RECLAIMED RUBBER
A new life for an old product

By
Andy Rushton
Managing Director
J. Allcock & Sons Ltd
My History

• 30+ years of selling Reclaim
• 30+ years of selling Crumb
• Almost 30 years of Manufacturing Crumb & Granules
• De-Link Distributor
• DeVulCo2 consortium member
• Remould consortium member
Contents

• What is Reclaimed Rubber?
• Why use Reclaim?
• Why Reclaim demand fell?
• Why is Reclaim now being used more?
• Financial Advantages of Using Reclaim
• Technical advantages of using Reclaim
• Reclaim the next Stage- Devulcanisation
Recycling of Rubber

• 3 Ways to Recycle Rubber
  1. Recycling
  2. Reclaiming
  3. Devulcanisation
What is Reclaimed Rubber?

- IT IS NOT CRUMB OR GRANULATE
IT IS NOT DEVULCANISATION
Description

• Reclaimed Rubber is cured rubber that has passed through a Thermo-Chemical process.
• This process softens and swells the rubber
• The viscosity of the rubber is reduced by shortening the polymer chain by mechanical shear and chemical action
• Yes there are some crosslinks broken
• Yes there are some double bonds broken
How is Reclaim made?

The first recorded reclaiming process dates back to 1846 when Muriate of Lime (Calcium Chloride) was used to remove free sulphur. The first process was the “Pan Process” in 1858. So its not a new idea.

Although there have been many different methods they all follow a similar path.
Step 1

• Collection and Selection of suitable materials

This is probably the most important step. In order to get a uniform and consistent product the correct materials must be selected (contaminant free). This part of the process was overlooked for many years producing inconsistent materials.
Step 2

- The rubber has to be reduced in size and any other contaminants removed.

In Tyre Reclaim this consists of removing the bead wire, cutting out the side wall then granulating the remaining materials to below 4mm aiding the removal of textiles and metals.

In Butyl Reclaim Tubes are de-valved and patches removed before being granulated.
Step 3

• Blending

The rubbers are mixed with the chemicals required and the oils needed for the reclaiming process to take place.

All the chemicals and oils used today are REACH registered and compliant on PAH’s
Step 4

• Digestion.
This is where the materials are subjected to heat to allow the reactions to occur.
There are 2 main ways this can be done.
In a digester using steam pressure to give 160° C
Or
Mechanically produce heat.
Step 5

- Mastication

Either in the extruder or on a 2 roll mill the rubber is physically worked to break the polymer chain. Also helps refining and blending the reclaim.
Step 6

• Filtering

The better quality producers at this point extrude the materials through a 60’s mesh (250 µm) filter to remove any undigested materials (nibs)
Step 7

- **Finishing**

The filtered material is either extruded into blocks or is put back on a mill where a paper thin sheet is built up to 15mm thickness before being cut into blocks, coated in anti-tack agent and weighed off into the desired bundle weight (normally 25 kilos, but any bundle size is possible on request)
Why use Reclaim?

Generally there are 3 main reasons to use Reclaim:

1. Source of Rubber Hydrocarbon
2. Source of Carbon Black
3. Processing Aid
Rubber Hydrocarbon

• Attractive Price
Most obvious reason as Reclaim is less expensive than Virgin Rubber. Reclaim generally contains approx. 50%+ RHC. For every 1% Reclaim you add you save 0.6% on Compound Cost*

• Price Stability
Price is not affected by NR and SBR prices.

• Other Savings include reduced mixing times and power consumption

• Based on an average compound cost of €2.00/kg (£1.70/kg or $2.75/kg)
Reclaim Prices vs NR Prices
Carbon Black

• Tyre reclaim contains approximately 27% of reinforcing Carbon Black

• Easy to use as a Black Pigment Masterbatch

• Much cleaner and easier to handle
Processing Aid

- Improved Processing
- Uniformity
- Low Heat Development
- Low Thermoplasticity
- Minimum Reversion
- Low Swelling and Shrinkage
- High Rate of Cure
- Good Aging
- Good Shape Retention
- Improved Tack
Why Reclaim demand fell?

• Tyre Reclaim contains approx. 50% RHC so you compare it to 50% of NR price
• There was a long period of time when Reclaim was not economically attractive
• Quality was inconsistent
• Commercial Rubber production was moving east
• Mixing Technology was improving
• New Technologists knew little or nothing of Reclaim and Crumb
Why is Reclaim now being used more?

• From 2000 onwards NR & SBR prices began rising
• By 2003 it became financially attractive
• Users found additional benefits
• Qualities of Reclaim improving
• Green Credentials
Technical advantages of using Reclaim

• Shorter Mixing Times
• Less Power Consumed
• Less Heat Build up
• Faster Processing
• Low Thermoplasticity
• Reduced Swelling and Shrinkage
• High Cure Rate
• Minimum Reversion
• Good Aging
RECLAIMS AVAILABLE

• TYRE
• BUTYL
• EPDM
• NATURAL TUBE
• DRAB
• SHOE SOLING
• FKM ?
Current Markets

• Tyre Reclaim
  Tyres- New
  Retreading
  General Moulding
  Belting
  Adhesives
  Footwear
  Sheeting/Matting
Current Markets

• Butyl Reclalm
  Inner Tubes
  Tyre Lining
  Tyre Repair
  Cable Bedding Compound
  Sound Reduction
  Sheeting & Belting
  Mastics and Adhesives
RECLAIM IN USE

• THE FOLLOWING TEST DATA WAS MAINLY PRODUCED BY LRCCP IN PARIS

• WORK WAS PART OF BIOMAS PROJECT FOR MAJOR RUBBER USERS IN FRANCE
## RECLAIM IN USE

- **Product Description** GRP NRM 35R/GR444
- **Colour** Black
- **Form** “Blanket”

### Composition

<table>
<thead>
<tr>
<th>Substance</th>
<th>% by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Black</td>
<td>27 ± 3</td>
</tr>
<tr>
<td>RHC (by difference)</td>
<td>47 min</td>
</tr>
<tr>
<td>Ash Content</td>
<td>7 ± 2</td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>15 ± 3</td>
</tr>
</tbody>
</table>

### Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td></td>
<td>1.14 ± 0.02</td>
</tr>
<tr>
<td>Mooney Viscosity</td>
<td>ML 1+4 at 100°C</td>
<td>25 – 45</td>
</tr>
<tr>
<td>Hardness</td>
<td>Shore A</td>
<td>59 ± 3</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>kg/cm²</td>
<td>35 min</td>
</tr>
<tr>
<td>Elongation @ Break</td>
<td>%</td>
<td>190 min</td>
</tr>
<tr>
<td>State of refining</td>
<td></td>
<td>Medium</td>
</tr>
</tbody>
</table>
# Test Tyre Tread Formulations

<table>
<thead>
<tr>
<th>Compound</th>
<th>Reference</th>
<th>+ 5% of GRP NRM 35 R/GR 444</th>
<th>+ 10% of GRP NRM 35 R/GR 444</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>BR</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>GRP NRM 35 R/GR 444</strong></td>
<td></td>
<td><strong>8,75</strong></td>
<td><strong>17,5</strong></td>
</tr>
<tr>
<td>Carbon Black</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Process Oil</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Zinc Oxide</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6PPD</td>
<td>1,2</td>
<td>1,2</td>
<td>1,2</td>
</tr>
<tr>
<td>Wax</td>
<td>1,2</td>
<td>1,2</td>
<td>1,2</td>
</tr>
<tr>
<td>Sulphur</td>
<td>1,4</td>
<td>1,4</td>
<td>1,4</td>
</tr>
<tr>
<td>CBS</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>174,8</strong></td>
<td><strong>183.55</strong></td>
<td><strong>192,3</strong></td>
</tr>
</tbody>
</table>
# Mixing Protocol

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t = 0 )</td>
<td>NR + BR + GRP NRM 35 R/ GR 444</td>
</tr>
<tr>
<td>( t = 1:00 )</td>
<td>ZnO + Stearic acid + 6PPD + Wax</td>
</tr>
<tr>
<td>( t = 1:30 )</td>
<td>½ Carbon Black + Oil</td>
</tr>
<tr>
<td>( t = 2:30 )</td>
<td>½ Carbon Black</td>
</tr>
<tr>
<td>( t = 3:30 )</td>
<td>Cleaning</td>
</tr>
<tr>
<td>( t = 4:30 )</td>
<td>Accelerating rotors 60 rpm \rightarrow 80 rpm</td>
</tr>
<tr>
<td>( t = 5:00 )</td>
<td>Discharge onto mill</td>
</tr>
</tbody>
</table>

Cure System added
## Test Results

<table>
<thead>
<tr>
<th>Measured characteristics</th>
<th>Standards used</th>
<th>Reference</th>
<th>+ 5% of GRP NRM 35 R/GR 444</th>
<th>+ 10% of GRP NRM 35 R/GR 444</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML(1+4) at 100°C (MU)</td>
<td>NF ISO 289-1</td>
<td>30</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>ML (dNm)</td>
<td>NF ISO 3417</td>
<td>1,19</td>
<td>1,19</td>
<td>1,19</td>
</tr>
<tr>
<td>MH (dNm)</td>
<td>NF ISO 3417</td>
<td>15,31</td>
<td>14,29</td>
<td>13,24</td>
</tr>
<tr>
<td>MH-ML (dNm)</td>
<td>NF ISO 3417</td>
<td>14,12</td>
<td>13,09</td>
<td>12,05</td>
</tr>
<tr>
<td>ts2 (min : s)</td>
<td>NF ISO 3417</td>
<td>02:49</td>
<td>02:25</td>
<td>01:59</td>
</tr>
<tr>
<td>t_{98} (min : s)</td>
<td>NF ISO 3417</td>
<td>06:39</td>
<td>05:57</td>
<td>05:13</td>
</tr>
</tbody>
</table>
# Test Results

<table>
<thead>
<tr>
<th>Measured characteristics</th>
<th>Reference</th>
<th>+ 5% GR 444</th>
<th>+ 10% GR 444</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness Shore A (3s)</td>
<td>56 ± 0,1</td>
<td>56 ± 0,1</td>
<td>55 ± 0,1</td>
</tr>
<tr>
<td>Density</td>
<td>1,09 ± 0,002</td>
<td>1,09 ± 0,001</td>
<td>1,10 ± 0,001</td>
</tr>
<tr>
<td>Tensile strength (MPa)</td>
<td>23,3 ± 1,2</td>
<td>21,7 ± 0,4</td>
<td>20,0 ± 0,4</td>
</tr>
<tr>
<td>Elongation at break (%)</td>
<td>589 ± 11</td>
<td>587 ± 7</td>
<td>585 ± 7</td>
</tr>
<tr>
<td>Modulus 100% (MPa)</td>
<td>1,7 ± 0,05</td>
<td>1,70 ± 0,05</td>
<td>1,69 ± 0,05</td>
</tr>
<tr>
<td>Modulus 300% (MPa)</td>
<td>8,1 ± 0,20</td>
<td>7,77 ± 0,22</td>
<td>7,43 ± 0,22</td>
</tr>
<tr>
<td>M300 / M100</td>
<td>4,8</td>
<td>4,60</td>
<td>4,40</td>
</tr>
<tr>
<td>Tear strength delft (N)</td>
<td>103 ± 5</td>
<td>103 ± 9</td>
<td>102 ± 13</td>
</tr>
<tr>
<td>Angle Tear Strength (kN/m)</td>
<td>77 ± 18</td>
<td>74 ± 14</td>
<td>69 ± 11</td>
</tr>
<tr>
<td>Compression set 70h at 70°C (%)</td>
<td>27 ± 1</td>
<td>31 ± 1</td>
<td>36 ± 1</td>
</tr>
<tr>
<td>FTFT at 100%</td>
<td>92.10³ ± 22.10³</td>
<td>90.40³ ± 22.10³</td>
<td>89.10³ ± 22.10³</td>
</tr>
<tr>
<td>Abrasion (mm³)</td>
<td>111 ± 3</td>
<td>121 ± 3</td>
<td>131 ± 4</td>
</tr>
</tbody>
</table>
Conclusion

• Tyre Reclaim can be used at 5% with no formulation change
• At 10% it can be used but it is more subjective depending on the compound formulation may need adjustment
• To attain higher loadings you will have to use better qualities of Reclaim
Devulcanisation

Is it the Future?
My opinion. YES so long as !!
For 5 years investigating a process
Reclaim’s are Generic
Devulc’s can be compound specific
Devulcanisation

• Compound and/or Customer Specific
• Smaller Batch Sizes are possible
• Locally produced
• Smaller capital outlay
• Greater additions possible
• Already proved 25% + is possible in Tyres
• Tends to be more expensive than Reclaim
Thank You for listening

ANY QUESTIONS?

Andy Rushton
Managing Director
J. Allcock & Sons Ltd
Tel +44-161-223-7181
Mob +44-7973-159295
Email andy@allcocks.co.uk
Data available at www.allcocks.co.uk