Innovative Solutions for the Rubber Industry: Tailoring Naphthenes, Plastisizers, EPDM Rubbers

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Innovations in Rubber Design
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Nynas
Outline

- Changes in base & process oil market
  - An introduction

- Performance of naphthenic oils
  - Comparative study of rubber process oils in EPDM
  - Quick review of the results in F-SSBR
Introduction to Base & Process Oil Market
Base oil classification

GROUP I
Unsaturation index < 80/120
Saturates > 95\% and/or
Polyunsaturates < 5\%

GROUP II
Unsaturation index < 80/120
Saturates > 95\% and
Polyunsaturates < 5\%

GROUP III
Unsaturation index < 120
Saturates > 95\% and
Polyunsaturates < 5\%

GROUP IV
Poly-alpha-olefin (PAO)

GROUP V
All other oils:
Mineral oils, Oils, lubricating greases, designed for special purposes

* American Petroleum Institute
Global base oil production 2007 vs 2016
- Total growth with ca 10% in production volume
- Gr I base oil output loses ground to Gr II & Gr III oils
- Naphthenic oil show a small growth in percentage and organic growth with market

Source: Khee
Process oils chemical composition and properties
Oil absorption in EPDM
Volatile of rubber process oils
<table>
<thead>
<tr>
<th>Property / Unit</th>
<th>Nylex 3120</th>
<th>Nylex 3185</th>
<th>Nylex 3250</th>
<th>Nylex 840</th>
<th>NE60 (Grl)</th>
<th>SN800 (Grl)</th>
<th>SS (Grl)</th>
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</thead>
<tbody>
<tr>
<td>Density, 15°C / kg/l</td>
<td>0.876</td>
<td>0.894</td>
<td>0.907</td>
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<td>Viscosity, 40°C / mm²/s</td>
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<td>Sulfur / %</td>
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<td>Ammonium Point / °C</td>
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<td>Viscosity / °C</td>
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<td>Cellos</td>
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Test formulations

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<th>Component Name</th>
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<td>RP (65%NL 5% ENB)</td>
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<td>Process all</td>
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- **List of process oil**
  - Nyflex 3020
  - Nyflex 3188
  - Nyflex 3280
  - Nyflex 3400
  - H 600 (3e II)
  - BN 000
  - Brightness

  ✓: Used
  -: Not used
OOH-cured, 70 Shore A:
Processing characteristics

Rheometer (MCR) at 170°C

Torque Development

Highest dev torque for Nyflex 3120 and N 600
SN 600 showed lowest torque
OOH-cured, 70 Shore A:
Tensile properties

- Nyflex 3120 and N 600 oil give highly crosslinked networks
- Nyflex 9145 & Nyflex 9250 shows a higher modulus compared to SN 600
OOH-cured, 70 Shore A: 
Hardness & Abrasion

- Hardness close to design target.
- Indication of somewhat higher +tink with Nylflex/Nyflex 3xxx.
- Nylflex 3120 & N600 show lowest abrasion.
OOH-cured, 70 Shore A: Compression set & Ageing

- Lowest compression set by N 600 followed by Hyflex 3120
- Naphthenic oils show a lower set compared to SN600
- Low impact of ageing on hardness
- Large level of change for Hyflex 3120 hard to rationalise
S-cured, 65 Shore A:
Processing characteristics

- Grip alternatives show a lower developed torque
S-cured, 65 Shore A:
Tensile properties

Naphthenic oils show high tensile properties
S-cured, 65 Shore A: Hardness & Abrasion

- Hardness close to design target
- D1000 somewhat lower
- Lowest abrasion for N 800 followed by Nyrex 3250 & Nyrex 3120
S-cured, 65 Shore A: Compression set & Ageing

- Brightstock highest low-temperature set
- Higher impact of ageing compared to OMD cured compounds
Conclusions

- Relatively small differences between naphthenic & paraffinic plasticisers
  - Potential to replace paraffinic oils with little or no change to the formulation
  - Selection recommendations to be found in Nynas Rubber Process Oil Guide

- Faster and more complete vulcanisation reaction with naphthenic RPO
  - Shorter TC30
  - Higher developed torque
  - Higher modulus

- Higher resistance against destructive load with naphthenic plasticisers
  - Tensile Strength
  - Abrasion
  - Stable ageing behaviour

- Excellent alternatives to Cr I plasticisers for EPDM
Performance of naphthenic oils
35 phr oil, F-SSBR/BR compound

Material properties
- Tensile properties, same level
- Low heat build-up & low rolling resistance
- High tear strength
- Lower abrasion
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**Additional Notes**

- D: Suitable for the application
- X: Not recommended for the application
Last Words

Changing Refinery Landscape
- Impact on the global process oil product slate
  - High viscosity & high solvency product getting more scarce
- Naphthenic process oil a long-term solution for the gap in the rubber process oil market

Nynas Naphthenic Rubber Process Oils
- High compatibility with a range of different rubbers
- Differentiated product offering for the rubber and tyre industry
- Proven performance in the market place
TAKING OIL FURTHER

We take oil further to bring lasting value to customers and the world we live in.