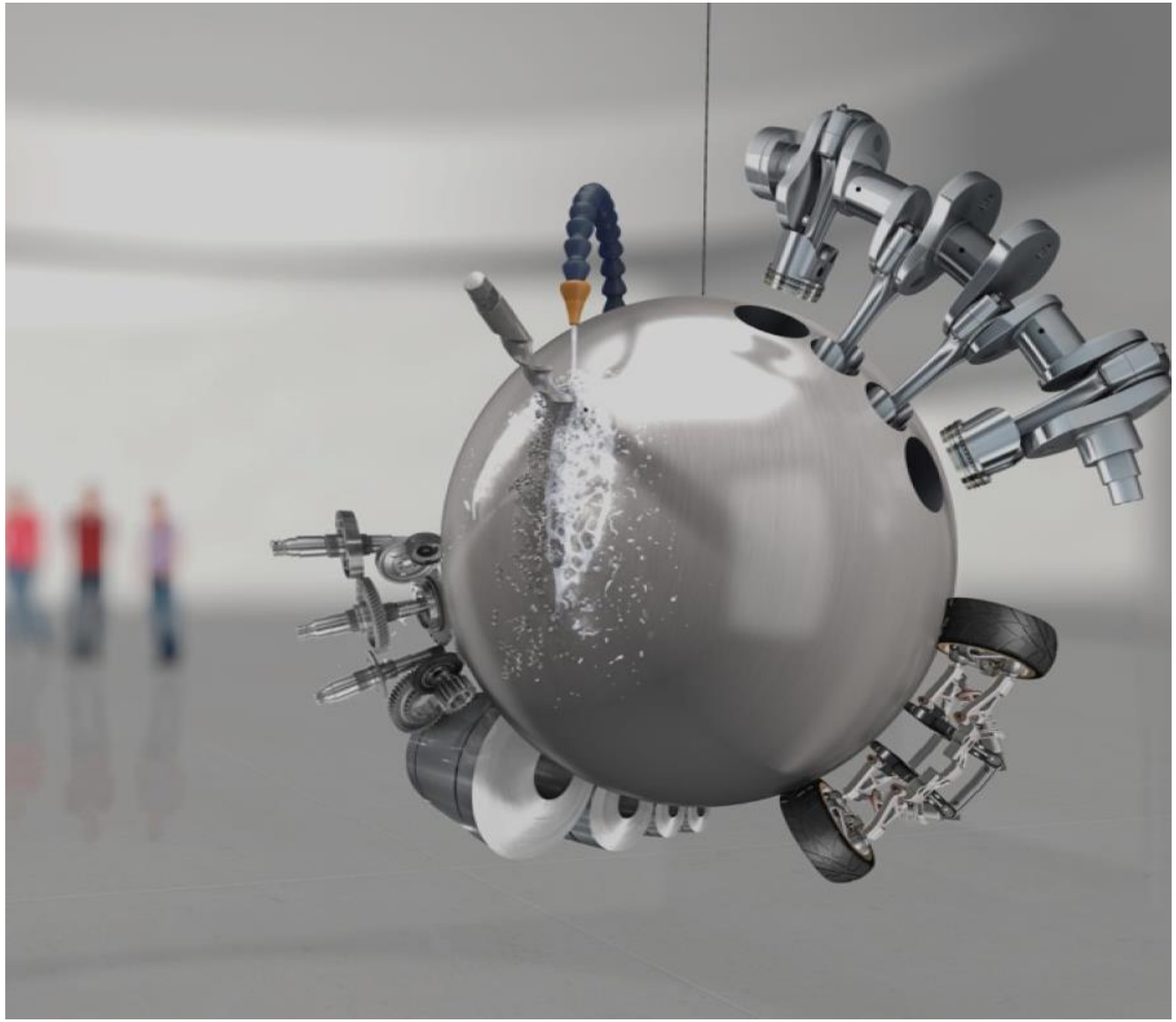
Emulsifiers for water-miscible Lubricants



Evonik Operations GmbH – Specialty Additives
Interface & Performance
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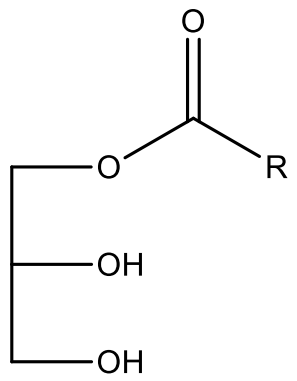
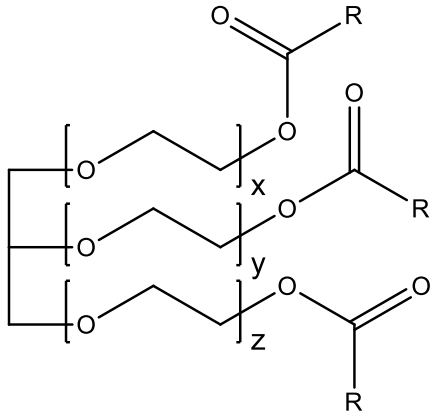
Glycerol Fatty Acid Esters

Glycerol Fatty Acid Ester



Monoester
R = fatty acid alkyl group

Ethoxylated Glycerol Fatty Acid Ester

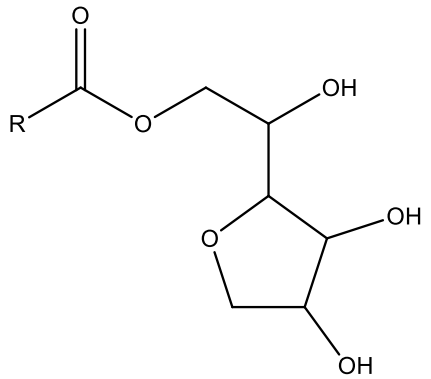


R = fatty acid alkyl group
x + y + z = moles of ethylene oxide

- Glycerol fatty acid esters have as their starting material glycerol, a polyhydroxy compound.
- The esters are usually prepared by the esterification of glycerol with the desired fatty acid such as oleic acid.
- Esters of fatty acids with glycerol are frequently ethoxylated to various degrees.

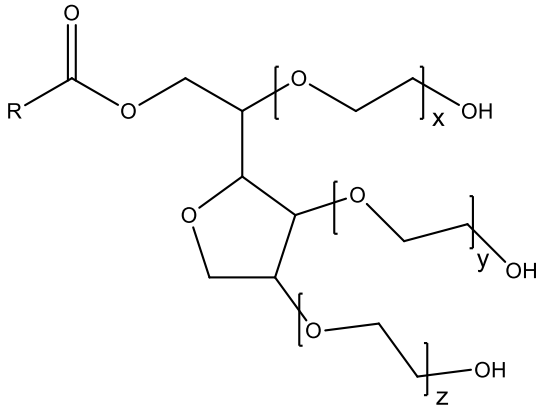
Sorbitan Fatty Acid Esters

Sorbitan Fatty Acid Ester



Monoester
R = fatty acid alkyl group

Ethoxylated Sorbitan Fatty Acid Ester



R = fatty acid alkyl group
x + y + z = moles of ethylene oxide

- Sorbitan fatty acid esters have as their starting material sorbitan, a polyhydroxy compound.
- The esters are usually prepared by the esterification of sorbitan with the desired fatty acid such as oleic acid.
- Esters of fatty acids with sorbitan are frequently ethoxylated to various degrees.

Product Overview

Product	Chemistry	HLB	Physical form
Glycerol fatty acid ester			
TEGIN® O V	Mono-di-glyceride of oleic acid	3.3	pasty
Ethoxylated glycerol fatty acid ester			
TAGAT® V 20	POE-20 glycerol oleoricinoleate	8.4	liquid
TAGAT® TO V	POE-25 glycerol trioleate	11.3	liquid
Sorbitan fatty acid ester			
TEGO® SMO V	Sorbitan monooleate	4.3	liquid
TEGO® STO V	Sorbitan trioleate	1.8	liquid
Ethoxylated sorbitan fatty acid ester			
TEGO® STO 85 V	POE-20 sorbitan trioleate	11.0	Liquid

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Benefits

- Based on raw materials derived from natural origin
- Good ecological and toxicological properties
  - Low water hazard classification number (WGK 1)
  - No hazard warning labels are required
- Good dermatological properties
  - No skin irritation
- Excellent emulsifying and stabilizing properties
- No negative impact on corrosion protection properties
- Positive influence on the solubility of biocides
- Good lubricating properties

TEGIN® O V

Composition
Mono-di-glyceride of oleic acid, HLB value 3.3 (± 1, calculated)

Application / Advantages

- Hydrophobic co-emulsifier for the combination with TAGAT® V 20 and TAGAT® TO V to adjust the necessary HLB value for a specific oil quality (e. g. rape seed oil, sunflower oil, mineral oil)
- Total mono ester content of 55 - 65 %
- In combination with TAGAT® V 20 or TAGAT® TO V an improved emulsion stability is usually achieved
- Improves lubricating properties of MWF emulsions

Remark

- Remark
- Pasty (but will become liquid at ~ 30 °C)

TAGAT® V 20

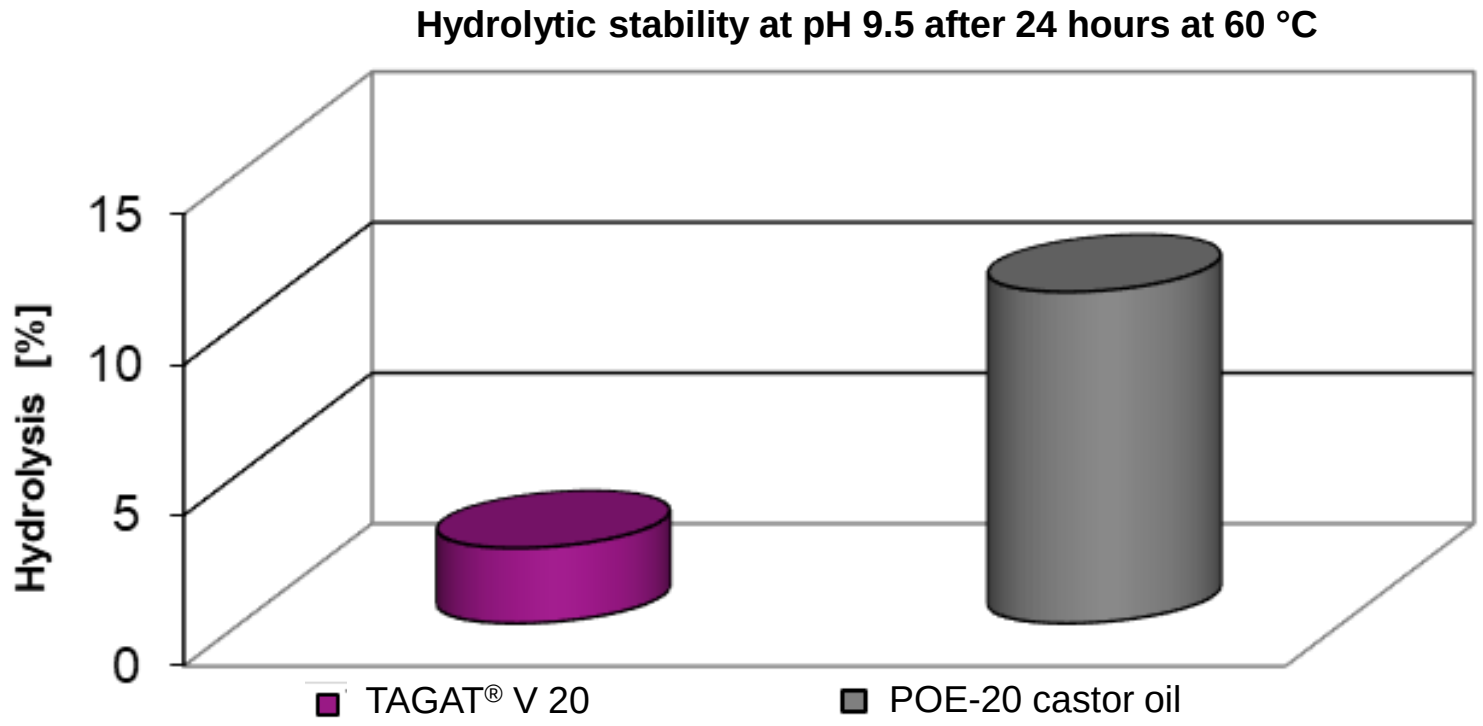
Composition
POE-20 glycerol oleoricinoleate, HLB value 8.4 (calculated)

Application / Advantages

- Basic emulsifier for the formulation of environmentally friendly water-miscible MWF as well as multifunctional fluids based on vegetable oils (e. g. rape seed oil, sunflower oil, canola oil), synthetic ester oils (e. g. Trimethylolpropane trioleate) and ester oil/mineral oil blends
- Good solubility in vegetable oils and synthetic ester oils
- Excellent emulsifying and stabilizing properties which ensures the spontaneous formation of finely dispersed and stable MWF emulsions
- The necessary HLB value for a specific oil quality can be adjusted with oleic acid or/and our hydrophobic co-emulsifier TEGIN® O V
- If combined with TEGIN® O V an improved emulsion stability is in general achieved
- Enhances lubricating properties of MWF emulsions
- If combined with alcohol ethoxylates or fatty acid alkanol amides, synergistic effects usually will occur
  - applicable in purely mineral oil-based MWF
  - increased emulsion stability of mineral oil based MWF
  - possible decrease of total emulsifier amount, often by 20 - 30 %
  - lower foaming tendency of MWF emulsions
  - improved corrosion protection properties
  - highly cost efficient

TAGAT® V 20

The hydrolytic stability of TAGAT® V 20 is superior compared to a POE-20 castor oil



Measuring conditions

- 10 % emulsifier solved in water of 20 °GH acc. to DIN 51367
- pH value adjusted with KOH on pH 9.5
- Aqueous dilution stirred at 60 °C in a closed vessel under exclusion of CO_2
- Acid released by hydrolysis was continously neutralised with KOH
- Automatic measuring of KOH amount every minute

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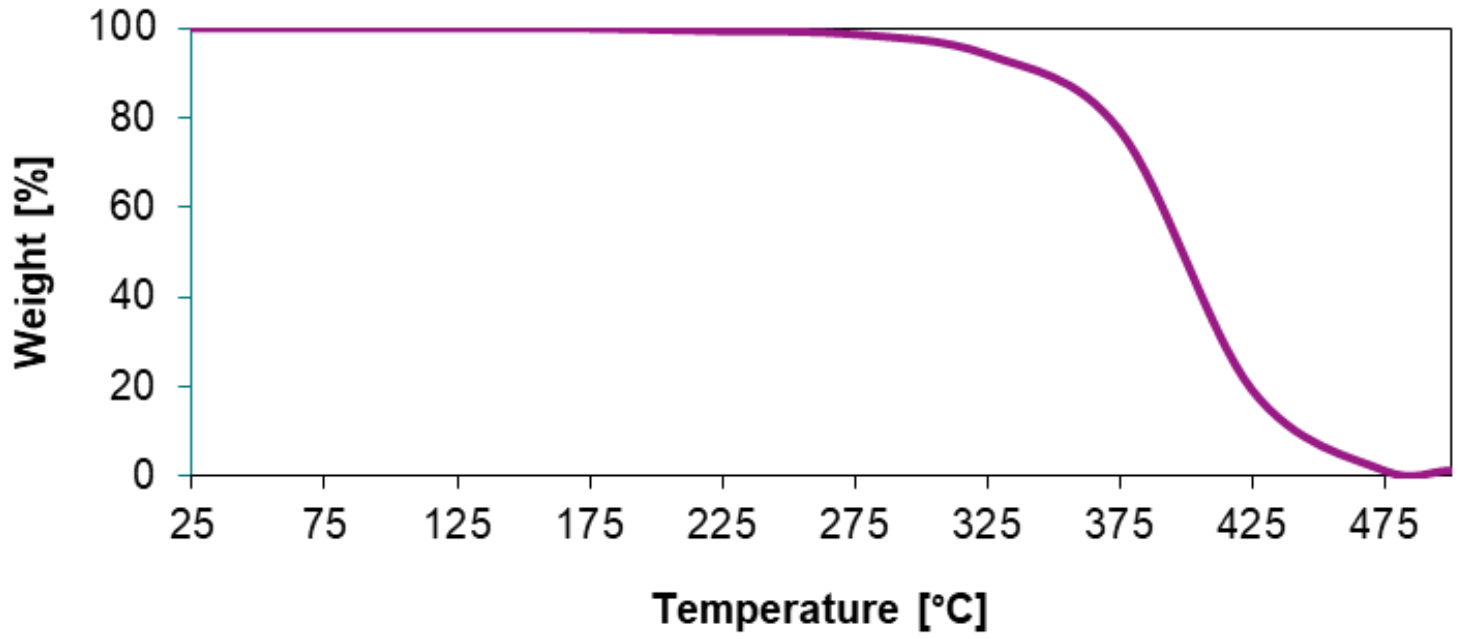
TAGAT® V 20

TAGAT® V 20 shows an excellent thermal stability

Thermogravimetric Analysis (TGA) of TAGAT® V 20



Measuring conditions

- Temperature range:
  25 to 500 °C
- Heating rate:
  10 °C/min
- Inert nitrogene atmosphere

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TAGAT® TO V

Composition
POE-25 glycerol trioleate, HLB value 11.3 (calculated)

Application / Advantages

- Basic emulsifier for the formulation of environmentally friendly MWF based on naphthenic oils, synthetic ester oils (e. g. ethyl hexyl oleate) and ester oil/mineral oil blends
- Good solubility in naphthenic oils and synthetic ester oils
- Excellent emulsifying and stabilizing properties which ensures the spontaneous formation of finely dispersed and stable MWF emulsions
- Improves lubricating properties of MWF emulsions
- The necessary HLB value for a specific oil quality can be adjusted with our hydrophobic co-emulsifier TEGIN® O V
- If combined with TEGIN® O V an improved emulsion stability is in general achieved
- If combined with alcohol ethoxylates, synergistic effects usually will occur
  - increased emulsion stability of naphthenic mineral oil - based MWF
  - possible decrease of total emulsifier amount
  - improved corrosion protection properties

TAGAT® SMO V

Composition
Sorbitan mono oleate, HLB value 4.3 (calculated)

Application / Advantages

- Hydrophobic co-emulsifier for TAGAT® V 20 to adjust the necessary HLB value for a specific oil quality (e. g. rape seed oil, sunflower oil, mineral oil)
- Improves lubricating properties of MWF emulsions

TAGAT® STO V

Composition
Sorbitan trioleate,
HLB value 1.8
(calculated)

Application / Advantages

- Hydrophobic co-emulsifier for TEGO® STO 85 V to adjust the necessary HLB value for a specific oil quality (e. g. paraffinic oils, hydro crack oils)
- Improves lubricating properties of MWF emulsions

TAGAT® STO 85 V

Composition
POE-20 sorbitan trioleate, HLB value 11.0 (calculated)

Application / Advantages

- Basic emulsifier for the formulation of environmentally friendly MWF based on paraffinic and hydro crack oils
- Good solubility in mineral oils
- Excellent emulsifying and stabilizing properties which ensures the spontaneous formation of finely dispersed and stable MWF emulsions
- The necessary HLB value for a specific oil quality can be adjusted with our hydrophobic co-emulsifier TEGO® STO V
- Improves lubricating properties of MWF emulsions

Emulsifiers Recommendation for different Base Oils

Base oil	Emulsifier blend	HLB value (calculated)
85 % Rape seed oil 45 – 65 % Oleic acid	10.5 % TAGAT® V 20 + 4.5 % Oleic acid	
	12.5 % TAGAT® V 20 + 2.5 % TEGIN® O V	~ 7.6
	10.0 % TAGAT® V 20 + 4.5 % TEGO® SMO V	~ 7.2
85 % Sunflower oil ~ 80 % Oleic acid	10.5 % TAGAT® V 20 + 4.5 % TEGIN® O V	~ 6.9
90 % Trimethylolpropane trioleate	10.0 % TAGAT® V 20	~ 8.4
90 % Naphthenic oil C/A: 10 %, C/N: 43 %, C/P: 47 %	10.0 % TAGAT® TO V	~ 11.3
	8.5 % TAGAT® TO V + 1.5 % TEGIN® O V	~ 10.1
	5.0 % TAGAT® TO V + 5.0 % TAGAT® V 20	~ 9.9
	5.0 % TAGAT® V 20 + 5.0 % 5-POE Oleyl-/Cetyl alcohol ethoxylate	~ 8.7
90 % Paraffinic oil C/A: 7 %, C/N: 25 %, C/P: 68 %	10.0 % TEGO® STO 85 V	~ 11.0
90 % Paraffinic oil C/A: 0 %, C/N: 37 %, C/P: 63 %	9.0 % TEGO® STO 85 V + 1.0 % TEGO® STO V	~ 10.1
55 % Rape seed oil 45 – 65 % Oleic acid 30 % Naphthenic oil C/A: 11 %, C/N: 45 %, C/P: 44 %	14.0 % TAGAT® V 20 + 1.0 % Oleic acid	
	14.0 % TAGAT® V 20 + 1.0 % TEGIN® O V	~ 8.1

The ratio of hydrophilic and hydrophobic emulsifiers that are given in our examples can vary depending on the specific oil quality which is used.


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