Creating Additive Value

Meeting Sustainability Standards in Metal Working Fluids Using Specialty Additives

6th International MWF Conference

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Agenda

- Sustainability and Additives
- Study of Renewable Biodegradable Defoamers in Metal Working Fluids
- Impact of High Performance Defoamers on Fluid Life Cycle

Bio-Based (Renewable) vs. Biodegradable

Bio-Based Carbon Content (Renewable)

- **Bio-based products are derived from biomass rather than fossil/petroleum sources.**
- Bio-based carbon content is calculated with respect to the active organic substance.
- Biomass contains some Carbon-14 isotope, aka ^{14}C. Fossil-derived materials no longer contain ^{14}C and only contain regular ^{12}C.
- Test method ASTM D6866 quantifies the ratio of ^{14}C to ^{12}C in the test material and compares it to the ratio in a 100% bio-based reference material.
- Other methods include ISO 16620-2 and CSN EN 16640.

Biodegradability

- **Biodegradability is the capacity for organic materials to decompose after interactions with biological elements.**
- Test methods OECD 301 A through F generally measure CO_2 release or oxygen consumption over time as the test material decomposes under controlled conditions.
- Other methods include *EN 13432* & *EN 14995* (Biodegradability & compostability).

Renewable materials are not necessarily also biodegradable, and vice versa.

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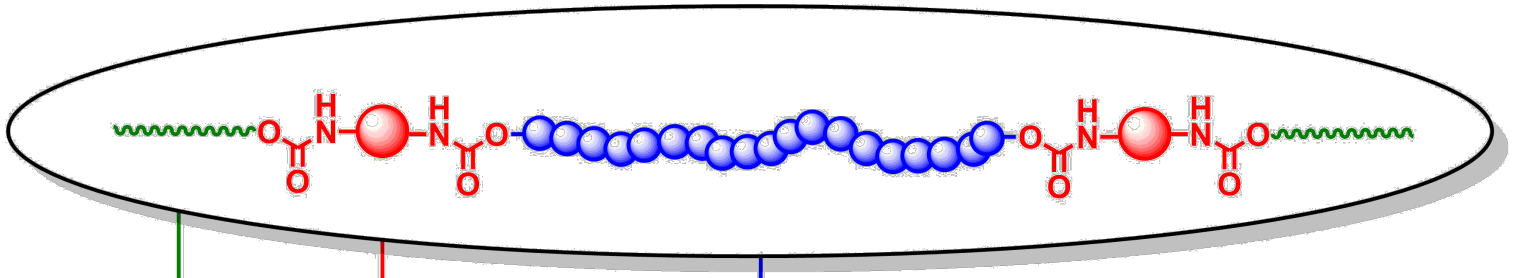
How can we make additives more Renewable?

- Some additives, and components used to make additives, are already inherently bio-based. These include materials such as:
  - ✓ Natural waxes
  - ✓ Fatty acids
  - ✓ Biopolymers
  - ✓ Vegetable oils
  - ✓ Esters
- Some components of additives that are not inherently bio-based can be alternatively synthesized from a biomass feedstock rather than a petrochemical feedstock.
- The resulting "**Renewable**" versions of the additives have the same composition and performance as the original additives, and also meet the same regulatory compliances as the originals.

Example: HEUR-type Rheology Modifiers



≈5% ≈5% 90%

Today: 0% bio-based

- ✓ Non food-competing feedstocks
- ✓ Certified & palm oil-free

- **Hydrophobic end-capping:** Already partially bio-based
- **Bifunctional bridge:** Not bio-based (yet)
- **Water-soluble spacer:** **Key building block**

Aim: 100% bio-based

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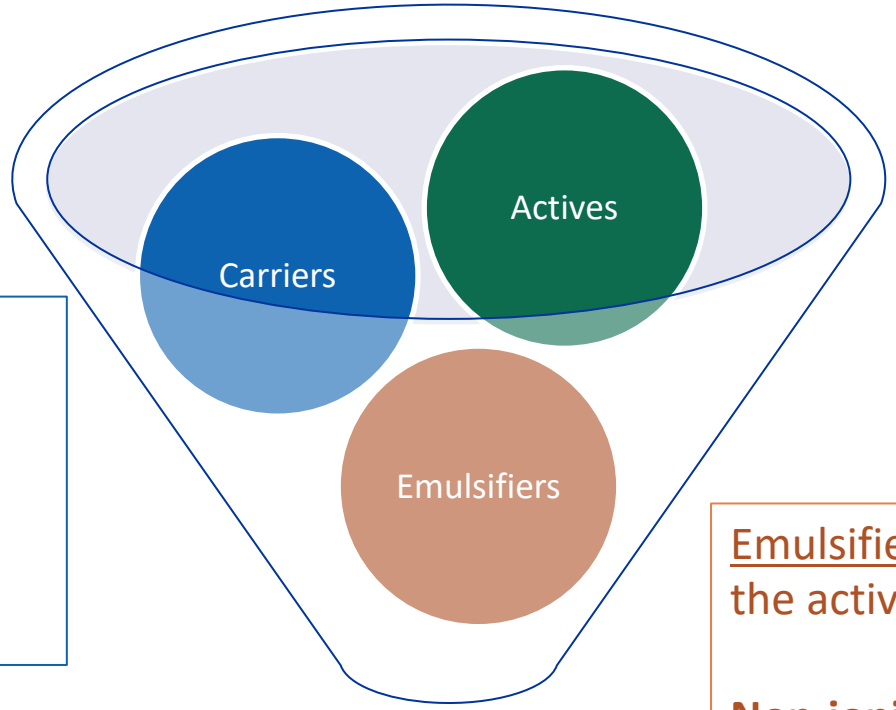
Defoamer Composition



Defoamer

Carriers lower the viscosity, carry and help disperse the actives into the fluid.

Water, Polyether glycols, Oils

Active performs the defoaming function. Entering, bridging and rupturing the lamella.

3D Siloxane, PDMS, Organo-Modified Siloxane (OMS) Hydrophobic Silica, Wax, Oil

Emulsifiers aid the dispersion and stability of the active. Helps set the droplet size.

Non-ionic ethoxylate surfactants, OMS

Some of the materials in each major defoamer component category have the potential to be substituted with a bio-sourced version.

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Sustainable Additives & Fluids

- **Product Carbon Footprint (PCF) vs. Life Cycle Analysis**
  - ✓ PCF typical range is 1000-4000 gCO_2/kg product
  - ✓ PCF is dominated by raw materials >90%
  - ✓ Defoamer only a fraction

- **More important: Impact on Life Cycle Emissions**
  - ✓ Impact on fluid life
  - ✓ Impact on performance
  - ✓ Impact on energy consumption
  - ✓ Impact on tool lifetime
  - ✓ **An additives Effect on LC is greater than PCF**

- **Example**: Defoamer with 3000 gCO_2/kg
  - ✓ Dosage 1000 ppm
  - ✓ + 3 gCO_2/kg to finished product PCF
  - ✓ Not in focus YET – more important for other additives

https://www.fuchs.com/se/en/products/product-program/what-are-cutting-fluids-made-of/

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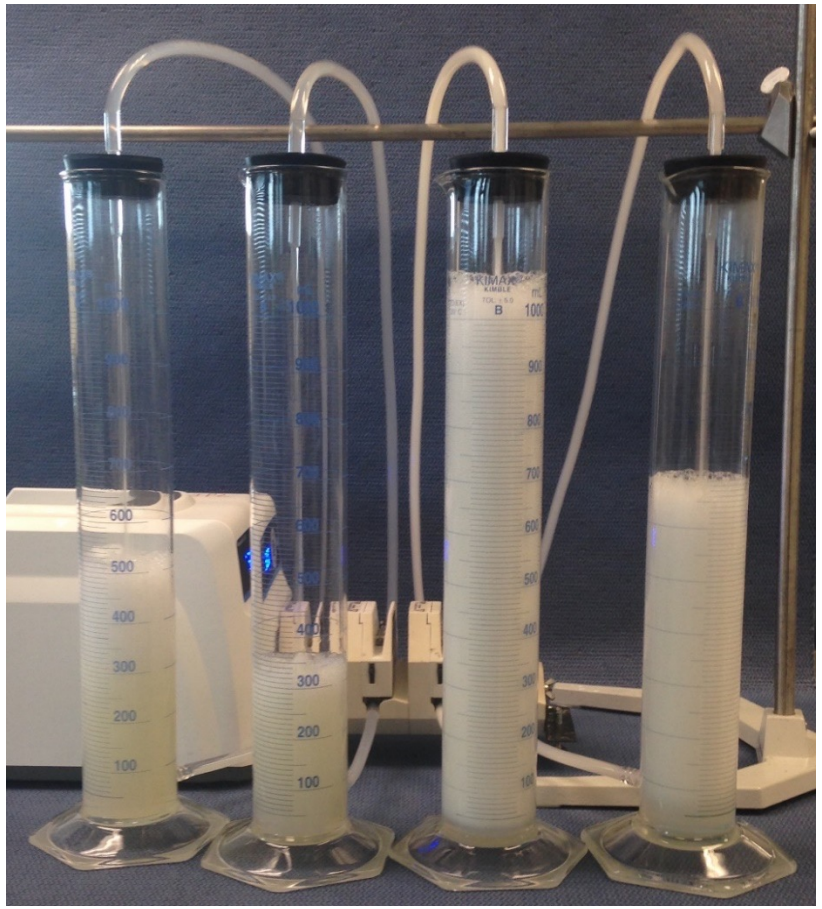
Study of Defoamers in Metal Working Fluids

- Test Methods:
  - ✓ Compatibility of the defoamer in concentrate
  - ✓ Small scale peristaltic recirculation test

Surface	Bottom	Body
• Cling on the glass • Oil collar/blanket • Suspended cloud • Floating Residue	• Sedimentation • Suspended precipitation or turbidity	• Haze or turbidity in the sample



- **Fluids tested:**
  - ✓ Semi-synthetic metal working fluid
  - ✓ Synthetic metal working fluid

Study of Defoamers in Metal Working Fluids

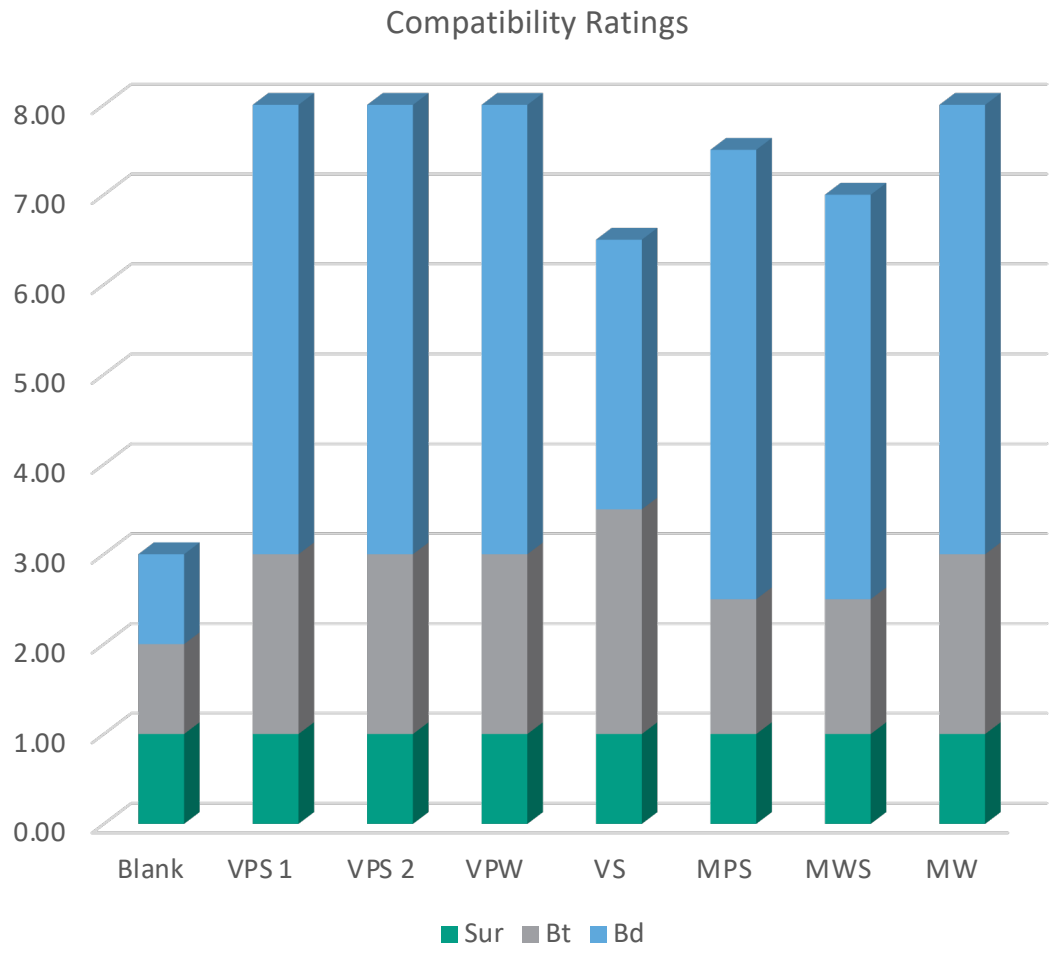
Renewable and Biodegradable Defoamers

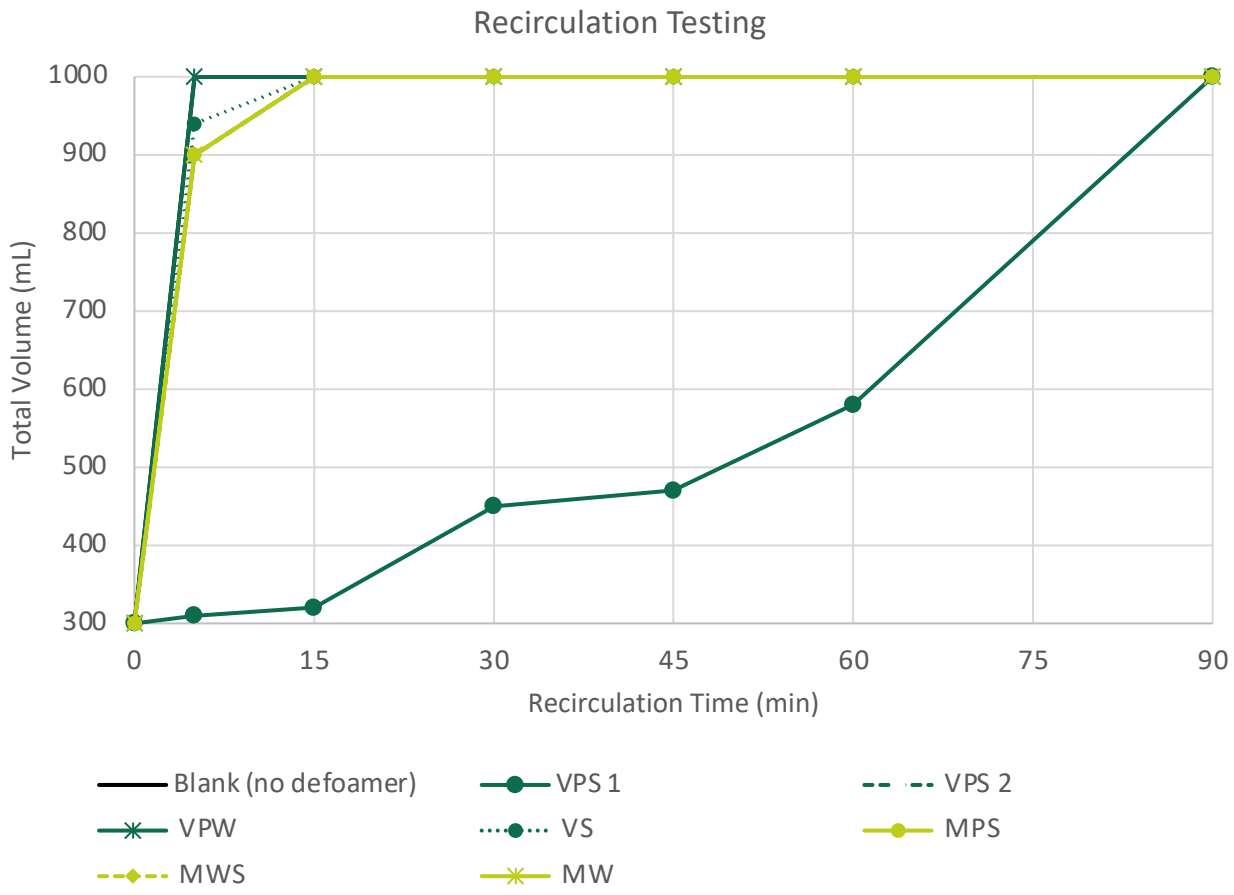
Designation in Data	Description	Renewable Content	Biodegradability
VPS 1	Vegetable oil, polyoxalkylene, silica	> 50%	> 50%
VPS 2	Vegetable oil, polyoxalkylene, silica	> 50%	> 50%
VPW	Vegetable oil, polyoxalkylene, wax	> 70%	> 75%
VS	Vegetable oil, silica	> 90%	> 90%

Non-Renewable or Biodegradable Defoamers of Similar Chemistry

Designation in Data	Description	Renewable Content	Biodegradability
MPS	Mineral oil, polyoxalkylene, silica	Non-renewable	< 5%
MWS	Mineral oil, wax, silica	Non-renewable	< 5%
MW	Mineral oil, wax	Non-renewable	< 5%

Compatibility and Foam Control Performance: Semi-Synthetic Metal Working Fluid





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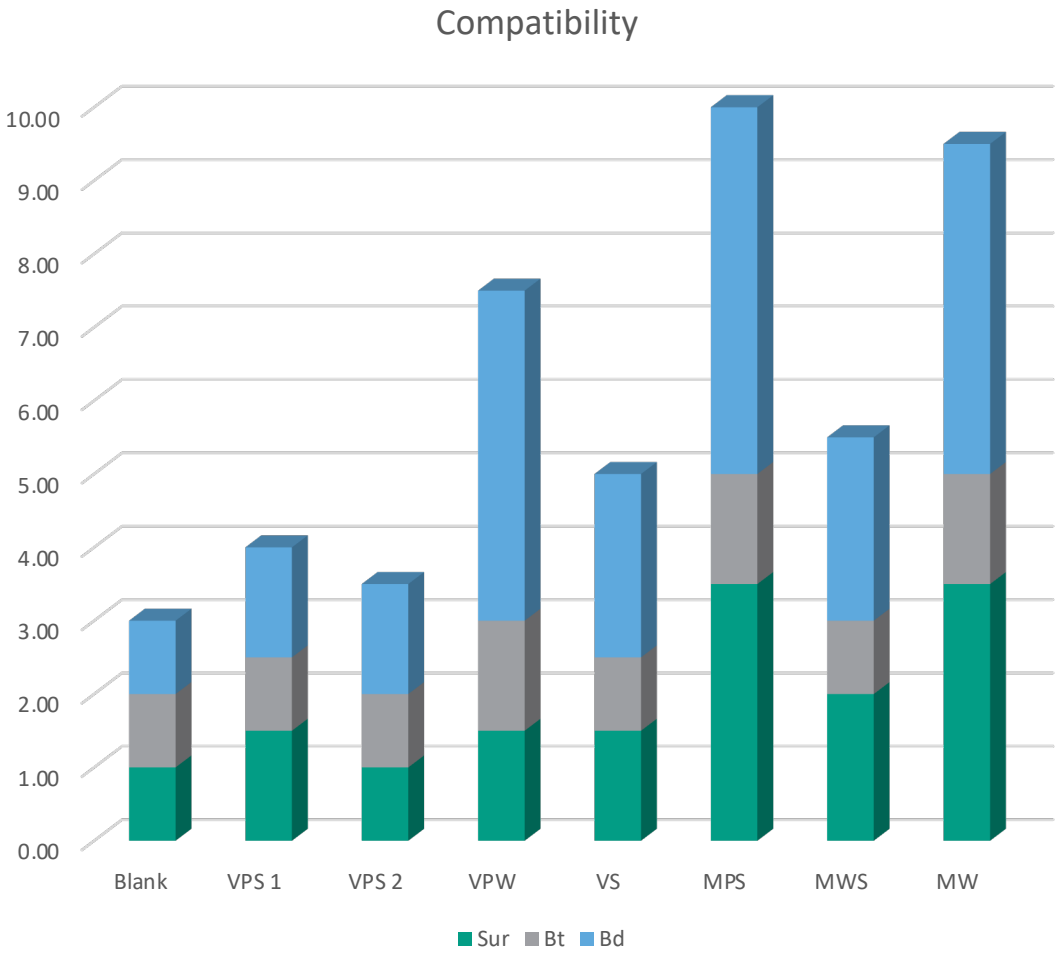
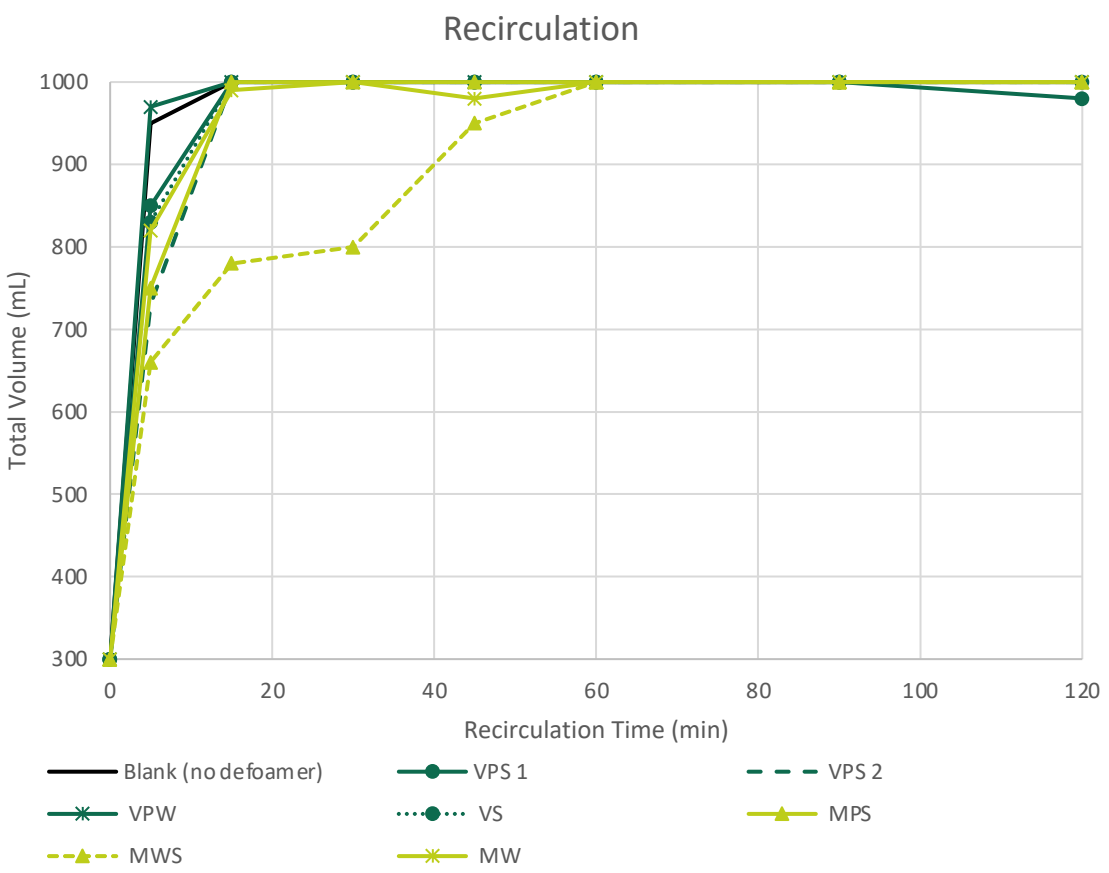
Compatibility and Foam Control Performance: Synthetic Metal Working Fluid





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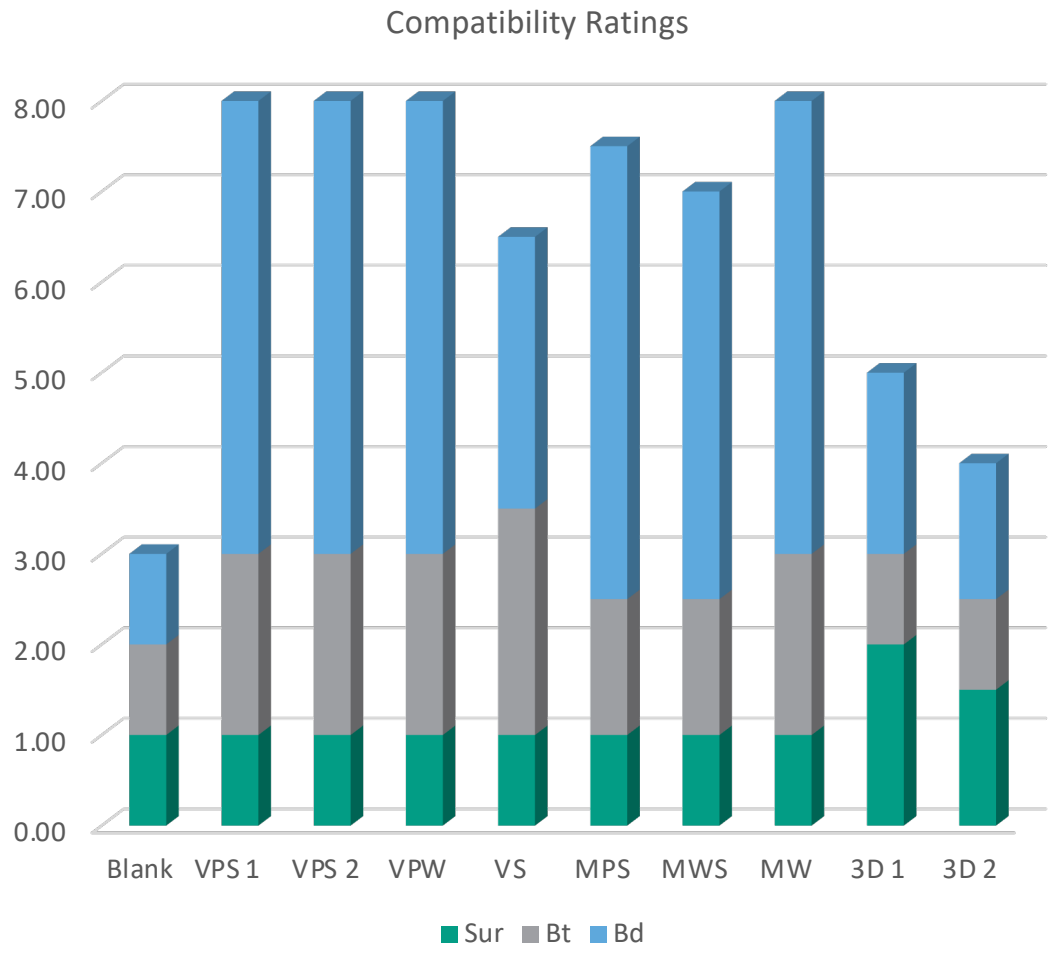
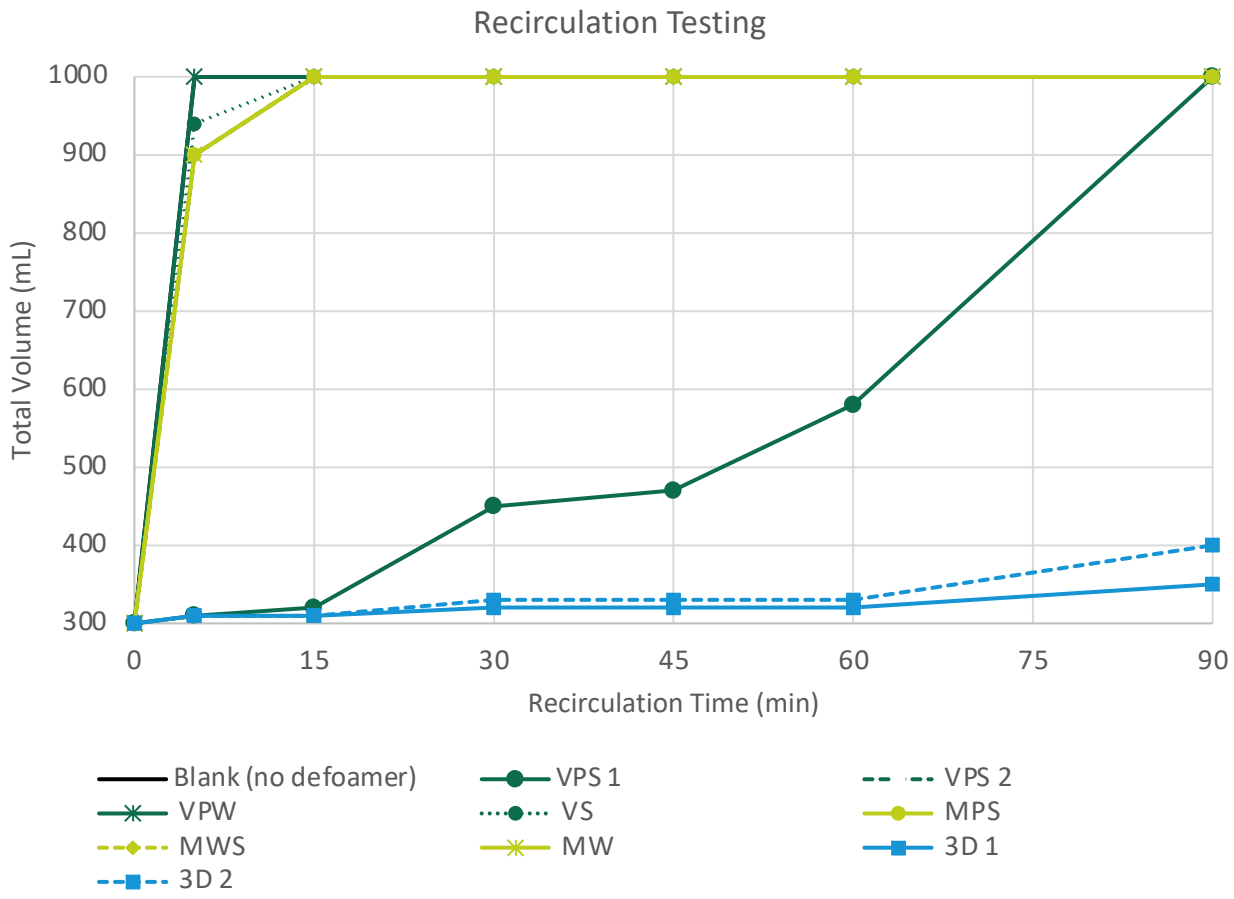
High Performance 3D-Siloxane Based Defoamers

Designation in Data	Description	Renewable Content	Biodegradability
3D 1	3D-Siloxane in polyoxalkylene	Non-renewable	> 80%
3D 2	3D-Siloxane in polyoxalkylene	Non-renewable	> 80%

Compatibility and Foam Control Performance: Semi-Synthetic Metal Working Fluid





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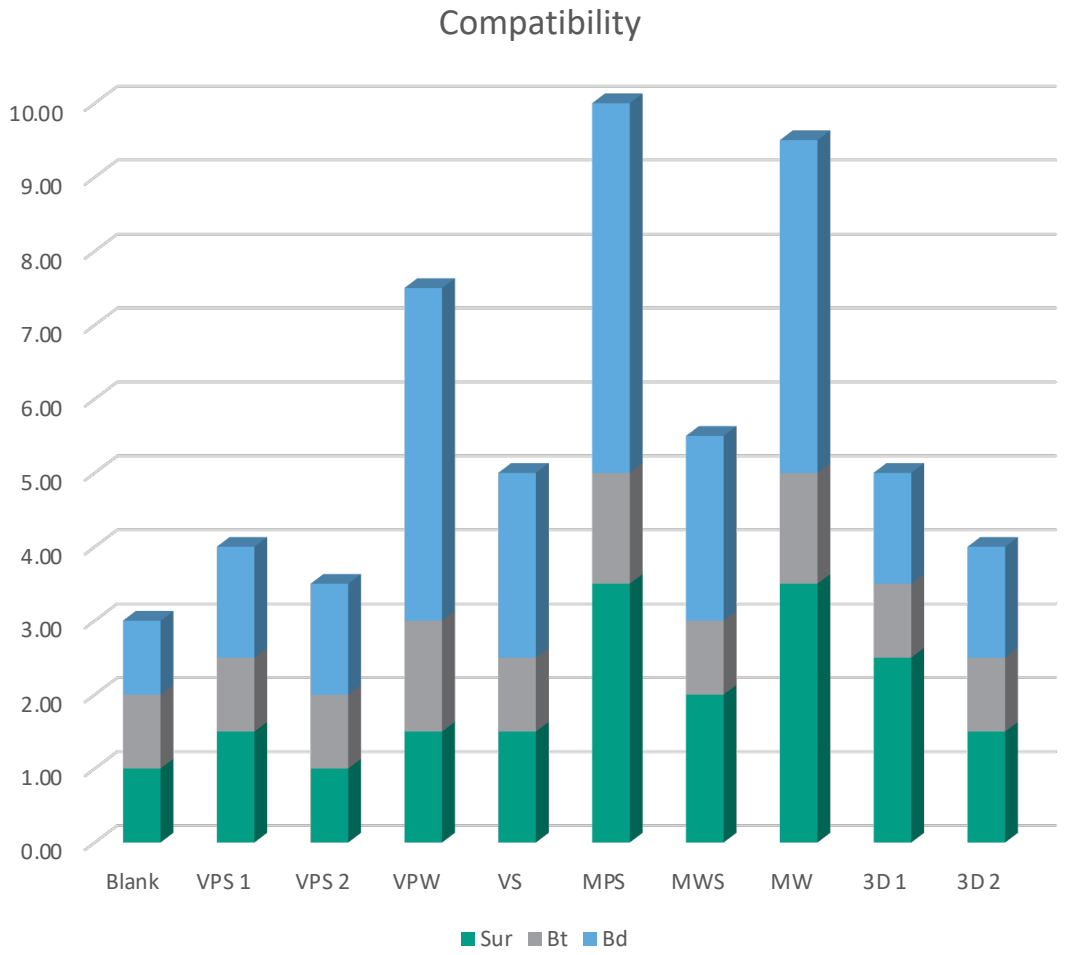
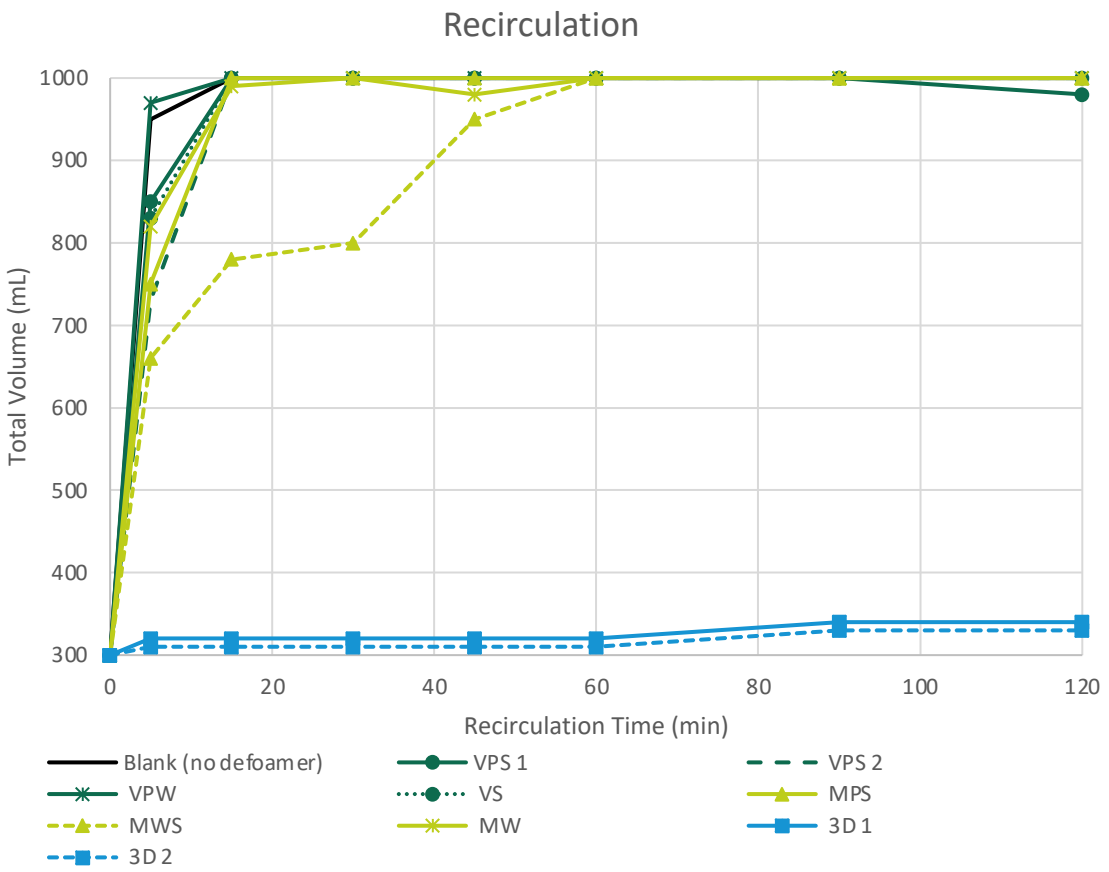
Compatibility and Foam Control Performance: Synthetic Metal Working Fluid





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Summary

- There are current renewable and biodegradable defoamers based on vegetable oil and polyoxalkylene technology available
  - ✓ These can improve sustainability of a fluid considering the improved environmental impact
  - ✓ From an economic standpoint, they may be less sustainable for the fluid
  - ✓ Long term ecological impact may not be improved due to shorter life cycle
  - ✓ “Greener” versions of similar defoamer chemistry, mineral oil, show similar or improved performance

- High Performance 3D-Siloxane can improve sustainability from an economic standpoint
  - ✓ Provide longer life cycle of the fluid – improves both economic and ecological impact
  - ✓ Less defoamer required to provide better performance – low impact from PCF standpoint

Thank you

Vielen Dank

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