Processing Influences of Additives on a Silica Filled Tread

by:

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Objective
Green tire tread

- Examine Silica influence
- Additive addition point
- Influence of zinc soap

- Mixing
- Processing
- Physicals

BANBURY

1600 ml
65-70% fill factor
3 pass mix
Addition variable, either 1\textsuperscript{st} pass or 2\textsuperscript{nd}
EXTRUDER

Brabender 17mm 20-1
3-1 compression screw
Garvey die
Triangle die
3 zones at 100C

Additive Variations

- Struktol EF 44A – soap blend
  - DP 96C
  - Zn 8.5%
- Struktol JV 46F (exp. Mixed surfactant)
  - DP ~95C
  - Zn 5.1%
FORMULATION

- Duradene 751  103.1
- Taktene 220  25
- Ultrasil 7000 GR  80  50  30
- N220  0  20  40
- SCA 98 CB 12.5  8  5  (TESPT-50%)
- Sundex 790  5

Formulation
Addition point

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>1st or 2nd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wax</td>
<td>1.5</td>
<td>1st or 2nd</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>1.0</td>
<td>1st or 2nd</td>
</tr>
<tr>
<td>6PPD</td>
<td>2.0</td>
<td>1st or 2nd</td>
</tr>
<tr>
<td>EF 44A</td>
<td>0 or 3</td>
<td>1st or 2nd</td>
</tr>
<tr>
<td>46F</td>
<td>0 or 3</td>
<td>1st or 2nd</td>
</tr>
<tr>
<td>ZnO</td>
<td>2.5</td>
<td>2nd</td>
</tr>
</tbody>
</table>

Sulfur  1.4
CBS  1.7
DPG  2.0
Silica – 80phr; No additive; First pass

Silica – 50phr; No additive; First pass

Silica – 30phr; No additive; First pass
Mix Data - First Pass

Silica – 80phr; EF44A in 1st pass (blue)

Silica – 50phr; EF44A in 1st pass

Silica – 30phr; EF44A in 1st pass
Silica – 80phr; Additive in 2\textsuperscript{nd} pass

Red Control
Blue EF 44A

Silica – 50phr; Additive in 2\textsuperscript{nd} pass

Silica – 30phr; Additive in 2\textsuperscript{nd} pass
Silica – 80phr; EF44A in 1st pass

Silica – 50phr; EF44A in 1st pass

Silica – 30phr; EF44A in 1st pass
Garvey Die – 80 phr Silica - 25 RPM

Silica Influence

2nd pass

Blank  EF44A  46F

2nd Pass

1st Pass

80 silica  50 silica  30 silica

control  46F

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Extrudate Profile
50 parts Silica 1st pass additives

127 133/140 153 °C

Temperature

Influence of ML(1+4) on Torque

ML(1+4)@100°C

Torque

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Cured Properties
100 % Modulus

Heat Build up
Firestone Flexometer
2nd pass

MPa

ºC

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TAN DELTA

1hz
MER-compression

Influence of Addition
Tan Delta (100 °C)
Summary

- Additive addition point
  - Limited changes in processing effects
  - Some changes in physicals
- Surfactant JV 46F
  - Major changes in processing
    - Excellent extrusion properties
  - Improved dynamic physical properties
  - Modifies polar filler/nonpolar rubber interface
Future work

• Look at other mixing procedures
  – Temperature influences
  – Chemical addition points
• Vary the silane structure
• Study influence of storage conditions
• Study concentration effects

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