SASOL NACOL Ether
Marketing Forum Presentation
at Annual STLE 2018

Prepared by: SASOL Global MWL R&D Team

David Pack
World scale cracker and derivatives plants

Backward-integrated growth for Sasol into a well-established and uniquely diversified market

Balanced portfolio of commodity and differentiated products
### Sasol’s alcohol portfolio

<table>
<thead>
<tr>
<th>Type</th>
<th>Formula</th>
<th>Brand/Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% linear, even numbered, C6 to C22+</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>Ziegler, oleo chemical ALFOL NAFOL NACOL</td>
</tr>
<tr>
<td>Monomethyl branched, C8 isomers</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>FT-Oxo alcohol LINCOL 8i</td>
</tr>
<tr>
<td>Blends of linear and C2-monobranched alcohol ranging from 5% to 95% linear, odd and even numbered, C11 to C17</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>Oxo alcohol ISALCHEM LIALALCHEM</td>
</tr>
<tr>
<td>C2- mono branched alcohol, even numbered, C12 to C32</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>Guerbet alcohol ISOFOL</td>
</tr>
<tr>
<td>Blends of linear and branched alcohol, C12 to C13</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>FT-Oxo alcohol SAFOL</td>
</tr>
<tr>
<td>Multiple methyl branched, C13</td>
<td><img src="https://via.placeholder.com/150" alt="OH" /></td>
<td>Isotridecyl alcohol MARLIPAL 013 (TDA)</td>
</tr>
</tbody>
</table>
Lubricants & MWL Additive Products

- **Chemical products**
  - Materials for LOA
  - Synlubes
  - Hydrophobes
  - Corrosion inhibitors
  - Coupling agents
  - Metal cleaning
  - Antifoam
  - Metal Rolling
  - Emulsifiers

- **Materials for LOA**
  - ISOCARB ESTERS, ISOFOL ESTERS, REPROXAL, MARLOWET M PAGs
  - LIAL, ISALCHEM, NAFOL, NACOL, ISOFOL
  - ISOCARB, MARLON OS MARLOWET ECAs
  - ISOFOl, ISALCHEM DIONIL
  - MARLOX, MARLOSOL TA, NACOL ETHERS

- **Solvents**
  - NACOL ETHERS, LPA, PARAFOL, DIONIL 6
  - NACOL ETHERS, DIONIL, MARLOX

- **Metal Rolling**
  - PARAFOL, LPA, LINPAR NACOL, NAFOL/ALFOL

- **Emulsifiers**
  - MARLOX RT, MARLOWET, MARLON

- **Synlubes**
  - HLAB, phenolics (PDDP), MARLON

- **Hydrophobes**
  - Sulphonates, alcohols, oil soluble PAGs

- **Corrosion inhibitors**
  - ISOCARB, MARLON

- **Coupling agents**
  - OS MARLOWET ECAs

- **Metal cleaning**
  - ISOFOL, ISALCHEM DIONIL

- **Antifoam**
  - MARLOX RT, MARLOWET, MARLON

- **Emulsifiers**
  - HLAB, phenolics (PDDP), MARLON

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NACOL ETHER

Linear di-n-alkyl-ether

- Sasol’s Ether portfolio comprises ethers from di-n-hexyl to di-n-stearyl ethers
- Produced from the corresponding linear alcohols
- Stabilized with alpha-tocopherol

Product family

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>NACOL ETHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexanol</td>
<td>6</td>
</tr>
<tr>
<td>Octanol</td>
<td>8</td>
</tr>
<tr>
<td>Octadecanol</td>
<td>18</td>
</tr>
</tbody>
</table>

NACOL ETHER 10, 12, 14 and 16 are developmental products and samples can be provided.
# Sasol liquid ether data

<table>
<thead>
<tr>
<th></th>
<th>NACOL Ether 6</th>
<th>NACOL Ether 8</th>
<th>NACOL Ether 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical name</td>
<td>Dihexyl ether</td>
<td>Dioctyl ether</td>
<td>Didecyl ether</td>
</tr>
<tr>
<td>Purity, %</td>
<td>&gt;96</td>
<td>&gt;96</td>
<td>&gt;96</td>
</tr>
<tr>
<td>Molecular weight, g/mol.</td>
<td>186</td>
<td>242</td>
<td>298</td>
</tr>
<tr>
<td>Acid number, mg KOH/g</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>Ester number, mg KOH/g</td>
<td>0.44</td>
<td>1.08</td>
<td>0.96</td>
</tr>
<tr>
<td>Water, wt. %</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Colour, hazen</td>
<td>1</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Density, g/ml @ 20°C</td>
<td>0.793</td>
<td>0.808</td>
<td>0.816</td>
</tr>
<tr>
<td>Viscosity, cSt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 20°C</td>
<td>2.1</td>
<td>4.5</td>
<td>8.5</td>
</tr>
<tr>
<td>@ 40°C</td>
<td>1.5</td>
<td>2.9</td>
<td>5.0</td>
</tr>
<tr>
<td>@ 95°C</td>
<td>-</td>
<td>1.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Boiling point, °C (°F)</td>
<td>218 (424)</td>
<td>264 (506)</td>
<td>272 (522)</td>
</tr>
<tr>
<td>Pour point, °C (°F)</td>
<td>-42 (-44)</td>
<td>-7 (19)</td>
<td>+17 (63)</td>
</tr>
<tr>
<td>Flash point, °C (°F)</td>
<td>97 (207)</td>
<td>141 (286)</td>
<td>180 (356)</td>
</tr>
<tr>
<td>Surface tension, mN/m @20°C</td>
<td>26.9</td>
<td>28.3</td>
<td>30.3</td>
</tr>
<tr>
<td>Kauri-butanol value</td>
<td>46</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>TSCA listed</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CAS number</td>
<td>112-58-3</td>
<td>629-82-3</td>
<td>2456-28-2</td>
</tr>
</tbody>
</table>

All data determined by testing in Sasol laboratory.
NACOL Ether – Adding value to your products

Metal surface cleaning application

**Aerosol Solvent**
- Chain Lube
- Brake Cleaner
- Fuel system cleaner
- Grease Cleaner
- Heavy oil Cleaner
- Gun Cleaner

via:
- Solvent degreaser
- Flushing solvent
- OEM Recon engine cleaner
- Turbine engine cleaner
- Carbon deposit cleaner
- Paint & Rust cleaner

**Parts Cleaner**

**Fuel Additives**
- Fuel Additive
- Injector cleaner
- Carbonator cleaner
- Gunk cleaner
- Throttle plate cleaner
NACOL Ether 6 – High flashpoint alternative to xylene and d-limonene

Fp: 93°C / >200°F

NACOL Ether 6 (Dihexyl ether)

Fp: 27°C / 81°F
p-xylene

Fp: 50°C / 122°F
d-limonene

Flash point (°F)
Toluene: 43
Xylene: 77
D-limonene: 110
NACOL ETHER 6: 207

Kauri-butanol
Toluene: 102
Xylene: 98
D-limonene: 67
NACOL ETHER 6: 46
Evaporation of NACOL ETHER 6 in comparison to longer chain NACOL ETHERS

Evaporation behaviour of NACOL ETHERS at 60°C

Thermogravimetric analysis (Netzsch TG 209 F1 libra)
Liquid NACOL ETHER – spread ability and wetting properties

Bubble size = **Spreadibility on filter paper** (Whatman 541)

<table>
<thead>
<tr>
<th>Wetting of:</th>
<th>Steel cold rolled</th>
<th>Steel hot rolled</th>
<th>Brass</th>
<th>Bronze</th>
</tr>
</thead>
<tbody>
<tr>
<td>NACOL ETHER 6</td>
<td>Complete</td>
<td>Complete</td>
<td>Complete</td>
<td>Complete</td>
</tr>
<tr>
<td>NACOL ETHER 8</td>
<td>Complete</td>
<td>Complete</td>
<td>Complete</td>
<td>Partial</td>
</tr>
<tr>
<td>NACOL ETHER 10</td>
<td>Complete</td>
<td>Complete</td>
<td>Partial</td>
<td>Partial</td>
</tr>
</tbody>
</table>

Wetting performance according to the wetting envelope model.
NACOL ETHER

Thermal stability tested at 180°C / 24 hour

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Substance (after 24hrs/180°C)</th>
<th>Volatility [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>d-limonene</td>
<td>99.4</td>
</tr>
<tr>
<td>2</td>
<td>NACOL ETHER 6</td>
<td>100.0</td>
</tr>
<tr>
<td>3</td>
<td>NACOL ETHER 8</td>
<td>99.9</td>
</tr>
</tbody>
</table>

NACOL ETHER 6 evaporates in total without staining!
NACOL ETHER 6 has excellent miscibility in CO₂ and hydrocarbon solvents

### Aerosol Solvent Physical Property

<table>
<thead>
<tr>
<th></th>
<th>Method</th>
<th>Result</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat of Combustion</td>
<td>ASTM D240</td>
<td>42.6</td>
<td>kJ/g</td>
</tr>
<tr>
<td>Ignition Distance Test</td>
<td>GHS Part III Section 31.5</td>
<td>Ignition at &gt;100</td>
<td>cm</td>
</tr>
<tr>
<td>Surface Tension</td>
<td>ASTM D1331</td>
<td>25.6</td>
<td>Dynes/cm</td>
</tr>
<tr>
<td>Enclosed Space Ignition Test</td>
<td><em>Impact Analytical TST-METH-022</em></td>
<td>68</td>
<td>s/m³</td>
</tr>
</tbody>
</table>
NACOL ETHER 6, 8 & 10

Surface tension and dynamic viscosity measured @ 20 °C; Kauri Butanol Value for d-limonene = 67, toluene = 102
Product properties

- High purity (>96%)
- Excellent flow and low viscosity properties
- Fast spreading agent
- Alternative to many silicone additives
- Excellent solubility of additives
- Good wetting properties of metal surfaces
- Hydrolytically stable (pH 3-11)
- Meets California VOC requirements
NACOL ETHER 6 – d-limonene replacement
Citrus derived d-limonene has been the product of choice for replacing xylene and other aromatic solvents in many cleaning and paraffin removal applications.

Advantages of d-limonene:
- Derived from natural sources
- Citrus odor
- Good solvency

Disadvantages of d-limonene:
- Flammable
- High odor
- Volatile pricing
- Currently high pricing
- Uncertain of future supply

![d-limonene is a cyclic terpene](image-url)

![Graph showing solvency power and flash point comparison](image-url)
# NACOL ETHER 6 vs other d-limonene replacements

<table>
<thead>
<tr>
<th></th>
<th>NACOL ETHER 6</th>
<th>Competitor 1</th>
<th>Competitor 2</th>
<th>Competitor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td><img src="image1.png" alt="Structure" /></td>
<td><img src="image2.png" alt="Structure" /></td>
<td><img src="image3.png" alt="Structure" /></td>
<td><img src="image4.png" alt="Structure" /></td>
</tr>
<tr>
<td><strong>Chemical description</strong></td>
<td>Di-hexyl ether</td>
<td>Methyl-9-decenoate</td>
<td>Isopropyl laurate</td>
<td>N,N-dimethyl-9-decenamide</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>Synthetic</td>
<td>Natural</td>
<td>Coconut</td>
<td>Natural</td>
</tr>
<tr>
<td><strong>Labeling</strong></td>
<td><img src="image5.png" alt="Label" /></td>
<td><img src="image6.png" alt="Label" /></td>
<td>-----</td>
<td><img src="image7.png" alt="Label" /></td>
</tr>
<tr>
<td><strong>Purity</strong></td>
<td>96% min.</td>
<td>99.0 % *</td>
<td>99.1 % *</td>
<td>98.5 % *</td>
</tr>
<tr>
<td><strong>Flash point</strong></td>
<td>97°C</td>
<td>102°C</td>
<td>138°C</td>
<td>134°C</td>
</tr>
<tr>
<td><strong>Boiling point</strong></td>
<td>222°C</td>
<td>235°C</td>
<td>270-280°C</td>
<td>297°C</td>
</tr>
<tr>
<td><strong>Kauri-Butanol value</strong></td>
<td>44</td>
<td>99</td>
<td>66</td>
<td>&gt;1000</td>
</tr>
<tr>
<td><strong>Density @20°C</strong></td>
<td>0.792 g/ml</td>
<td>0.88 g/ml</td>
<td>0.854 g/ml</td>
<td>0.892 g/ml</td>
</tr>
<tr>
<td><strong>Viscosity @20°C</strong></td>
<td>1.7 mPa</td>
<td>1.5 mPas</td>
<td>3.0 mPas</td>
<td>4.0 mPas</td>
</tr>
</tbody>
</table>

* Sasol GC analysis
Cleaning Efficiency Tests – Filter test

- 0.1 g grease in 10 ml solvent
- 1h incubation at RT
- Filtration with glasfibre prefilter (Sartorius 13400-44-Q)
- Filter with deposit dried at 40°C or 60°C
- Evaluation:
  \[ \text{% solubilized grease} = 100 - \% \text{filter deposit} \]

Test-set up according to APN Journal of Engineering and Applied Sciences Vol.10, No. 22, December 2012, p.10555-10565
Cleaning Efficiency Tests – IKA shaking table

- Silicone grease

<table>
<thead>
<tr>
<th>Competitor 1</th>
<th>Competitor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Chemical Structure" /></td>
<td><img src="image2.png" alt="Chemical Structure" /></td>
</tr>
</tbody>
</table>

- Steel plate
- Coated with an uniform film (100 µm) of grease
- Immerse 2 min in 100 ml solvent at RT under slight shaking (100 rpm)
- Evaluation: % removal efficiency
Cleaning Efficiency Tests – IKA shaking table

- Various Greases

NACOL ETHER 6 cleaning efficiency is comparable to d-limonene.

![Graph showing cleaning efficiency of various greases compared to d-limonene.](image-url)
NACOL ETHER 6 / d-limonene

Sealant compatibility tests

NACOL ETHER 6 has similar sealant compatibility compared to mineral oil and d-limonene.
NACOL ETHER 6 / d-limonene

Sealant compatibility tests

NACOL ETHER 6 has similar sealant compatibility compared to mineral oil and d-limonene.
Conclusion

- NACOL ETHER 6 is a water like, non flammable liquid with high spreading power.
- NACOL ETHER 6 completely wets various metal surfaces.
- NACOL ETHER 6 can evaporate at 185°C after 1 min without staining.
- NACOL ETHER 6 is a pH stable cleaning solvent showing similar solvency power and cleaning efficiency on various grease types (silicone, lithium and all-round).
- Is highly miscible with other solvents and additives and can be easily sprayed.
- NACOL ETHER 6 is a non-VOC for metalworking fluids and lube applications.
- NACOL ETHER 6 has similar sealant compatibility compared to mineral oil and d-limonene.

- NACOL Ether 6 can be used for any cleaning applications or as base stock for micro emulsion.
Sasol may, in this document, make certain statements that are not historical facts and relate to analyses and other information which are based on forecasts of future results and estimates of amounts not yet determinable. These statements may also relate to our future prospects, developments and business strategies. Examples of such forward-looking statements include, but are not limited to, statements regarding exchange rate fluctuations, volume growth, increases in market share, total shareholder return, executing our growth projects and cost reductions, including in connection with our Business Performance Enhancement Programme and Response Plan. Words such as "believe", "anticipate", "expect", "intend", "seek", "will", "plan", "could", "may", "endeavour", "target", "forecast" and "project" and similar expressions are intended to identify such forward-looking statements, but are not the exclusive means of identifying such statements. By their very nature, forward-looking statements involve inherent risks and uncertainties, both general and specific, and there are risks that the predictions, forecasts, projections and other forward-looking statements will not be achieved. If one or more of these risks materialise, or should underlying assumptions prove incorrect, our actual results may differ materially from those anticipated. You should understand that a number of important factors could cause actual results to differ materially from the plans, objectives, expectations, estimates and intentions expressed in such forward-looking statements. These factors are discussed more fully in our most recent annual report on Form 20-F filed on 27 September 2016 and in other filings with the United States Securities and Exchange Commission. The list of factors discussed therein is not exhaustive; when relying on forward-looking statements to make investment decisions, you should carefully consider both these factors and other uncertainties and events. Forward-looking statements apply only as of the date on which they are made, and we do not undertake any obligation to update or revise any of them, whether as a result of new information, future events or otherwise.

Please note: A billion is defined as one thousand million. All references to years refer to the financial year ended 30 June. Any reference to a calendar year is prefaced by the word "calendar".

Comprehensive additional information is available on our website: www.sasol.com
Thank you for your attention!