Zschimmer & Schwarz

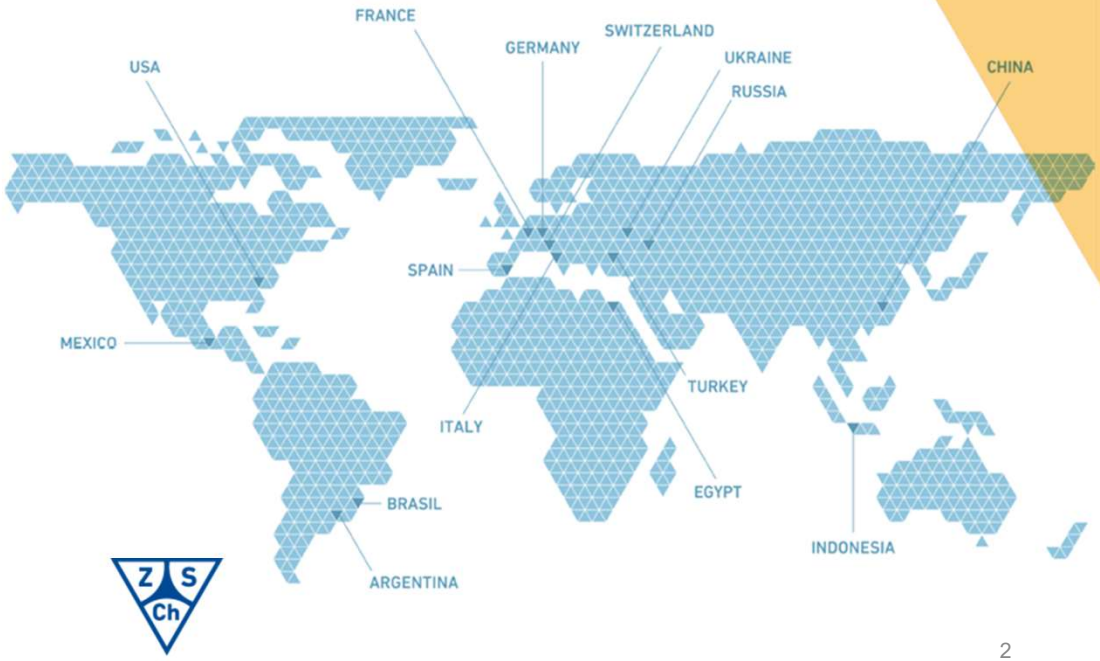
LUBRICANTS

lexolube
synthetic esters

ZSCHIMMER & SCHWARZ

Zschimmer & Schwarz today

- HQ in Lahnstein, Germany
- Global manufacturer of tailor made chemical solutions
- 9 product divisions
- 16 countries, 30 subsidiaries
- more than 1,400 employees
- € 600 million (~$700M) group revenue in 2019



Business divisions

- Lubricants
- Paints & Coatings
- Personal Care
- Industrial Specialities
- Fibre Auxiliaries
- Textile Auxiliaries
- Leather Auxiliaries
- Ceramic Auxiliaries
- Cleaning Specialities

Fields of application for our products

- Hydraulic fluids
- Oven chain oils
- Grease
- Compressor fluids
- Transformer oils
- Metalworking fluids
- Environmentally sensitive applications
- Engine oils
- Transmission fluids
- Gear oils
- Aviation turbine oils
- Drilling mud lubricants
- Food processing H1 lubricants

Lubricants

MANUFACTURING SITES

Lubricants division manufacturing

- ZS manufacturing Synthetic Esters in Milledgeville, GA since 2005
- ZS manufacturing Synthetic Esters in Tricerro, Italy since 2016
- LEXOLUBE® line acquired from Inolex in January 2017
- ZS Ivey, Georgia, USA Ester plant opened in 2019
- LEXOLUBE® and LUBRICIT portfolio now manufactured in Italy and two sites in the USA
- ZS also manufactures alkoxylate esters, phosphate esters, phosphonates, amides, and other auxiliary ingredients in multiple locations around the globe

New manufacturing site

- Ivey, Georgia, USA
- Greenfield location near Atlanta, Georgia
- Built to manufacture advanced lubricant grade synthetic esters
- Multiple reactors support our broad Synthetic Ester product line and commitment to tailor-made products
- Modular design to integrate additional capacity quickly
- Commissioned in January 2019

Ivey manufacturing – QEC process

- Quality, Efficiency, Consistency
- Equipment designed for challenging, lubricant grade Synthetic Esters
- Accurate charging and temperature control for fast cycles
- Reduced losses in evaporation, filtration
- Less waste to process
- Significant efficiency improvement
- Automated process control leads to lower product variability

Z&S Italiana – Tricerro Technologies

- Sulfation
- Sulfonation
- Amidation
- Quaternarization
- Compounding & Blending
- **Esterification**
  - New production line built in 2016
  - Dedicated vessels for finishing/refining
  - On-line process control testing

Manufacturing synthetic esters to optimize performance

- QUALITY RAW MATERIALS
  - Food safety standards
    - Select products are also Kosher/Halal
  - Color, odor, viscosity, etc.
- ACCURATE REACTOR CHARGING
  - Efficient use of raw materials
  - Short cycle times
  - Viscosity control
  - Product consistency
- ESTERIFICATION KNOW-HOW
  - Low acid value
  - Low water content
  - Tight specifications
  - Filtration
- FORMULATED FLUIDS
  - Blending
  - Additive treatment
  - Drumming and Private labelling

Lubricants

PRODUCT OVERVIEW

Product overview

- Synthetic Esters (LEXOLUBE®, LUBRICIT®)
- PEG/PPG Esters (MULSIFAN®)
- Phosphate Esters (PHOSPHETAL™)
- Phosphonates (CUBLEN®)
- Amides (PURTON®)

Performance characteristics

- SYNTHETIC ESTER BASE OILS
  - Boundary lubrication
  - Thermal and oxidative stability
  - Low volatility/high flash point
  - Wide temperature performance
  - Low sludge or deposit formation
  - Energy efficient
  - Biodegradable
  - Environmentally and worker friendly

- ALKOXYLATE ESTERS (PEG/PPG)
  - Non-ionic emulsifiers
  - Hard water stable
  - Boundary lubrication

- PHOSPHATE ESTERS & AMIDES
  - Emulsifier/Co-emulsifiers
  - Corrosion inhibitors
  - Non-staining

Synthetic ester summary

- Z&S esters are tailor-made to meet the requirements of the formulator
- Multi-functional performance
  - Lubricity
  - Extreme temperature performance
  - Extended drain intervals
  - Clean operation
  - Low volatility
  - High VI for fluid energy efficiency
- Used in automotive and industrial lubricant formulations that outperform mineral oil products
- Excellent environmental safety and toxicological profile
- Incidental food contact (HX-1) grades available

Lubricants

ESTER CHEMISTRY

DESIGN OPTIONS

Lubricant Synthetic Ester types

- Mono Esters
- Diesters
- Polyol Esters
- Complex Esters
- Aromatic Esters
- Food Grade (H1) Formulated Fluids
- Food Grade (HX-1) Base Stocks and Additives

Monoesters

- Typically made from natural fatty acids and mono-alcohols
- 60-90% renewable
- Low viscosity
- Excellent lubricity
- Low odor and color
- Environmentally and worker friendly
- Can be designed for excellent hydrolytic stability
- Biodegradable

- FIELDS OF APPLICATION
  - Metalworking
  - Textile lubricants
  - Aerosol products
  - Adjuvants
  - Oil field drilling mud
  - Biobased lubricants
  - HX1 grades available

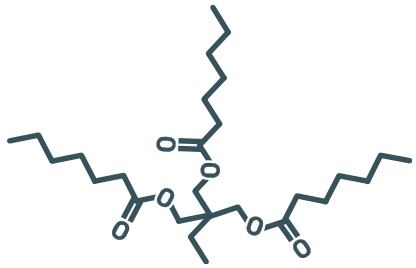
Diesters

- Typically made from dibasic acid and mono-alcohol
- Not usually bio-based
- Low to medium viscosity
- Excellent lubricity
- Very low pour point
- Excellent oxidative stability
- Low odor and color
- Biodegradable

- FIELDS OF APPLICATION
  - Engine oils
  - Compressor oils
  - Hydraulic fluids
  - Gear oils
  - Grease
  - Bearings
  - Seal swell additives

Polyol esters

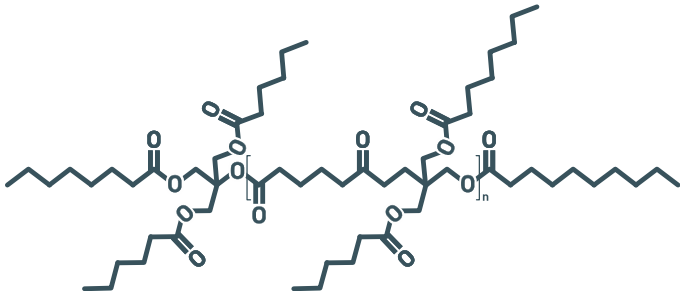
- Made from neo-polyol and mono-acid
- Can be bio-based
- Low to high viscosity
- Low volatility / High flash point
- Low pour point
- Long drain intervals
- Outstanding oxidative stability
- Can be biodegradable



- FIELDS OF APPLICATION
  - Compressor oils
  - Fire resistant hydraulic fluids
  - Oven chain oils
  - Aviation turbine engine oils
  - Gear oils
  - Engine oils
  - Grease
  - HX-1 products available

Complex esters

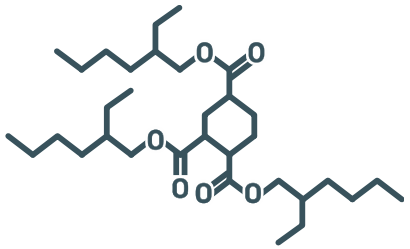
- Capped polymeric ester
- Can be bio-based
- Very high viscosity possible
- Low volatility/High flash point
- High viscosity index
- Antiwear/Extreme pressure
- Can be biodegradable



- FIELDS OF APPLICATION
  - Compressor oils
  - Gear oils
  - Grease
  - Thickening
  - Metal protection
  - HX-1 products available

Aromatic esters

- Made from aromatic anhydrides and mono-alcohols
- Not bio-based
- High viscosity
- Low viscosity index
- Low volatility / High flash point
- Reduced varnish
- Stable against oxidation & hydrolysis
- Long fluid life



- FIELDS OF APPLICATION
  - Compressor oils
  - Gear oils
  - Grease
  - Oven chain lubricants
  - Plasticizers

Lubricants

BENEFITS OF SYNTHETIC ESTERS

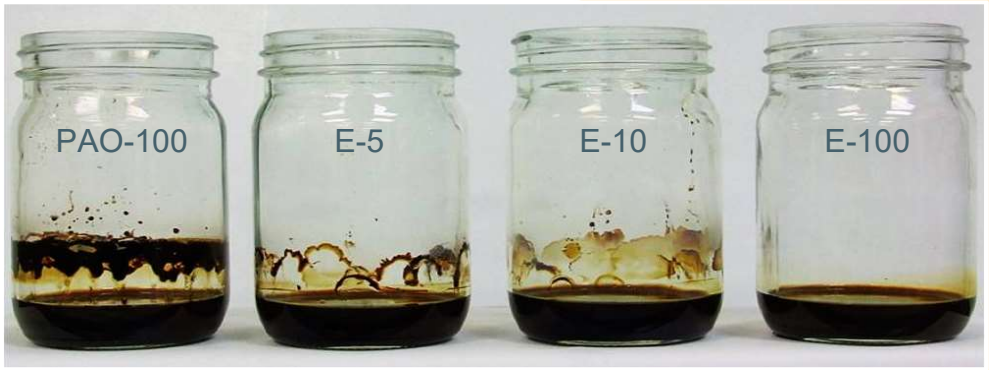
Synthetic Ester Design Considerations

- Determine critical application performance requirements
  - Low cost – Oleates, natural fatty acids, commodity raw materials
  - High viscosity – Dipentaerythritol, complex esters
  - High viscosity index – Linear structures, long chain fatty acids
  - Thermal stability – Polyols, branched acids, fully saturated components
  - Biodegradability – Natural fatty acids, less branching
  - Food contact – Ingredients with detailed information on toxicity, NSF listed

- Build the ester from components that will give the desired properties

Esters as base oil blend components reduce deposits and sludge

- BLENDS OF PAO AND POE
  - All fluids were ISO 68
  - Tested 20 hours at 260ºC
- RESULTS
  - 6-7% evaporation for all samples
  - 5% POE significantly reduces deposits

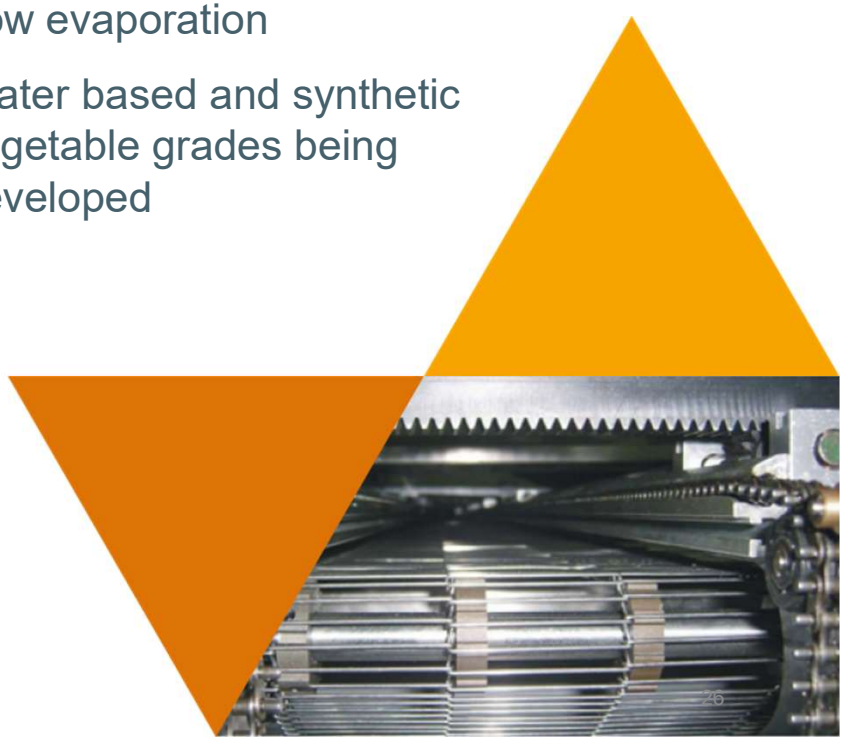


Hydraulic fluids

- Synthetic Esters provide excellent thermal and oxidative stability
- Low sludge formation
- Fire resistance („Less Hazardous“ HFDU fluids)
- Low volatility
- Very low compressibility
- High VI provides improved energy efficiency
- Typical viscosity grades – ISO 32, 46, 68
- Good lubricity

Oven chain oils

- Synthetic Esters provide excellent thermal and oxidative stability
- Typical formulation (ISO 68-460)
  - 97% synthetic ester, 3% additives
- Polyol esters – up to 275ºC
  - Best oxidative stability, very clean, low varnish
- Aromatic esters – up to 250ºC
  - Higher evaporation, softer deposits
- Complex esters – up to 225ºC
  - Better lubricity and antiwear, low evaporation
- Water based and synthetic vegetable grades being developed



Grease

- Synthetic Esters allow wide temperature range performance
- Typically requires non-soap thickener (urea, silica, etc.)
- Polyol esters: up to 240ºC
  - Best oxidative stability, very clean, low varnish
- Arctic grease: down to -60ºC
  - Low viscosity diester or polyol ester
- Bio-based esters: -20 to +175ºC
  - Excellent lubricity
  - Recommended for environmentally sensitive areas

Compressor Oils

- Synthetic Esters offer deposit control and long fluid life
- Excellent solubility/compatibility with HFC refrigerants
- POE used in combination with PAO or Group III MO
- Reciprocating and rotary vane compressors
  - Diesters and Aromatic esters for lubricity and solvency
- Rotary screw and centrifugal compressors
  - Polyol esters for oxidation stability
- HX-1 Polyol esters
  - For compressors in food processing plants

Synthetic electrical transformer oils

- High flash and fire point
- Good thermal stability for long life
- Low viscosity with low volatility
- Good dielectric properties
- Compliant with IEC 61099
- Environmentally friendly
- Bio-based esters offer improvement over vegetable oils

Automotive applications

- Synthetic Esters have a long history of high performance in racing oils and premium synthetics
- Full synthetic oils typically utilize a combination of PAO and POE
- Diesters improve additive solubility
- Low viscosity trend (0W-20 and lower)
- Low NOACK volatility
- Clean, reduces sludge formation
- Long drain intervals

Environmentally acceptable lubricants (EAL)

- Synthetic Esters are environmentally friendly
  - Marine
  - Mining
  - Forestry
  - Agriculture
  - Transformers
  - Wind turbines
- Performance is as good or better than petroleum oils

- Most esters meet USA EPA Marine (VGP) Vessel General Permit standards
- Many esters are renewable, sustainable, and have USDA BioPreferred status
- Wide variety of synthetic esters on LuSC list achieve EU Ecolabel status

Lubricants

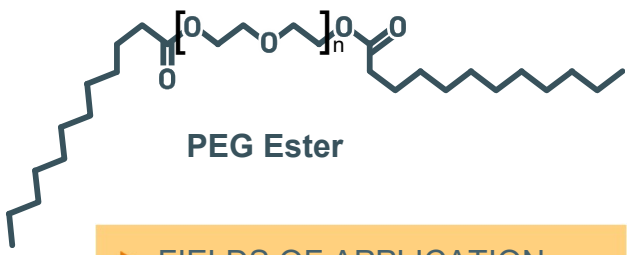
PRODUCTS FOR METALWORKING FLUIDS

Esters in metalworking fluids

- SIMPLE ESTERS
  - Excellent lubricity
  - Non-toxic, Non-hazardous handling
  - Low color and odor
  - Biodegradable
- COMPLEX ESTERS
  - Boundary lubrication
  - Improves AW/EP
- ALKOXYLATE ESTERS (PEG/PPG)
  - Non-ionic emulsifiers
  - Hard water stable
  - Boundary lubrication
- PHOSPHATE ESTERS
  - Emulsifier/Co-emulsifier
  - Corrosion inhibitor
  - Non-staining

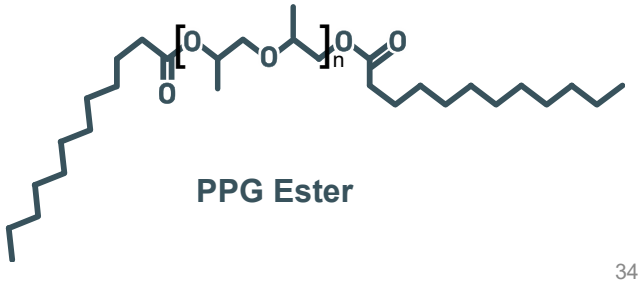
MULSIFAN series

- Esters of natural fatty acids and polyglycols
- Emulsifiers with HLB 6 to 14
  - Higher PEG increases HLB
  - Longer fatty acid decreases HLB
  - Diesters have lower HLB
- Couplers, dispersants, defoamers
- Good lubricity
- Non-toxic, Non-hazardous handling
- Low foam, hard water stable



PEG Ester

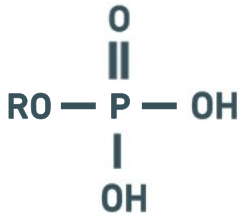
- FIELDS OF APPLICATION
  - Metalworking
  - Textile lubricants
  - Cosmetics
  - Oil field
  - Water treatment
  - Agricultural products



PPG Ester

Phosphate esters (PHOSPHETAL)

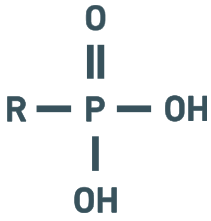
- Monophosphoric acid esters of alcohols and alcohol ethoxylates
- Available as acid form or neutralized
- Corrosion inhibitors
- EP Enhancement
- Co-Emulsifiers
- Dispersing agents



- FIELDS OF APPLICATION
  - Metalworking
  - Lubricants
  - Textile finishing
  - Oil field
  - Water treatment
  - Cleaning products

Phosphonates (CUBLEN)

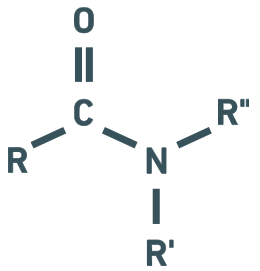
- Organic carbon directly bonded to phosphorus
- Wide range of phosphonates available
- High stability in aqueous systems
- Outstanding metal chelation
- Effective at low concentrations
- Dispersion stabilizers
- Scale inhibitor



- FIELDS OF APPLICATION
  - Metalworking
  - Lubricants
  - Textile finishing
  - Oil field
  - Water treatment
  - Cleaning products

Amides (PURTON)

- Made from fatty acid + secondary amine
- Non-ionic emulsifier
- Corrosion inhibitor
- Antistatic additive
- High stability in aqueous systems
- Effective at low concentrations
- Dispersion stabilizers



- FIELDS OF APPLICATION
  - Metalworking
  - Oil field
  - Lubricants
  - Personal Care
  - Cleaning and Degreasing
  - Metal treatment
  - Paints and Coatings

Thank you.

ZSLubes.com

zschimmer-schwarz.com

ZSCHIMMER & SCHWARZ