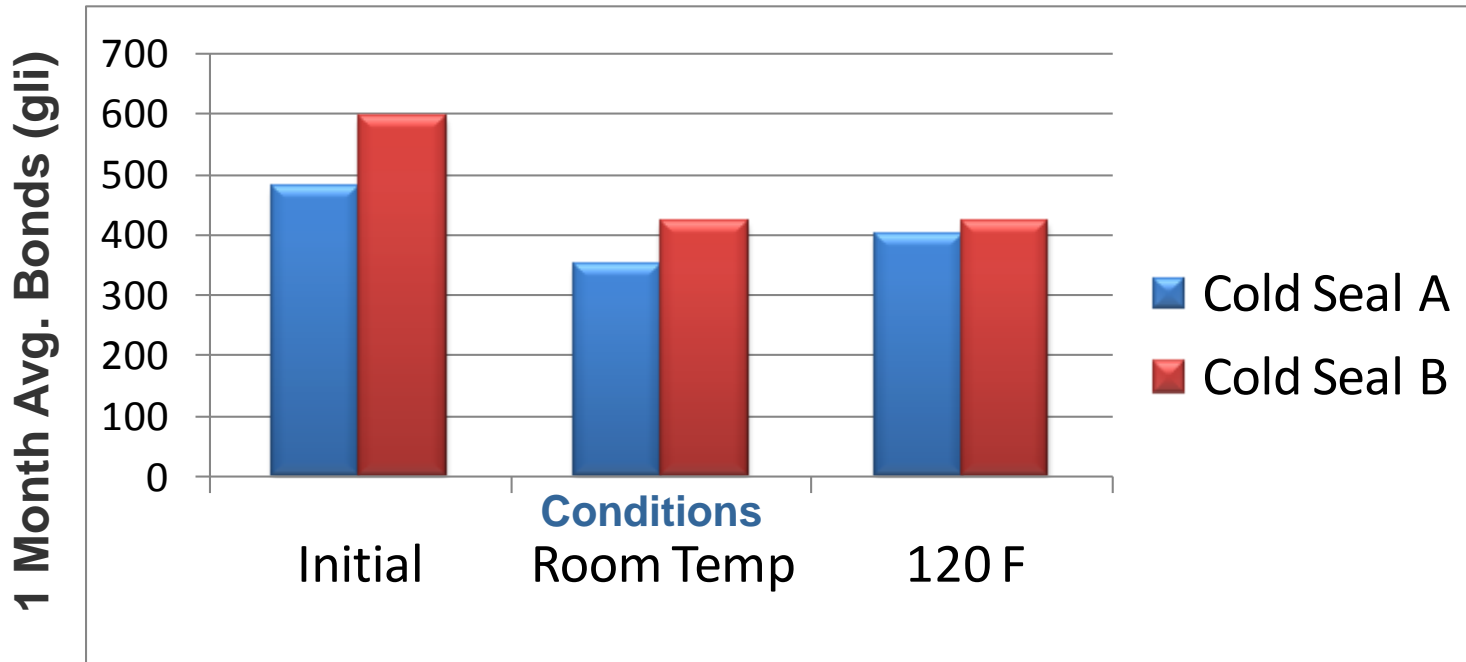
Source: Testing provided by a leading adhesive manufacturer and ASC member



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Release Film/Met-OPP



Source: Testing provided by a leading adhesive manufacturer and ASC member



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Resources

Technical Tools

- www.vytex.com
- Technical Bulletin
- Technical Data Guide
- Technical Papers
- COA
- MSDS

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Johnwyn Hollman

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johnwyn@centrousa.com





Vytex NRL – A High Performance, Ultra Low Protein, Green Solution for Adhesives

Vytex Natural Rubber Latex:

- **Excels** in adhesive applications over *Hevea* NRL and synthetics
- **Demonstrates** excellent stability, compoundability and coating properties
- **Contains** total and antigenic protein levels considered “safer” by latex industry standards
- **Exhibits** very low odor
- **Incorporates** into existing manufacturing processes easily
- **Accomplishes** corporate achievement of Green Initiatives
- **Provides** a healthy environment for workers and consumers





Take Vytex NRL for a Test Drive

- Complimentary 1 gallon sample (HA or LA)
- Evaluators provide non-proprietary testing results
- Additional quantities available
- Contact Johnwyn Hollman @ Centrotech

757-518-2300

johnwyn@centrousa.com

- Ships from Baltimore, MD in 5-7 days

