SASOL NACOL Ether

Marketing Forum Presentation

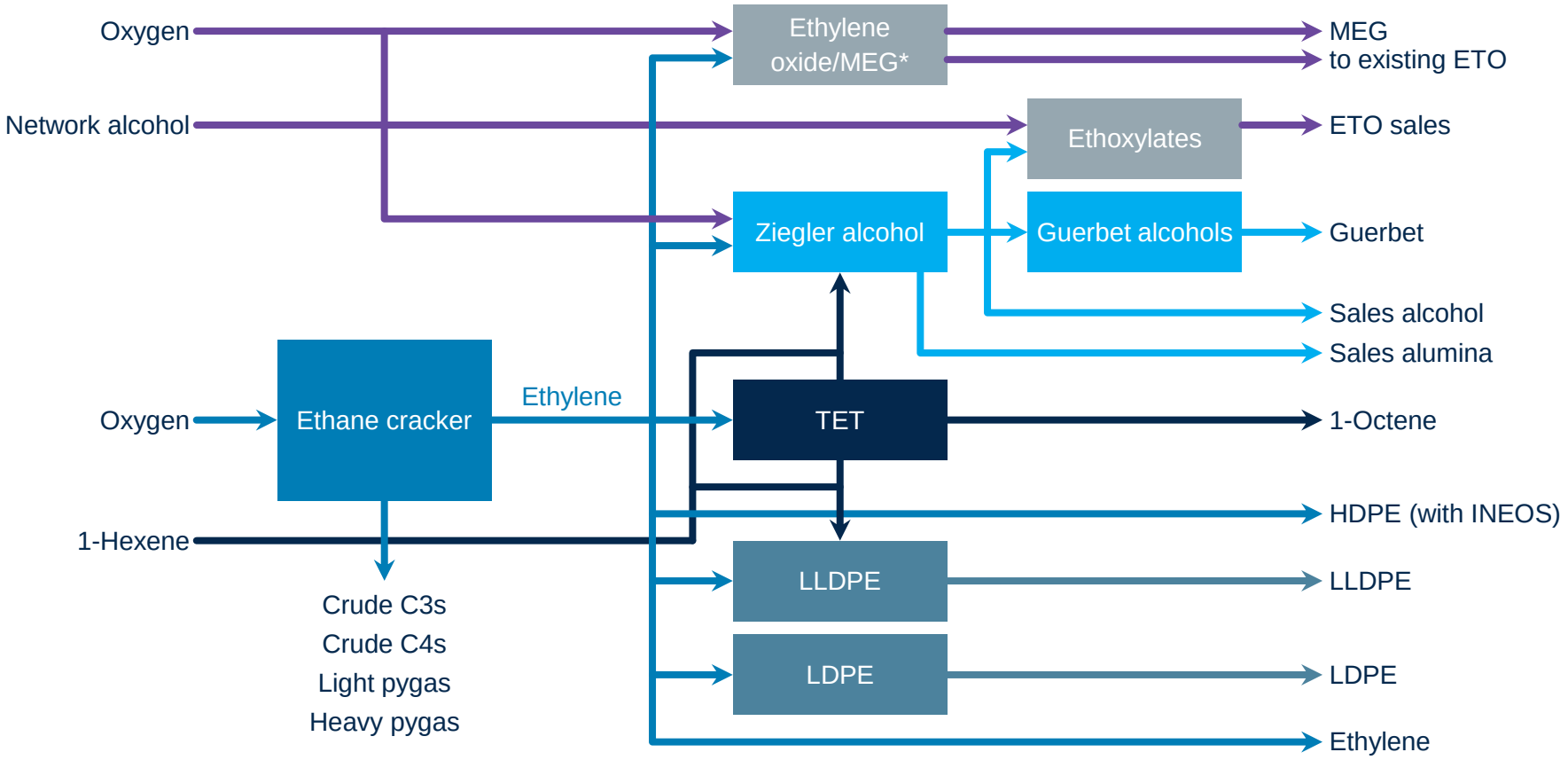
at Annual STLE 2018

Prepared by: SASOL Global MWL R&D Team

David Pack

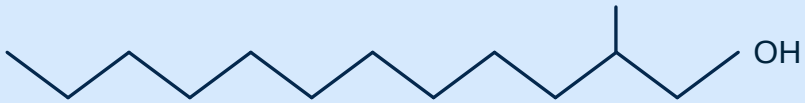
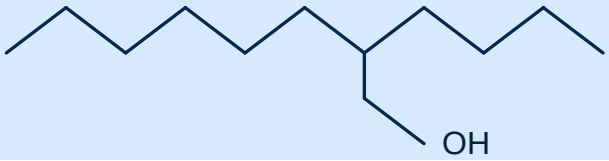
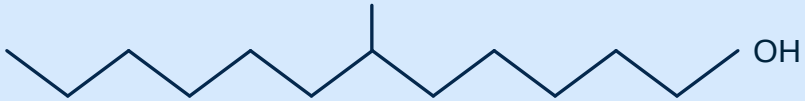
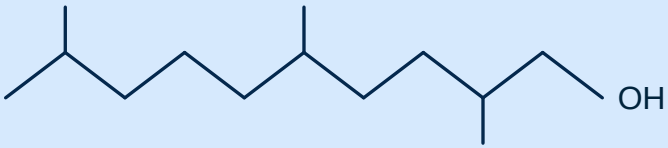
World scale cracker and derivatives plants

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

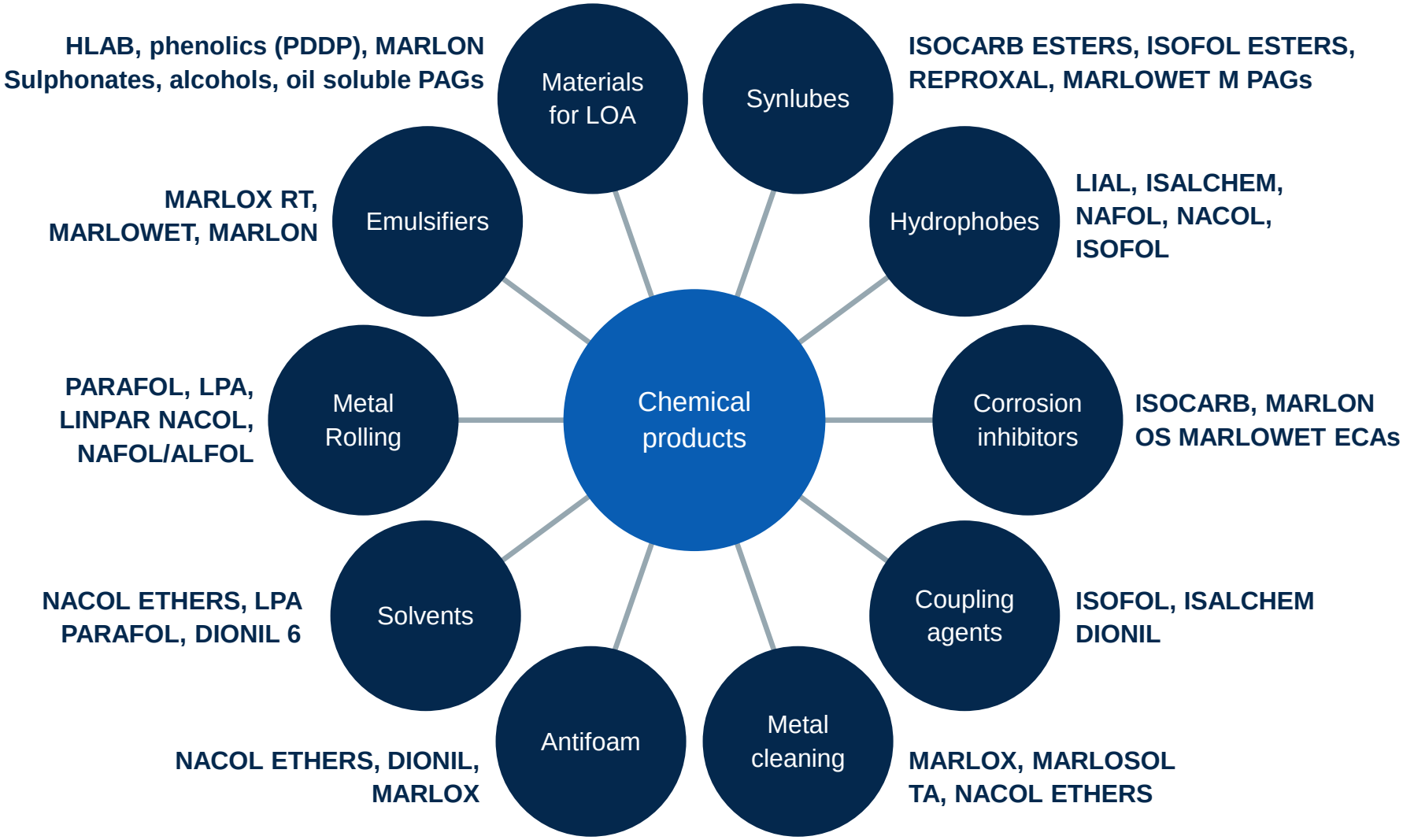


Balanced portfolio of commodity and differentiated products

Sasol's alcohol portfolio

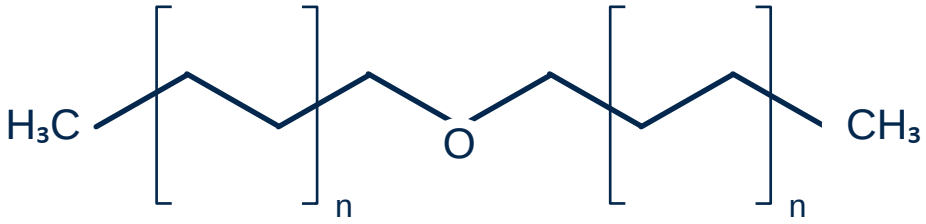
• 100% linear • Even numbered • C6 to C22+		Ziegler, oleo chemical ALFOL NAFOL NACOL
• Monomethyl branched • C8 isomers		FT-Oxo alcohol LINCOL 8i
• Blends of linear and C2-monobranched alcohol ranging from 5% to 95% linear • Odd and even numbered • C11 to C17		Oxo alcohol ISALCHEM LIAL ALCHEM
• C2- mono branched alcohol • Even numbered • C12 to C32		Guerbet alcohol ISOFOL
• Blends of linear and branched alcohol • C12 to C13		FT-Oxo alcohol SAFOL
• Multiple methyl branched • C13		Isotridecyl alcohol MARLIPAL 013 (TDA)

Lubricants & MWL Additive Products



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

Hexanol	→	NACOL ETHER 6
Octanol	→	NACOL ETHER 8
Octadecanol	→	NACOL ETHER 18

NACOL ETHER 10, 12, 14 and 16 are developmental products and samples can be provided.

Sasol liquid ether data

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

All data determined by testing in Sasol laboratory

NACOL Ether – Adding value to your products

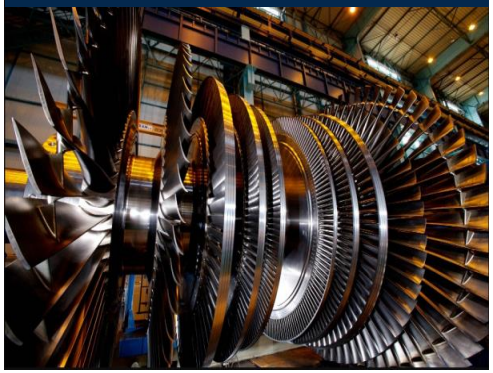
Metal surface cleaning application

Aerosol Solvent

via:

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

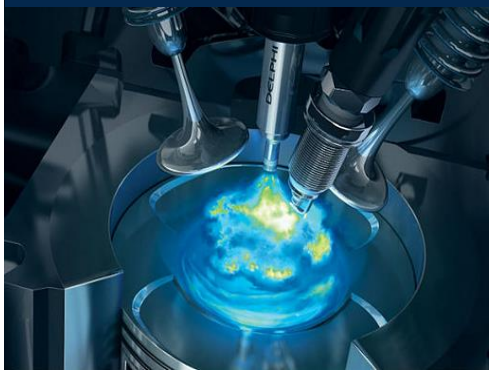
Parts Cleaner



via:

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

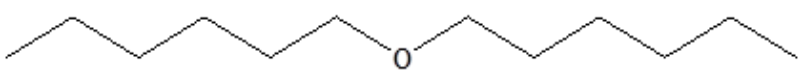
Fuel Additives



via:

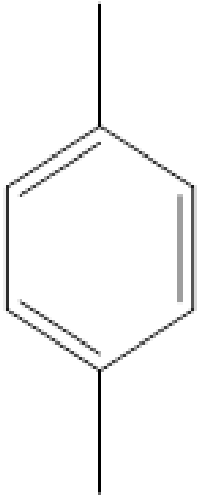
- Fuel Additive
- Injector cleaner
- Carbonator cleaner
- Gunk cleaner
- Throttle plate cleaner

NACOL Ether 6 –
High flashpoint alternative to xylene and d-limonene



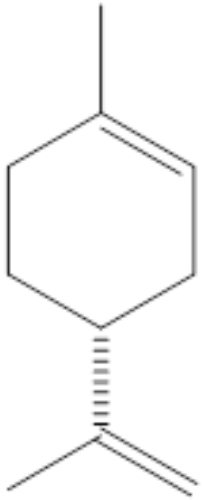
Fp: 93ºC / >200ºF

NACOL Ether 6 (Dihexyl ether)



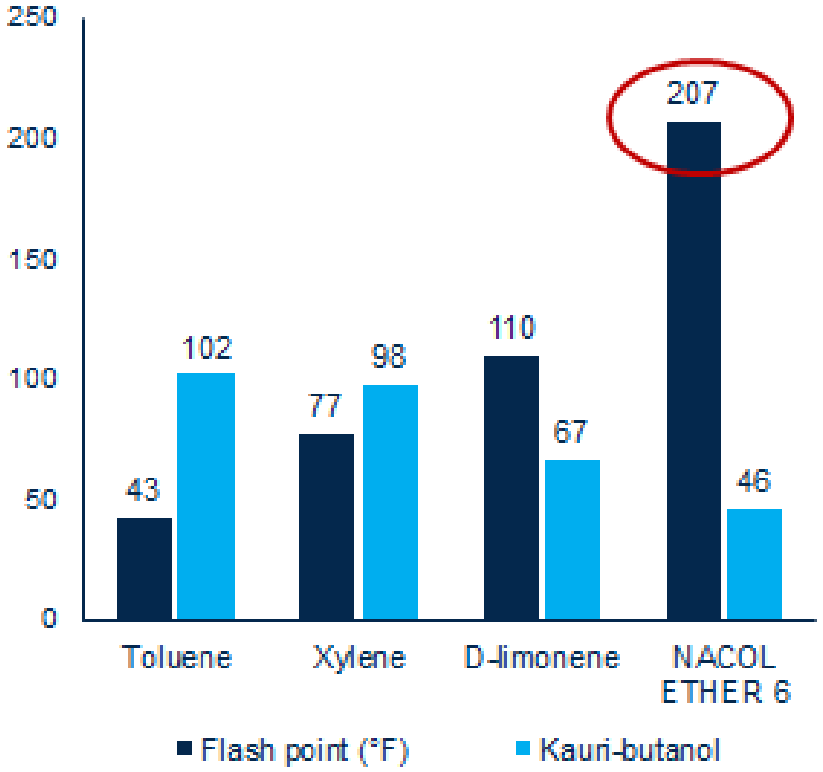
Fp: 27ºC / 81ºF

p-xylene



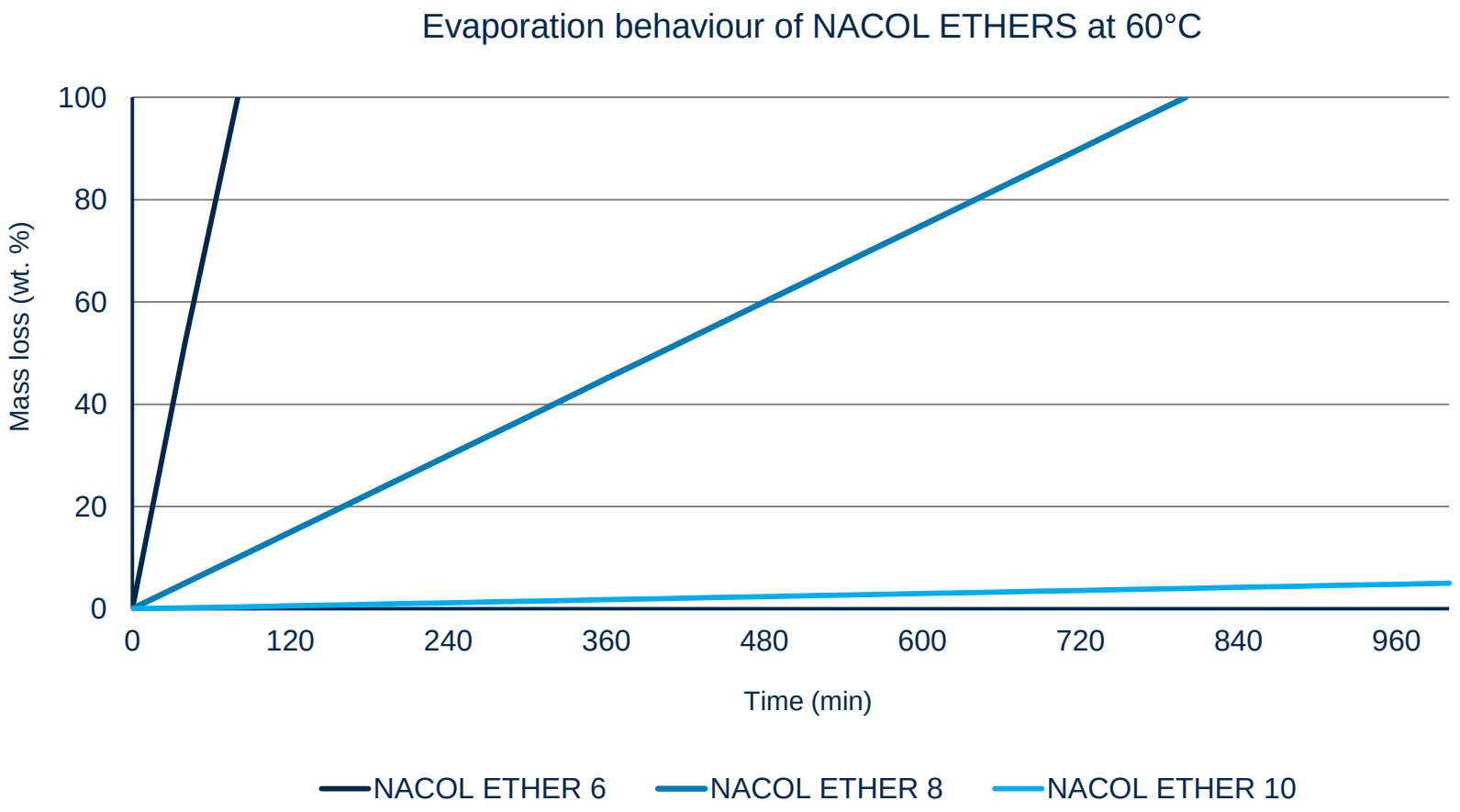
Fp: 50ºC / 122ºF

d-limonene



NACOL ETHER

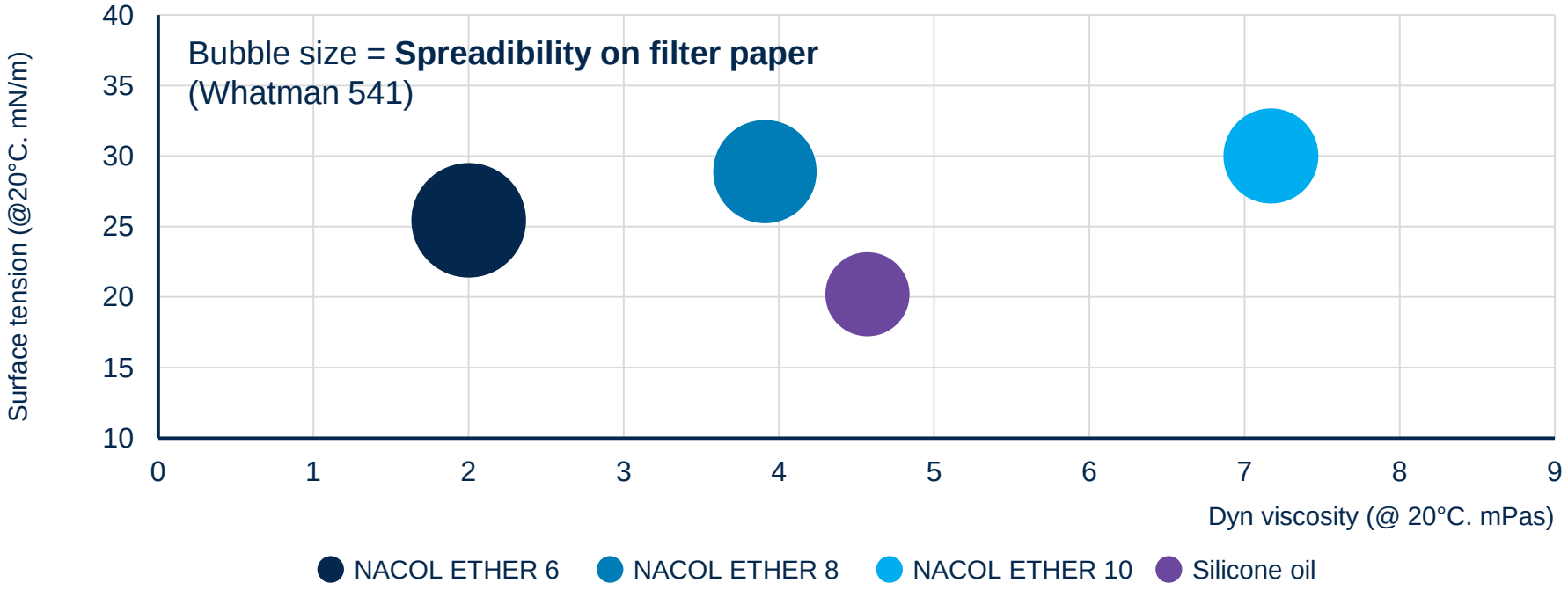
Evaporation of NACOL ETHER 6 in comparison to longer chain NACOL ETHERS



Thermogravimetric analysis (Netzsch TG 209 F1 libra)

NACOL ETHER

Liquid NACOL ETHER – spread ability and wetting properties



Wetting of:	Steel cold rolled	Steel hot rolled	Brass	Bronze
NACOL ETHER 6	Complete	Complete	Complete	Complete
NACOL ETHER 8	Complete	Complete	Complete	Partial
NACOL ETHER 10	Complete	Complete	Partial	Partial

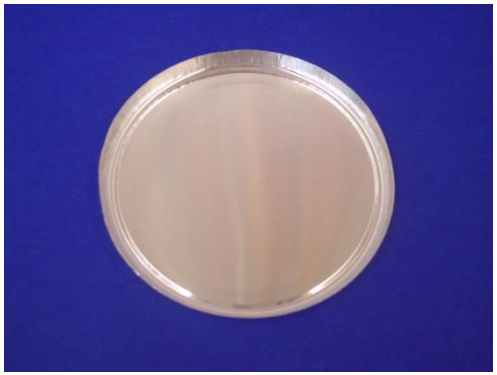
Wetting performance according to the wetting envelope model

NACOL ETHER

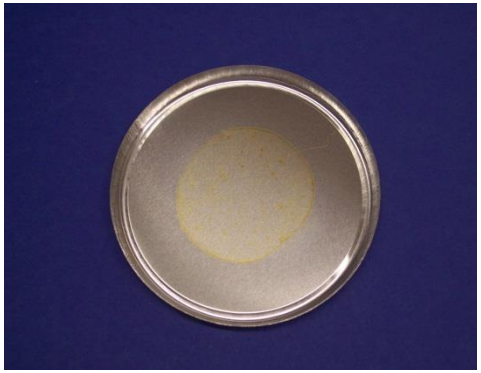
Thermal stability tested at 180°C / 24 hour

Sasol method 61-EE-10

d-limonene



NACOL ETHER 6



NACOL ETHER 8

Nr.	Substance (after 24hrs/180°C)	Volatility [%]
1	d-limonene	99.4
2	NACOL ETHER 6	100.0
3	NACOL ETHER 8	99.9

NACOL ETHER 6 evaporates in total without staining!

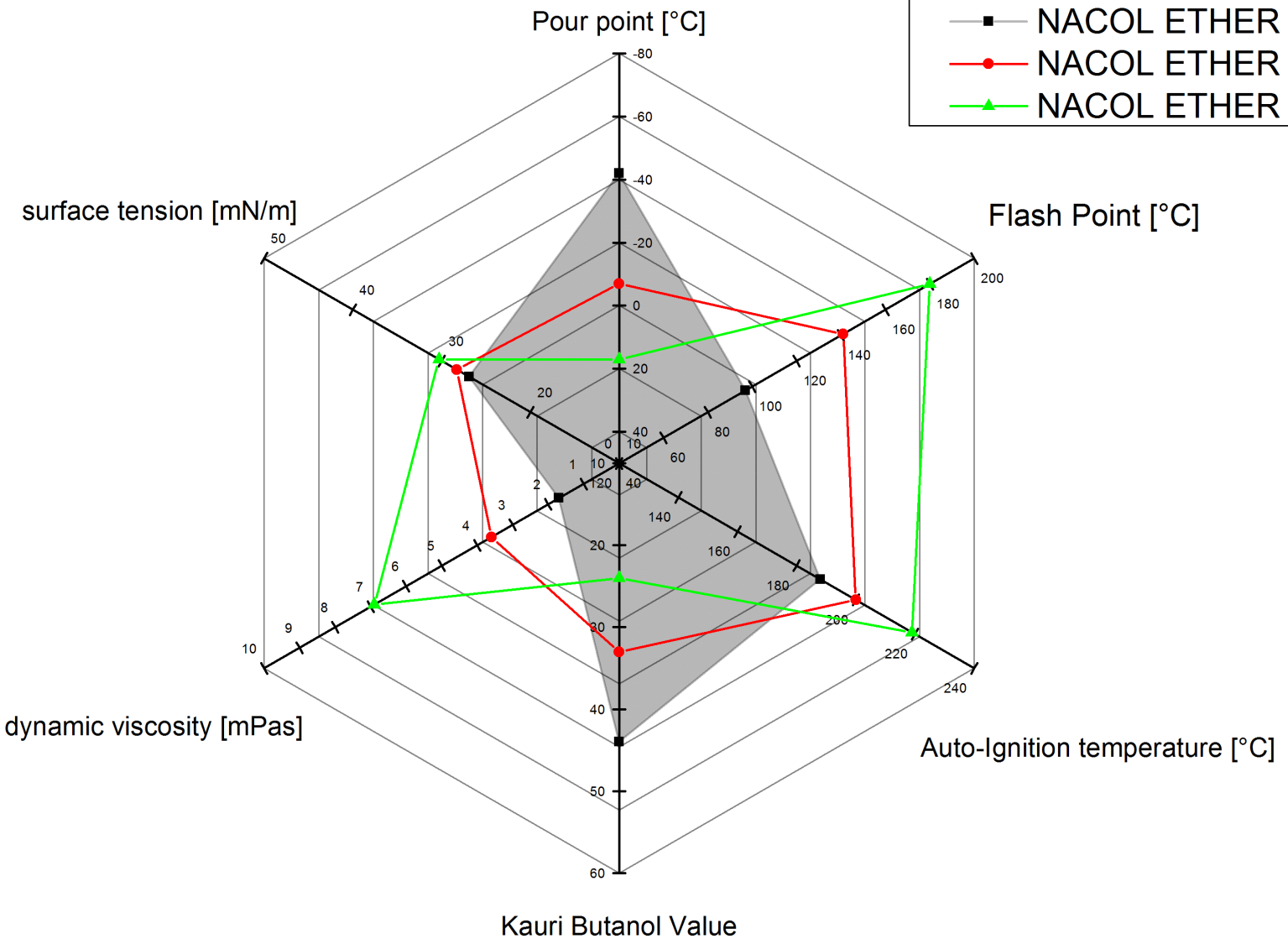
NACOL ETHER 6 For Aerosol Application

NACOL ETHER 6 has excellent miscibility in CO_2 and hydrocarbon solvents

Aerosol Solvent Physical Property

	Method	Result	Unit
Heat of Combustion	ASTM D240	42.6	kJ/g
Ignition Distance Test	GHS Part III Section 31.5	Ignition at >100	cm
Surface Tension	ASTM D1331	25.6	Dynes/cm
Enclosed Space Ignition Test	*Impact Analytical TST-METH-022*	68	s/m^3

NACOL ETHER 6, 8 & 10



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

NACOL ETHER 6 & 8

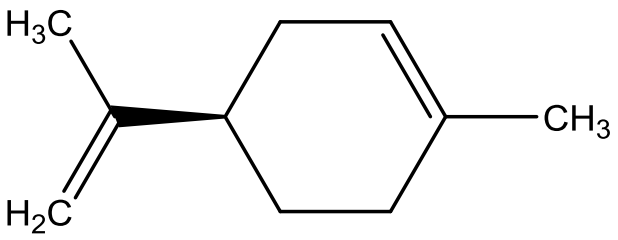
Product properties

- 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

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.



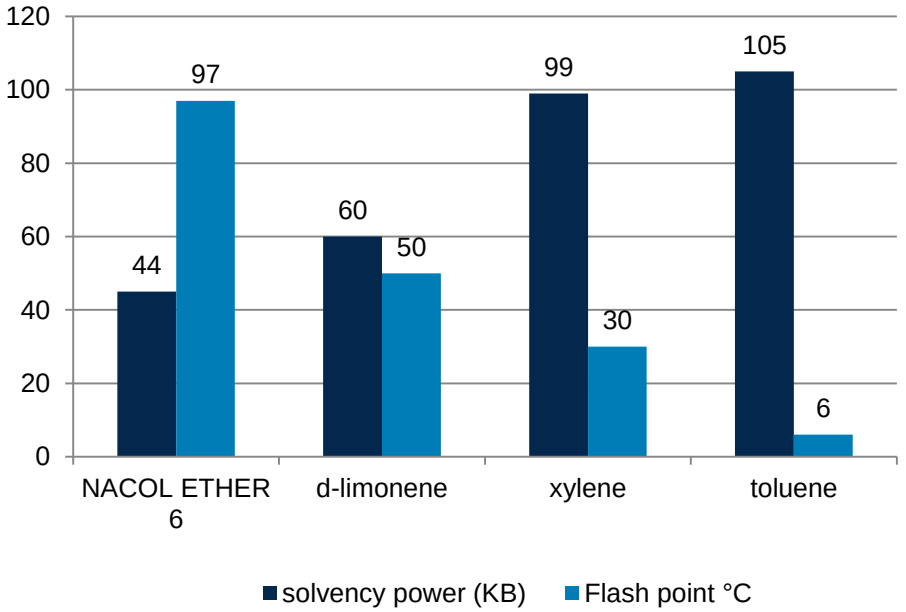
d-limonene is a cyclic terpene

Advantages of d-limonene:

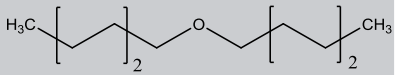
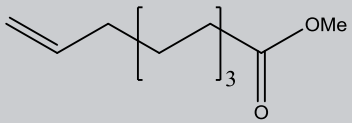
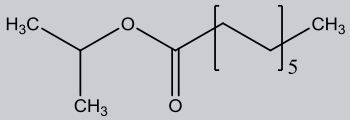
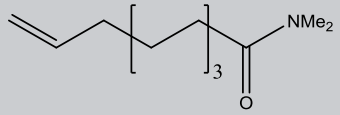
- Derived from natural sources
- Citrus odor
- Good solvency

Disadvantages of d-limonene:

- Flammable
- High odor
- Volatile pricing
- Currently high pricing
- Uncertain of future supply

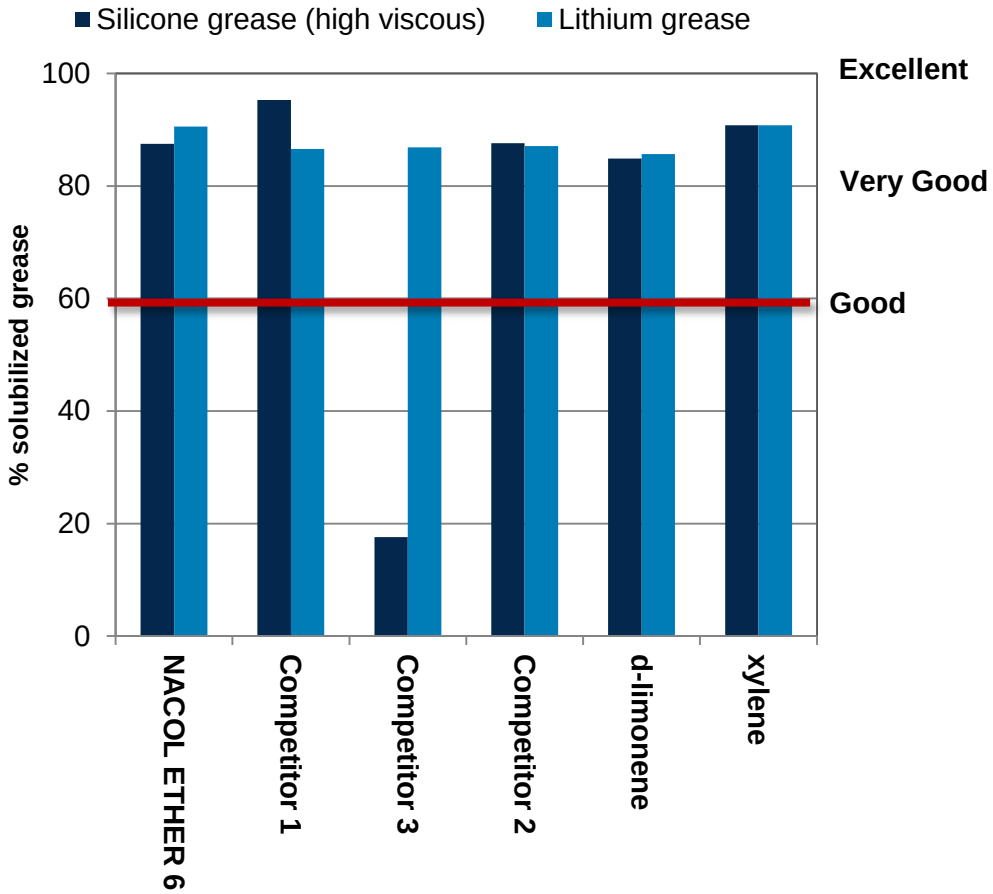


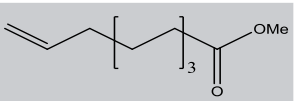
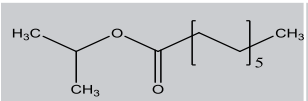
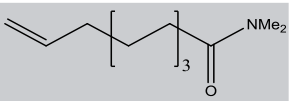
NACOL ETHER 6 vs other d-limonene replacements

	NACOL ETHER 6	Competitor 1	Competitor 2	Competitor 3
Structure				
Chemical description	Di-hexyl ether	Methyl-9-decenoate	Isopropyl laurate	N,N-dimethyl-9-decenamide
Feedstock	Synthetic	Natural	Coconut	Natural
Labeling			-----	
Purity	96% min.	99.0 % *	99.1 %*	98.5 %*
Flash point	97°C	102°C	138°C	134°C
Boiling point	222°C	235°C	270-280°C	297°C
Kauri-Butanol value	44	99	66	>1000
Density @20°C	0.792 g/ml	0.88 g/ml	0.854 g/ml	0.892 g/ml
Viscosity @20°C	1.7 mPa	1.5 mPas	3.0 mPas	4.0 mPas

* Sasol GC analysis

Cleaning Efficiency Tests – Filter test

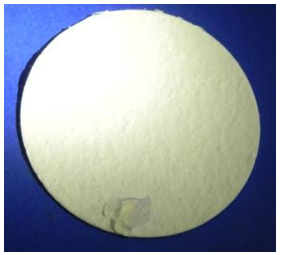


Competitor 1	Competitor 2	Competitor 3
		

- 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:**
  % solubilized grease =
  100 - % filter deposit

Silicone grease deposit

NACOL ETHER 6

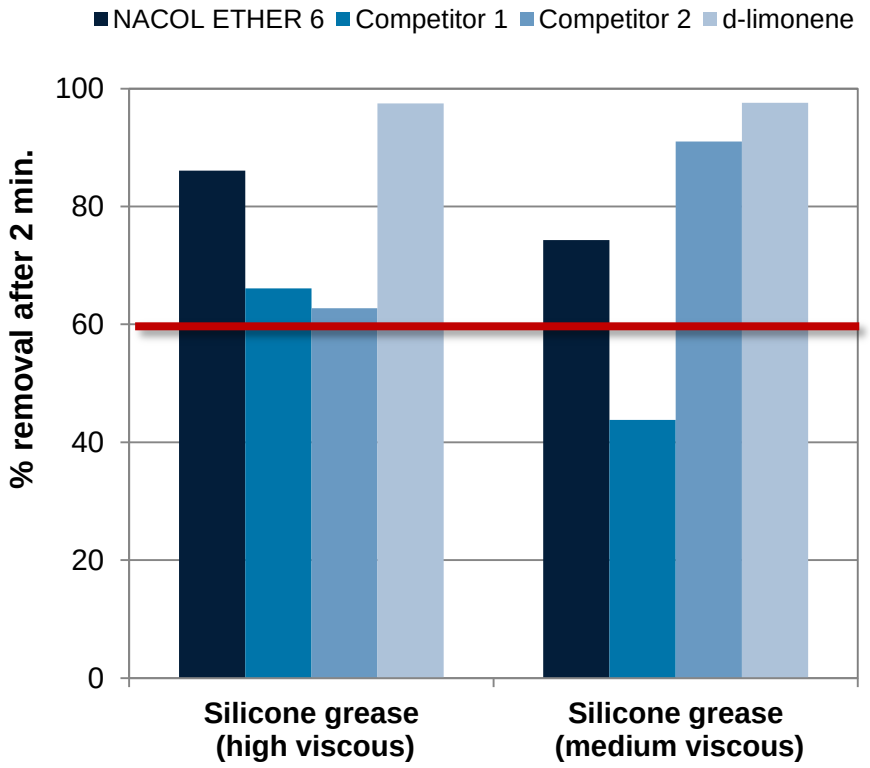


Competitor 3

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

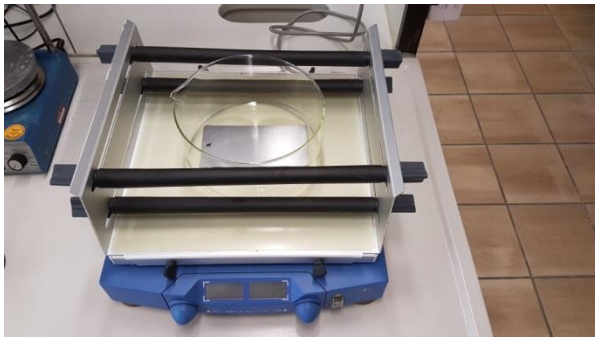
- **Silicone grease**



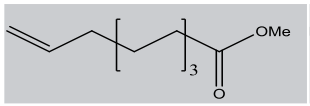
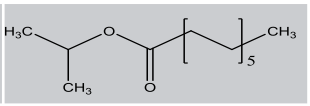
Excellent

Very Good

Good

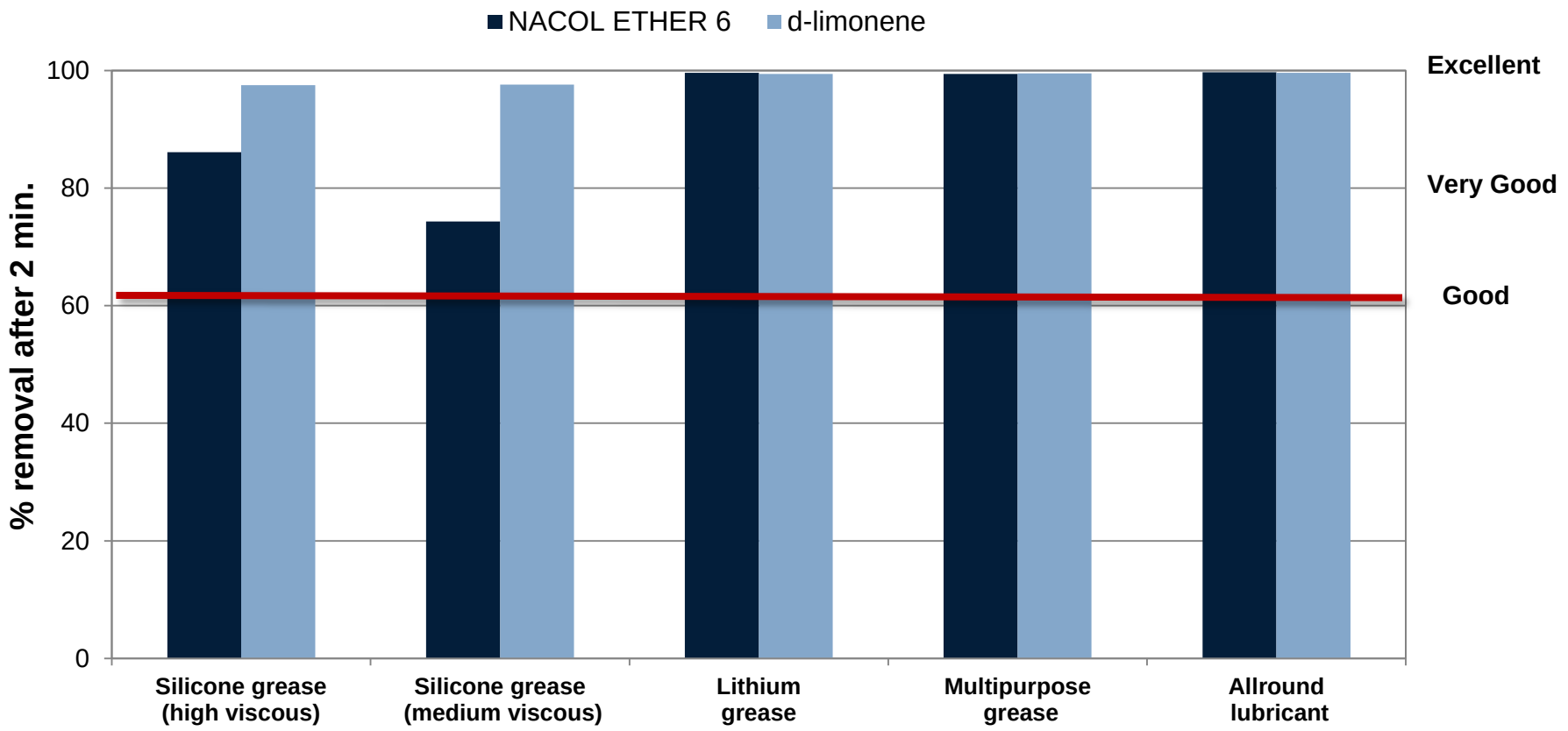


- Steel plate
- Coated with an uniform film (100 µm) of grease
- Immerse 2 min in 100 ml solvent at RT under slight shaking (100 rpm)
- **Evaluation: % removal efficiency**

Competitor 1	Competitor 2
	

Cleaning Efficiency Tests – IKA shaking table

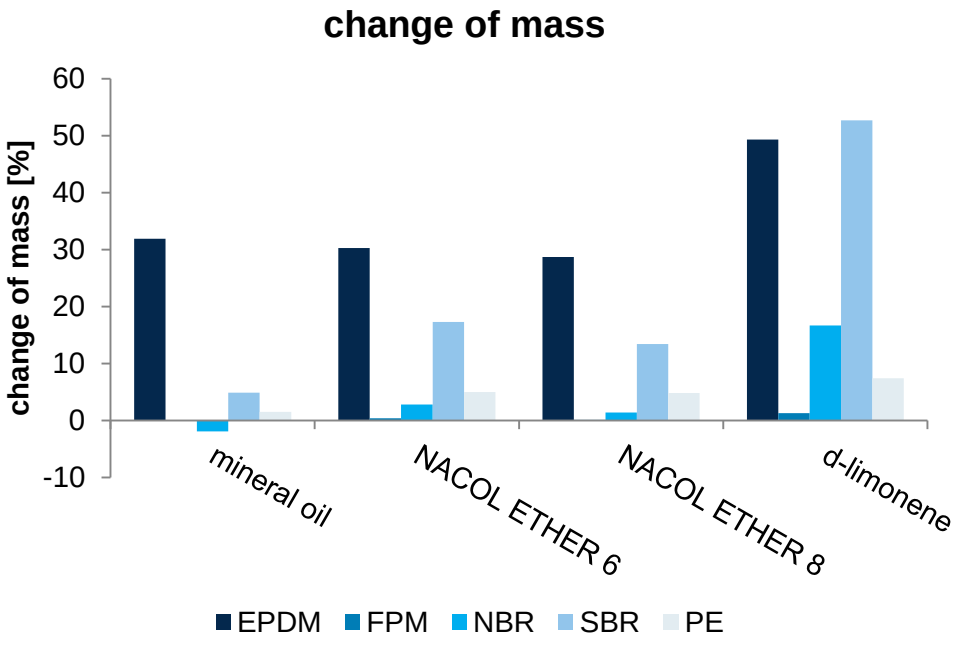
- **Various Greases**

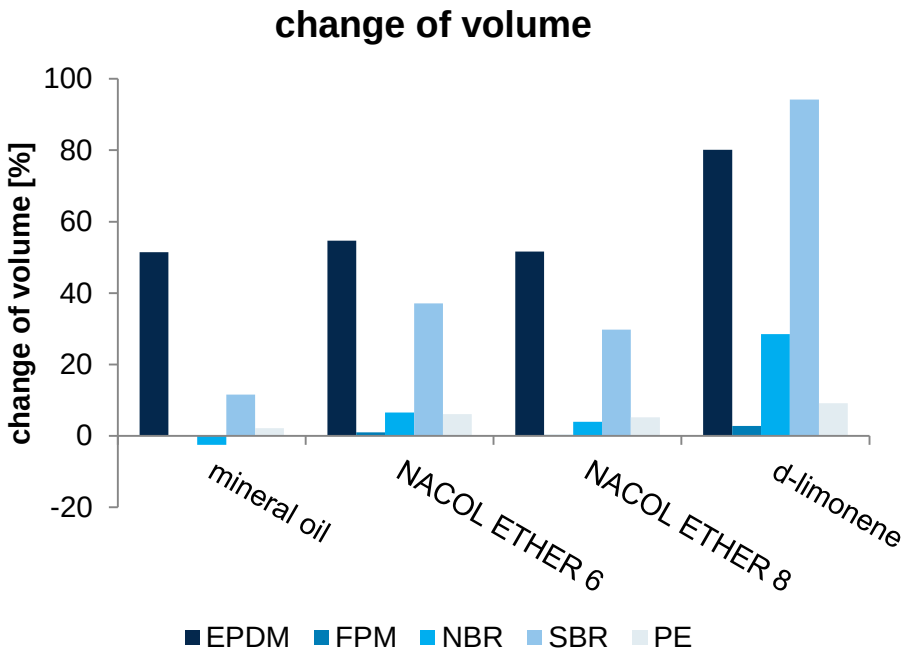


NACOL ETHER 6 cleaning efficiency is comparable to d-limonene.

NACOL ETHER 6 / d-limonene

Sealant compatibility tests

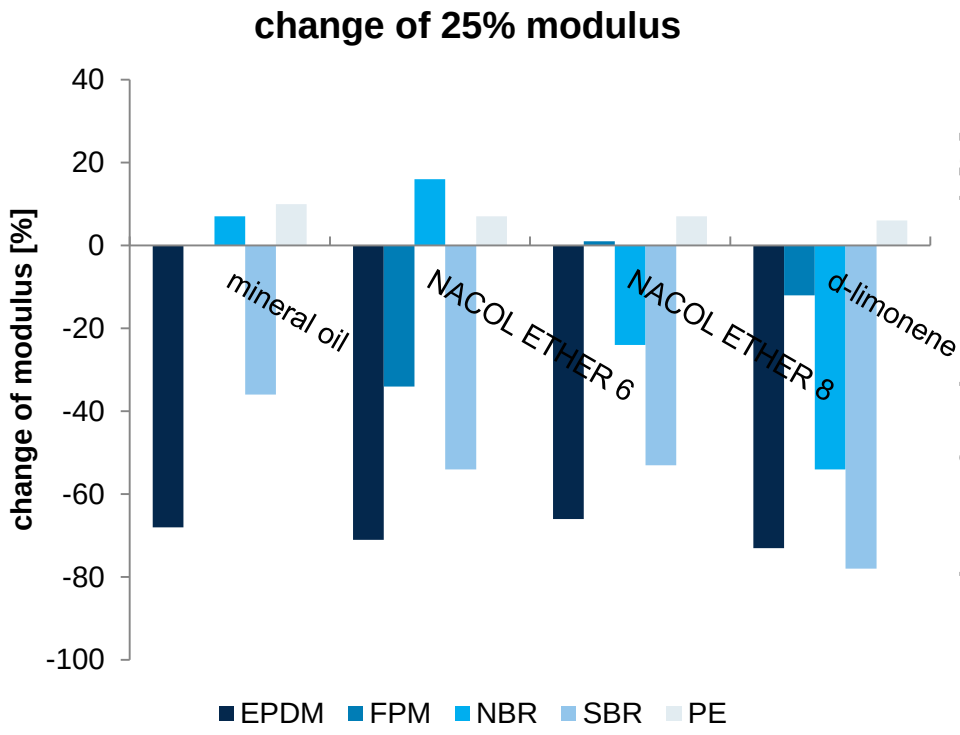


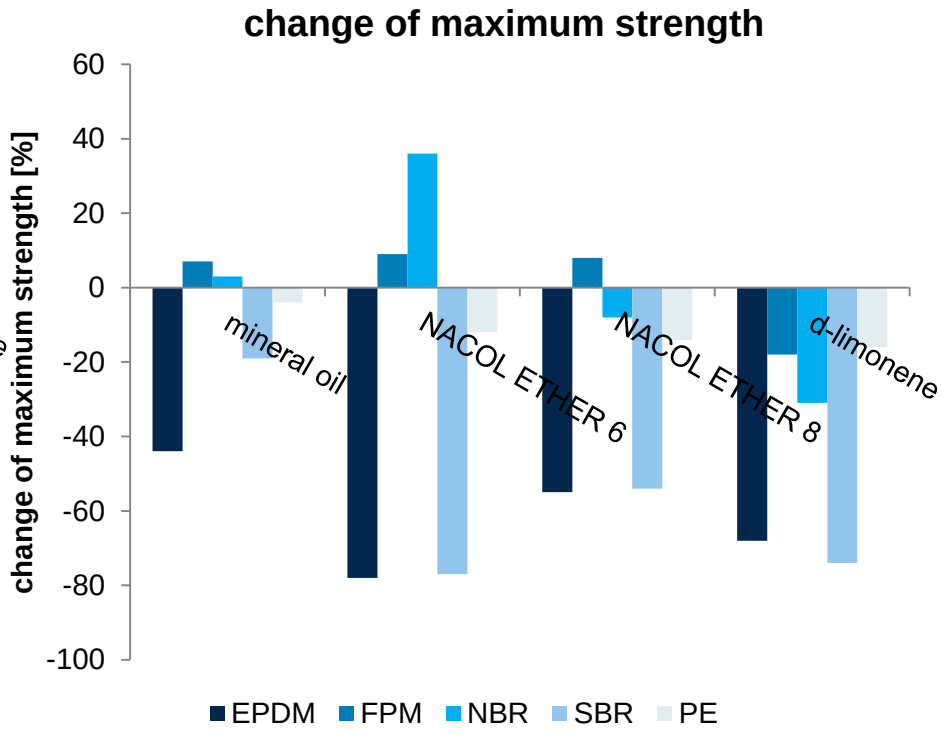


NACOL ETHER 6 has similar sealant compatibility compared to mineral oil and d-limonene.

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.**

Forward-looking statements

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!