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

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Matthew Clark, William Doyle, Jim Judson and Sandra Parker

www.vytex.com
Vystar Milestones

- **2000**
  - Vystar Founded

- **2005**
  - 1st Patent Issued

- **2006**
  - Production Scale-up Work Begins
  - 2nd Patent Issued

- **2007**
  - Vytex SOP & Repeatability Study Completed

- **2008**
  - Global Trials Begin (45)
  - ASTM: New Category of Ultra-Low Hevea Protein NRL Proposed

- **2009**
  - 3rd 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.

- Researchers conclude that latex allergy may play a role in autism.
  [http://iospress.metapress.com/content/w6820728082nu597/](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.”
  

  
  Establish regulations requiring total protein content thresholds
  
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”
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 $\text{Al(OH)}_3$ for the effective exchange/complexing of proteins from the field latex sap emulsion to/with $\text{Al(OH)}_3$

**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
Al(OH)$_3$ Crystals Generated in Distilled Water

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

Protein Adsorption

Protein Removal

Centrifugation

60% Concentration

Field latex containing water soluble protein + Solid Al(OH)$_3$ = Protein adsorbed Al(OH)$_3$

protein  Al(OH)$_3$ crystal

www.vytex.com
Typical Vytex NRL Protein Behavior Upon Aging

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

* Well over 500 samples have been tested for protein

Source: Independent test results from Donald Guthrie Foundation, Sayre, PA. www.guthrie.org
## Colloidal Properties Vytex NRL & Vytex LA

<table>
<thead>
<tr>
<th>Property</th>
<th>Specifications (HA)</th>
<th>Typical Vytex NRL</th>
<th>Specifications (LA)</th>
<th>Typical Vytex LA</th>
<th>ISO Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity cps (sp 2/60)</td>
<td>20 – 100</td>
<td>81</td>
<td>20 – 100</td>
<td>92</td>
<td>1652</td>
</tr>
<tr>
<td>TSC (%)</td>
<td>60.0 – 61.5</td>
<td>60.88</td>
<td>60.0 – 61.5</td>
<td>60.34</td>
<td>124</td>
</tr>
<tr>
<td>Alkalinity (%)</td>
<td>0.65 - 0.8</td>
<td>0.71</td>
<td>0.20 - 0.29</td>
<td>0.24</td>
<td>125</td>
</tr>
<tr>
<td>VFA no.</td>
<td>0.07 max.</td>
<td>0.018</td>
<td>0.07 max.</td>
<td>0.019</td>
<td>506</td>
</tr>
<tr>
<td>Mechanical Stability</td>
<td>650 Seconds min.</td>
<td>1860</td>
<td>650 Seconds min.</td>
<td>1870</td>
<td>35</td>
</tr>
<tr>
<td>Coagulum (mesh# 80) ppm</td>
<td>100 max.</td>
<td>23</td>
<td>100 max.</td>
<td>19</td>
<td>706</td>
</tr>
<tr>
<td>pH</td>
<td>10.5 – 11.5</td>
<td>10.87</td>
<td>9.5 – 10.5</td>
<td>9.89</td>
<td>976</td>
</tr>
</tbody>
</table>
Vytex NRL: From Tree to Product
Cold Seal & Pressure Sensitive Adhesives

Chemical & Physical Properties

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

Source: Independent testing provided by National Polymer Laboratories, Akron, OH
www.nationalpolymerlabs.com
Cold Seal & Pressure Sensitive Adhesives

Physical Properties

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Cold Seal Non-Vytex NRL</th>
<th>Cold Seal Vytex NRL</th>
<th>PSA Non-Vytex NRL</th>
<th>PSA Vytex NRL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T-Peel (Avg) units: (# / lineal in.)</strong></td>
<td>1.0</td>
<td>0.9</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>ASTM D1876</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Peel Adhesion (Avg) units: (# / lineal in.)</strong></td>
<td>n/a</td>
<td>n/a</td>
<td>3.3</td>
<td>4.0</td>
</tr>
<tr>
<td>ASTM D3330</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Loop Tack (Avg) units: (# / in².)</strong></td>
<td>2.7</td>
<td>3.3</td>
<td>37.5</td>
<td>36.8</td>
</tr>
<tr>
<td>ASTM D6195</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shear (minutes) (Avg) units:</strong></td>
<td>n/a</td>
<td>n/a</td>
<td>&gt;10,080</td>
<td>&gt;10,080</td>
</tr>
<tr>
<td>ASTM D6195</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Independent testing provided by National Polymer Laboratories, Akron, OH

www.nationalpolymerlabs.com
### Unformulated Cold Seal Characteristics

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Vytex NRL</th>
<th>Non-Vytex NRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-Peel</td>
<td>0.88 lbs/in</td>
<td>0.88 lbs/in</td>
</tr>
<tr>
<td>PAFT</td>
<td>185</td>
<td>204</td>
</tr>
<tr>
<td>SAFT</td>
<td>218</td>
<td>252</td>
</tr>
<tr>
<td>TOTAL PROTEIN</td>
<td>&lt;200 ug/dm²</td>
<td>~600 ug/dm²</td>
</tr>
<tr>
<td>ANTIGENIC PROTEIN</td>
<td>&lt;10 ug/dm²</td>
<td>&gt;55 ug/dm²</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D6499-07 (Antigenic Protein)</td>
<td>&lt;10 ug/dm²</td>
</tr>
<tr>
<td>ASTM D5712-05 (Total Protein)</td>
<td>&lt;200 ug/dm²</td>
</tr>
</tbody>
</table>

- 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

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Resources

Technical Tools

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

Sales/Technical Support

Minneapolis 612-521-1385
Jim Judson jjudson@vytex.com
Mike Dochniak mdochniak@vytex.com

Atlanta 770-965-0383
Sandra Parker sparker@vytex.com
Matt Clark mclark@vytex.com

Centrotrade 757-518-2300
(Distributor)
Johnwyn Hollman 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 @ Centrotrade
  
  757-518-2300  
  johnwyn@centrousa.com

- Ships from Baltimore, MD in 5-7 days