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Advantages of using Sulfur Carriers as EP-Additives in emulsifiable Metalworking Fluids

Isabell Lange, Wilhelm Rehbein; LANXESS Deutschland GmbH, Mannheim, Germany
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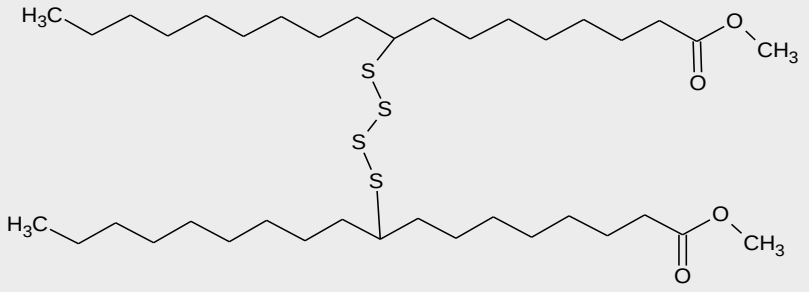
Agenda

- Sulfur Carriers Definition
- Function of EP Additives
- Technical and H&S Aspects of Sulfur Carriers
- Tribological Test Results
- Summary and Conclusion

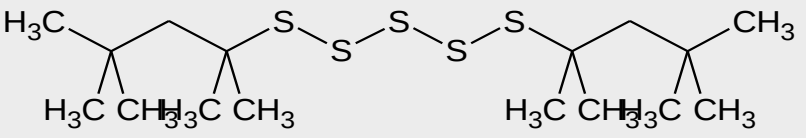
What are Sulfur Carriers?

“Sulfur Carriers”

- Are made from olefins, natural oils or synthetic esters
- Contain 1 to 5 sulfur atoms forming a “bridge” between the olefin or ester parts
- Have polar centers to adsorb on metal surfaces
- Make sulfur oil-soluble and able to form protective layers
- Work perfectly as EP additives in metalworking processes
- Are excellent replacements for chlorinated paraffins

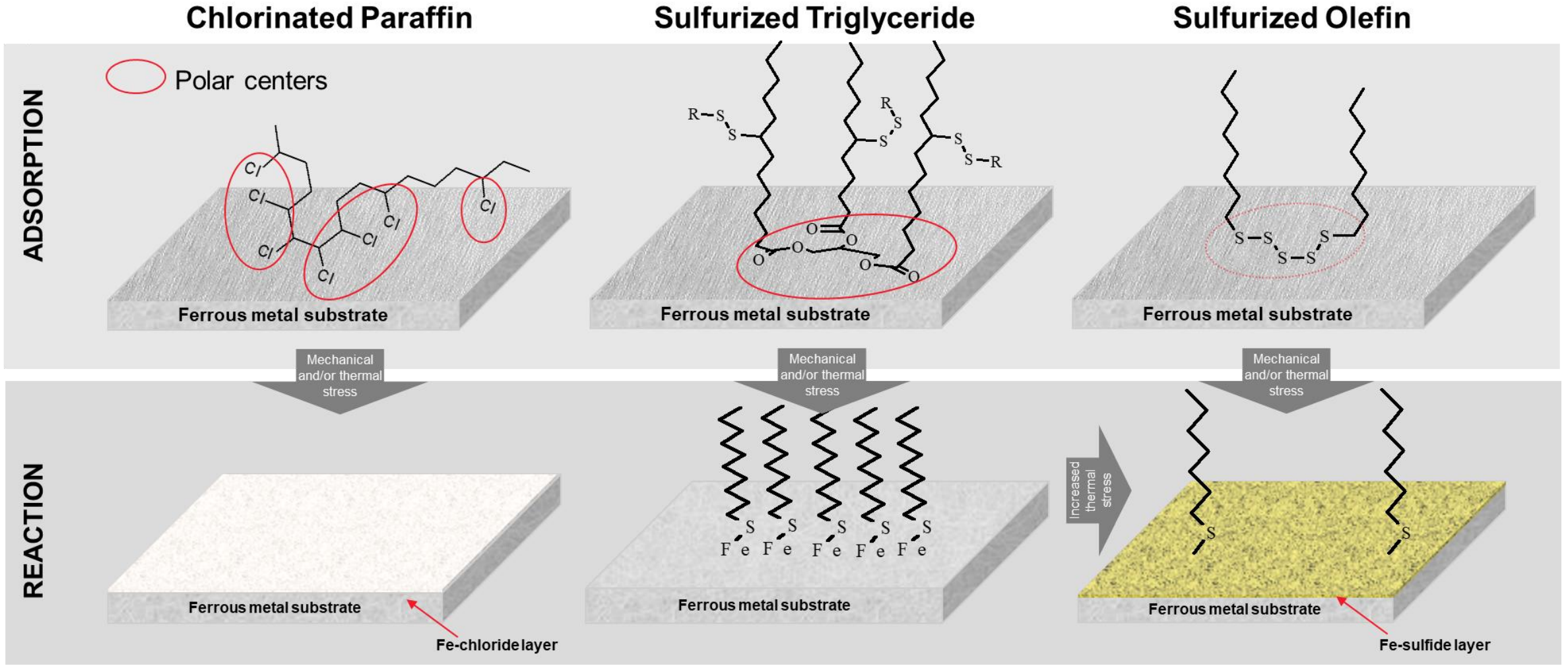


Sulfurized methylester



Sulfurized olefin

Formation of Adsorption and Reaction Layers by EP-Additives



Sulfur Carriers as EP-Additives

Technical Aspects

- Sulfur carriers with different activities and polarities available
- Outstanding efficiency over a broad temperature range
- Perfect EP additives for neat oils and emulsifiable metalworking fluids
- Support fast chip breaking, prevent formation of long chips
- Compatible with other MWF additives
- Light color and low odor
- Standard waste oil treatment, no additional requirements on disposal

H&S Aspects

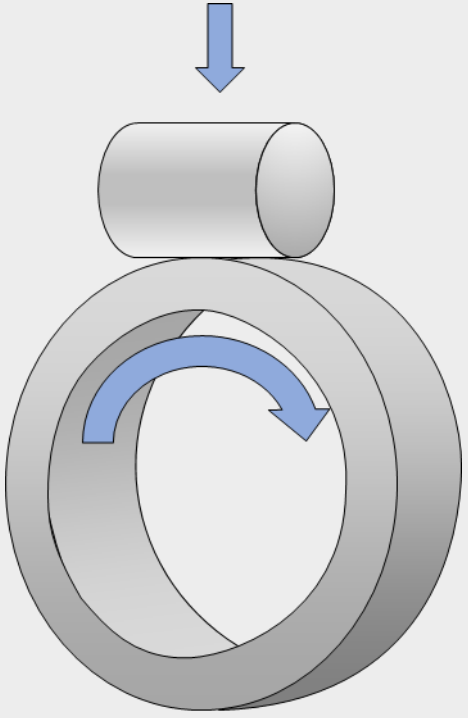
- No hazard classification
- Many sulfur carriers are based on renewable raw materials
- Some sulfur carriers are 100% biodegradable and nontoxic to aquatic life
- Some sulfur carriers are suitable formulation components for EU Ecolabel and US VIDA compliant formulations
- Many sulfur carriers can be certified as having low or no impact on the environment and showing no health hazards

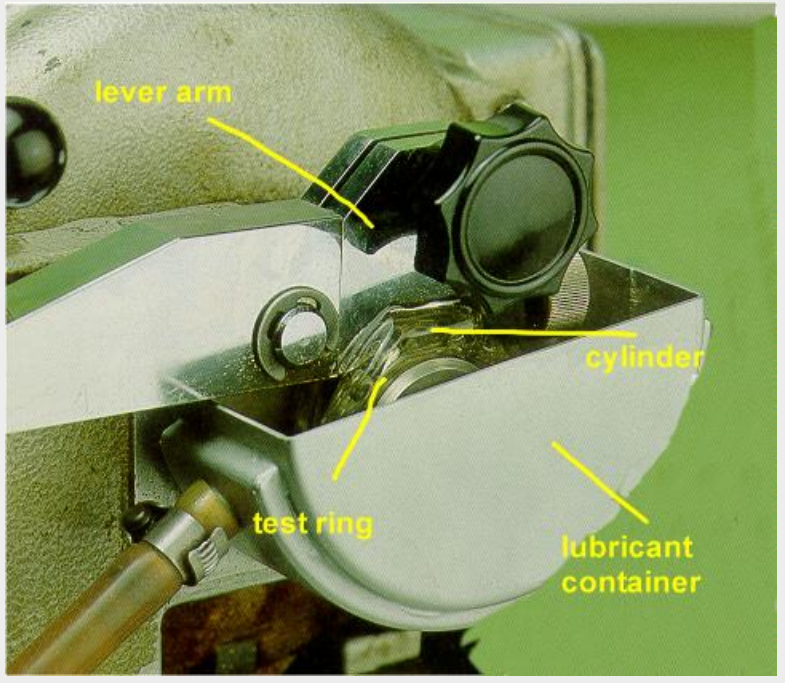
Semisynthetic emulsifiable Metalworking Fluid Formulation

Component	% by weight
Nynas T22	25 - 35
Na-sulfonate (LMW)	8 - 10
Potassium hydroxide solution 45%	3 - 5
Coupling agent	6 - 10
Fatty acid	8 - 10
EP-Additive	10
Corrosion inhibitor	2 - 3
Nonionic emulsifiers	3 - 4
Anionic emulsifier	1
Water	add. 100%

Tribological Test Results

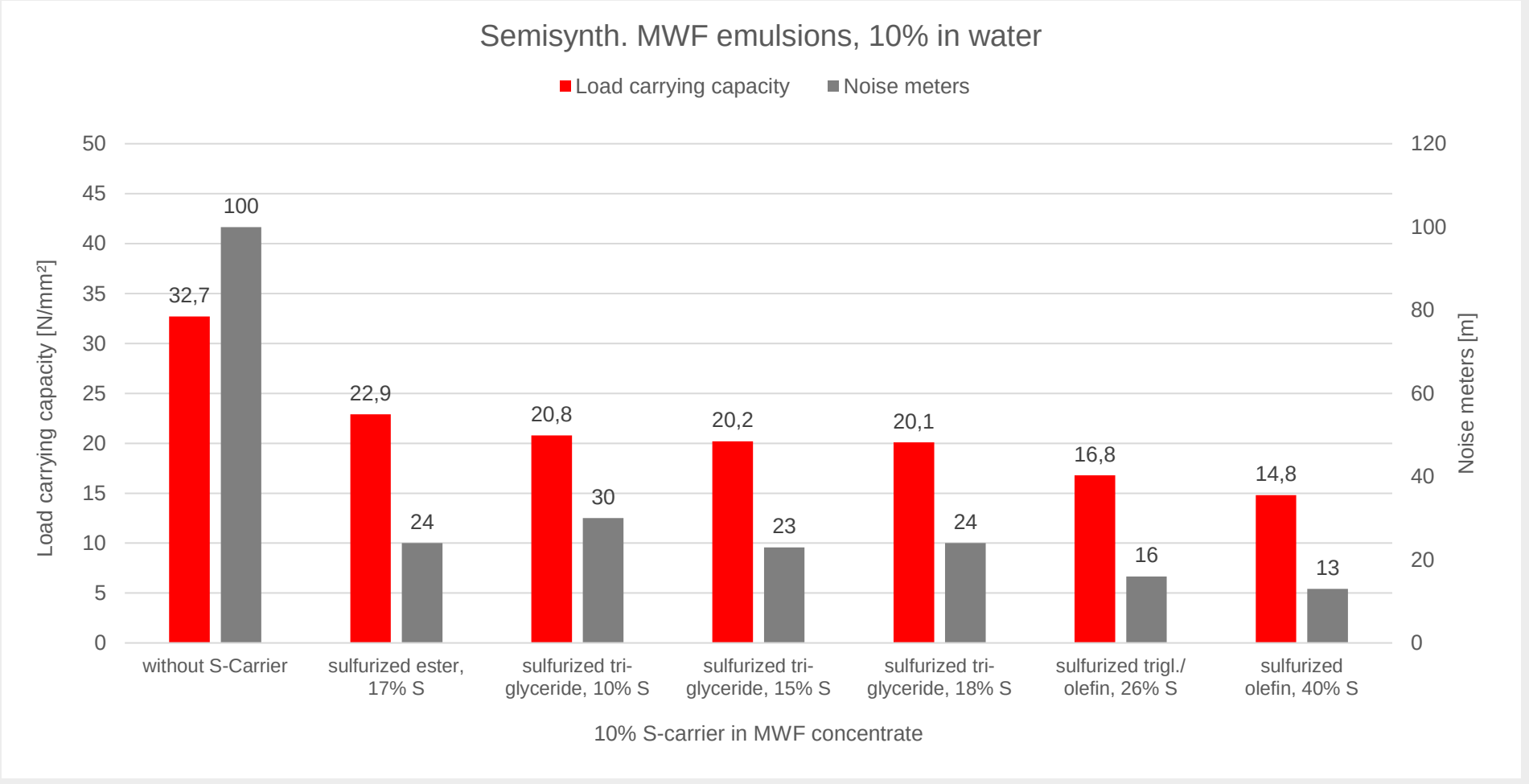
Reichert Wear Test





- Cylinder pressed against a rotating ring (steel 100Cr6; AISI 52100; HRC 62)
- Pressing force 300N, speed 900 rpm,
- Continuous lubricant supply to the contact zone
- Simulates the tribological conditions of a turning process
- Transferable to real metalworking processes
- Length of noise generation (noise meters) indicates formation of protective EP layers
- Smaller wear scar area indicates lower tool wear in cutting processes

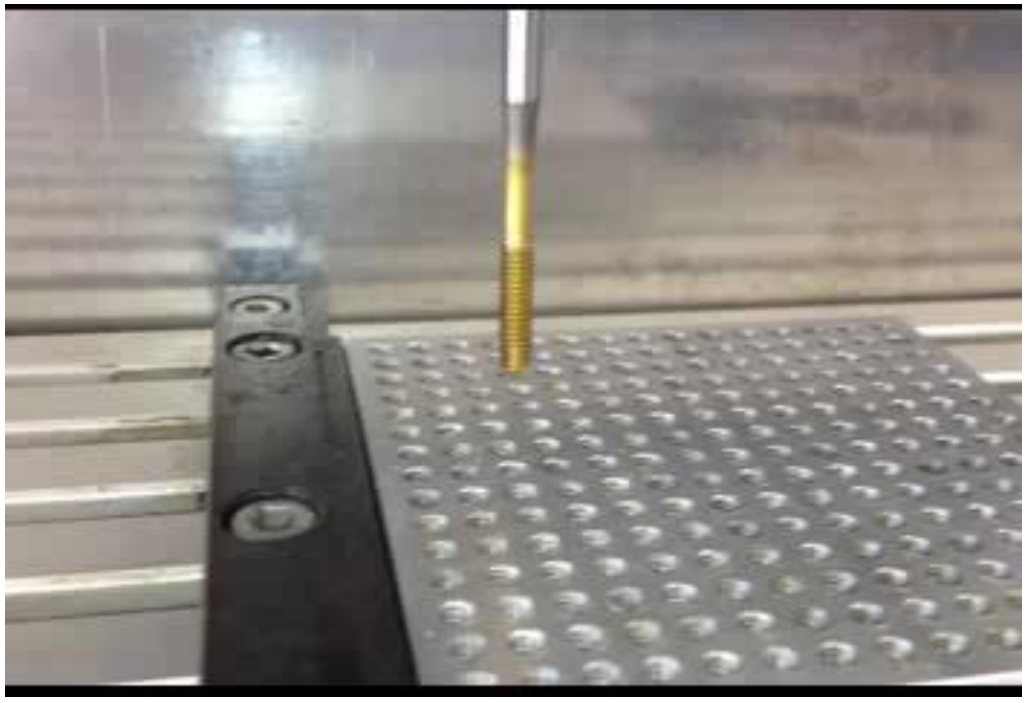
Reichert Wear Test Results



Tapping Torque Test

- Real thread cutting or thread forming process
- Can be done with many different workpiece materials and tools
- Transferable to real metalworking processes
- Torque is recorded and used for evaluation of MWF

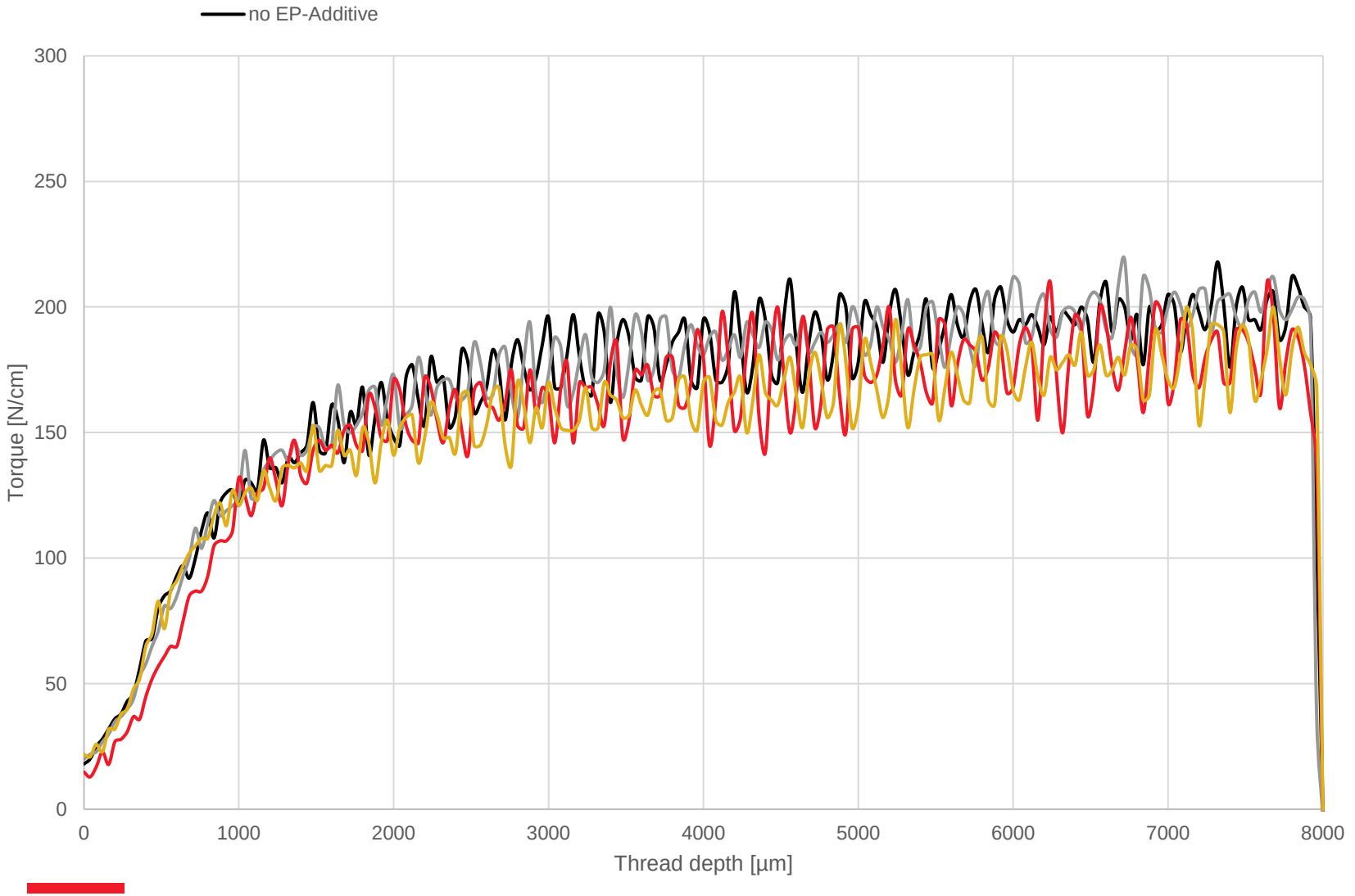
Thread Forming



Forming an internal thread

- Materials:
  - Steel CK45 (AISI 1045)
  - Stainless steel V4A (AISI 316)
  - Aluminum EN AW-7075 T6
- Core hole diameter 3.7 mm
- Thread forming tool: M4, TiAlN-coated
- Depth of thread 8 mm
- Speed 1000 rpm
- 10% semisynthetic concentrate in water
- Repeatability: < 5% of average value
- Mixed friction and boundary friction conditions

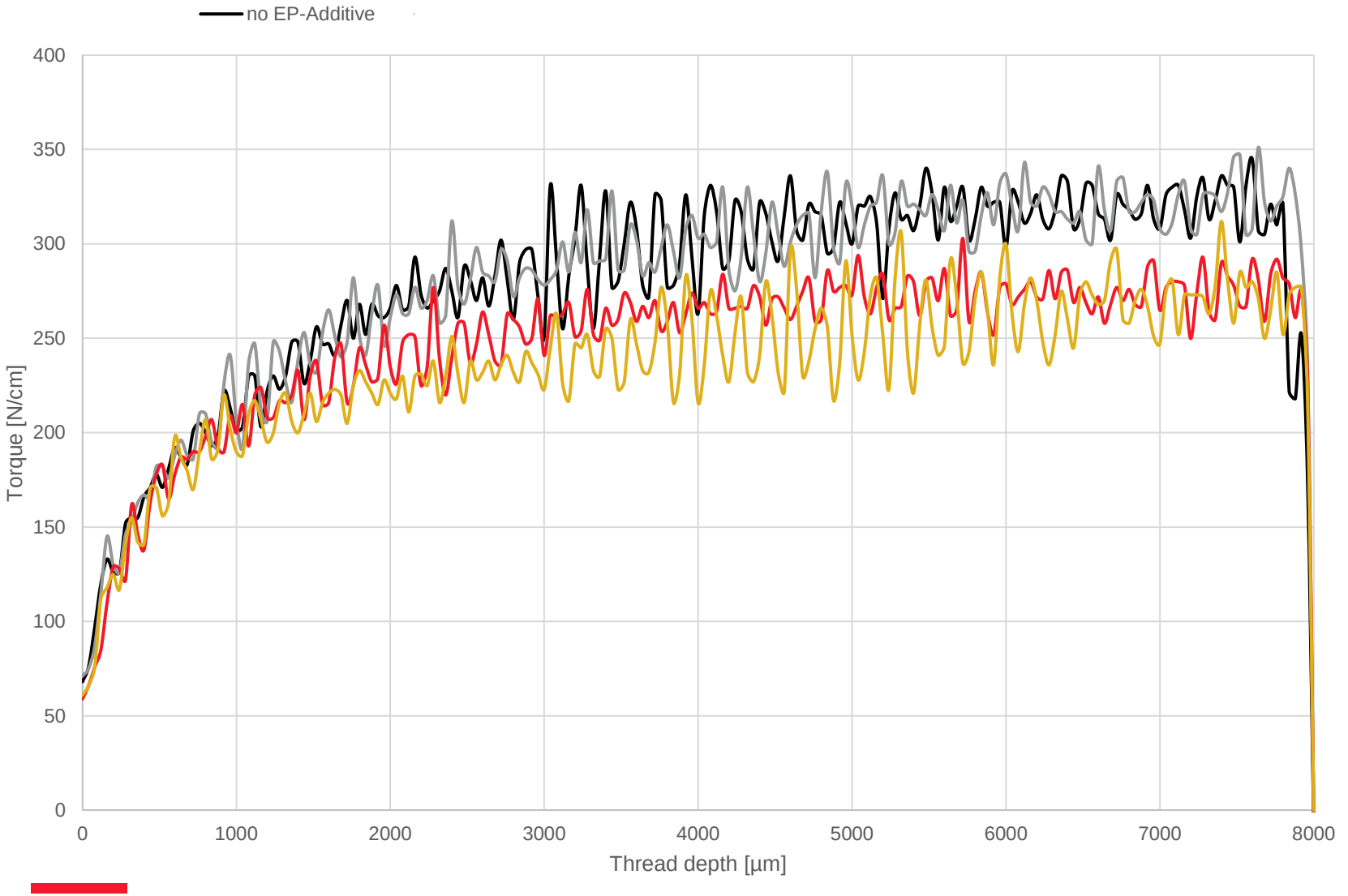
Thread Forming
Low alloyed Steel



Thread forming, Steel CK45 (AISI 1045)

	Average torque [N/cm]	Max. torque [N/cm]
No EP-Additives	181	218

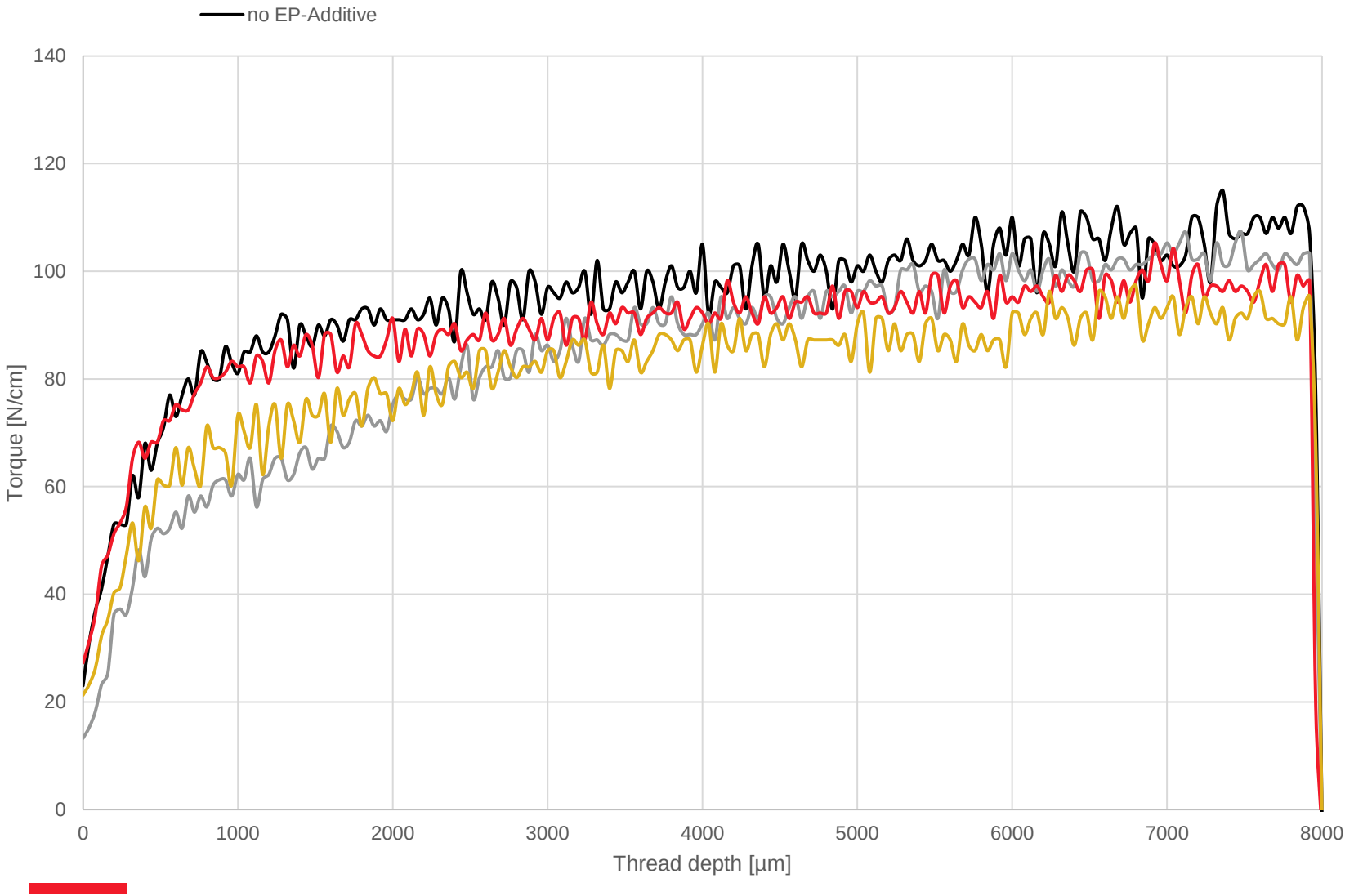
Thread Forming
Stainless Steel



Thread forming,
Stainless steel V4A (AISI 316)

	Average torque [N/cm]	Max. torque [N/cm]
No EP-Additives	295	345

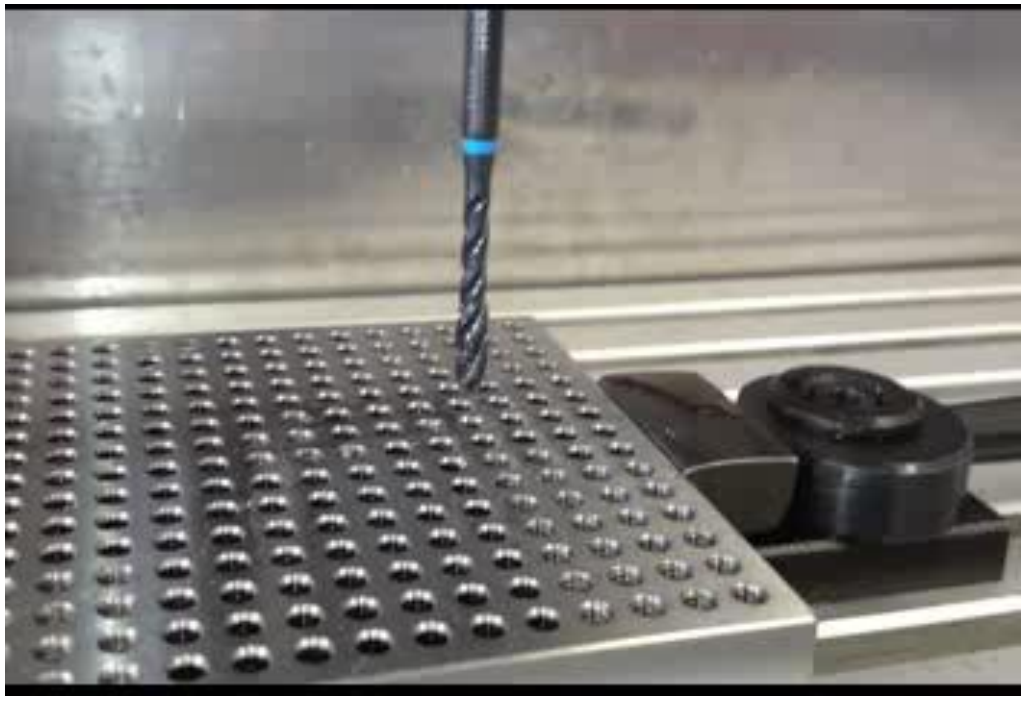
Thread Forming Aluminum



Thread forming, Aluminum EN AW-7075 T6

	Average torque [N/cm]	Max. torque [N/cm]
No EP-Additives	99	115

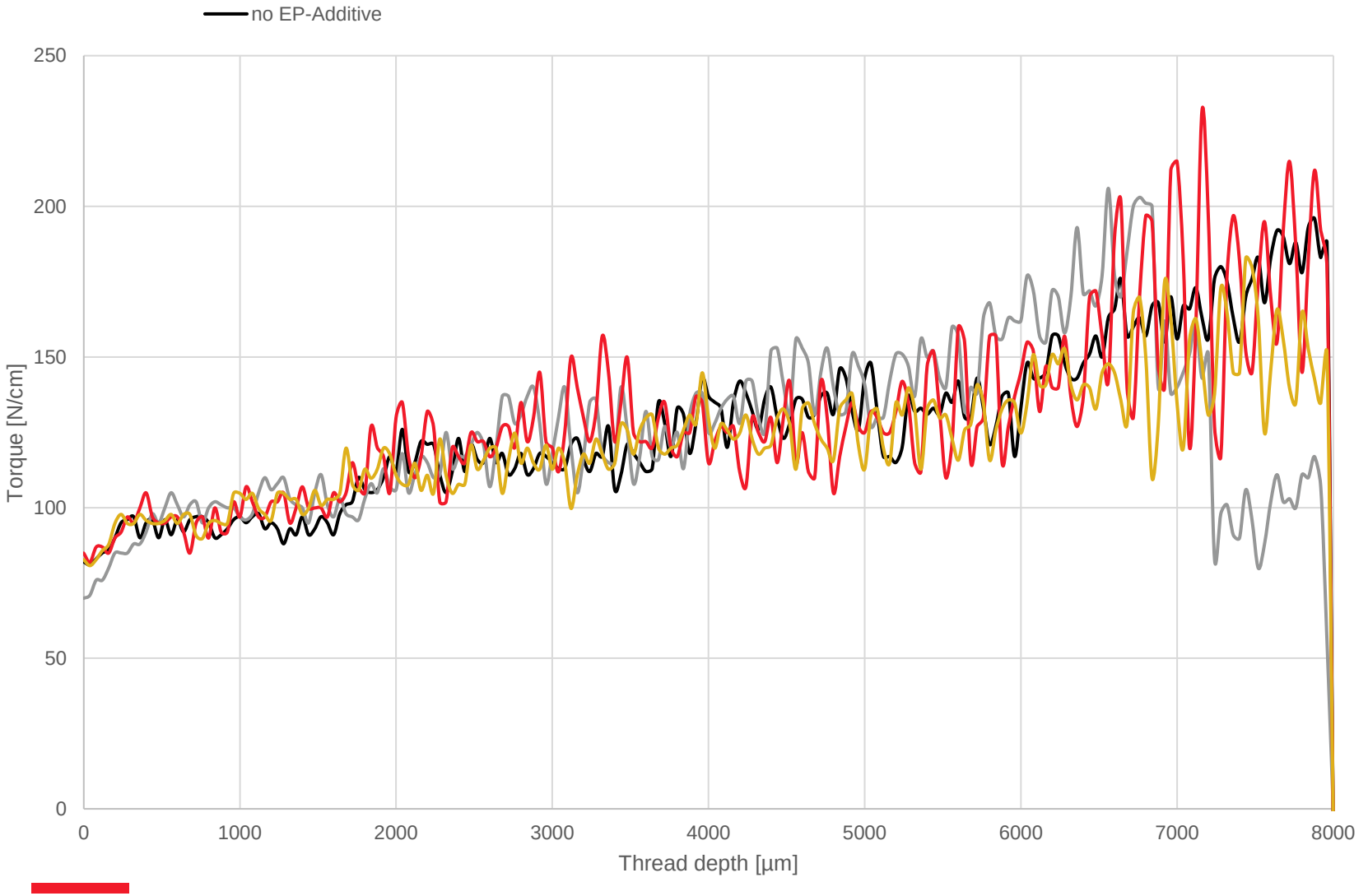
Thread Cutting



Cutting an internal thread

- Material:
  - Steel CK45 (AISI 1045)
- Core hole diameter 3.3 mm
- Thread cutting tool: M4, non coated
- Depth of thread 8 mm
- Speed 1000 rpm
- 10% semisynthetic concentrate in water
- Repeatability: < 5% of average value
- Mixed friction and boundary friction conditions

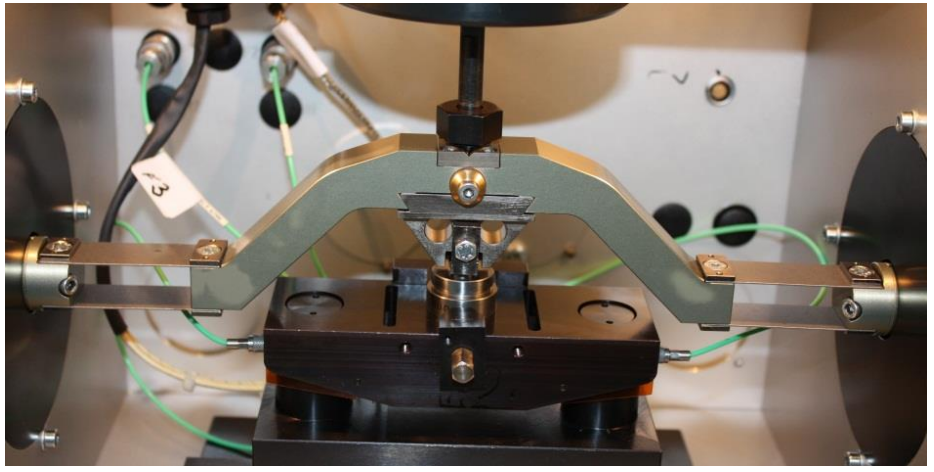
Thread Cutting
Low alloyed Steel

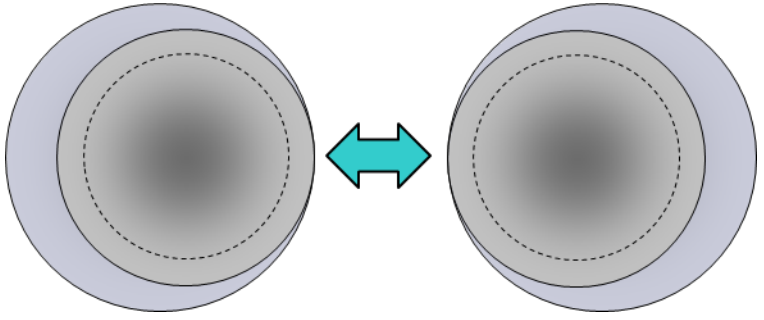


Thread cutting, Steel CK45 (AISI 1045)

	Average torque [N/cm]	Max. torque [N/cm]
No EP-Additives	132	196

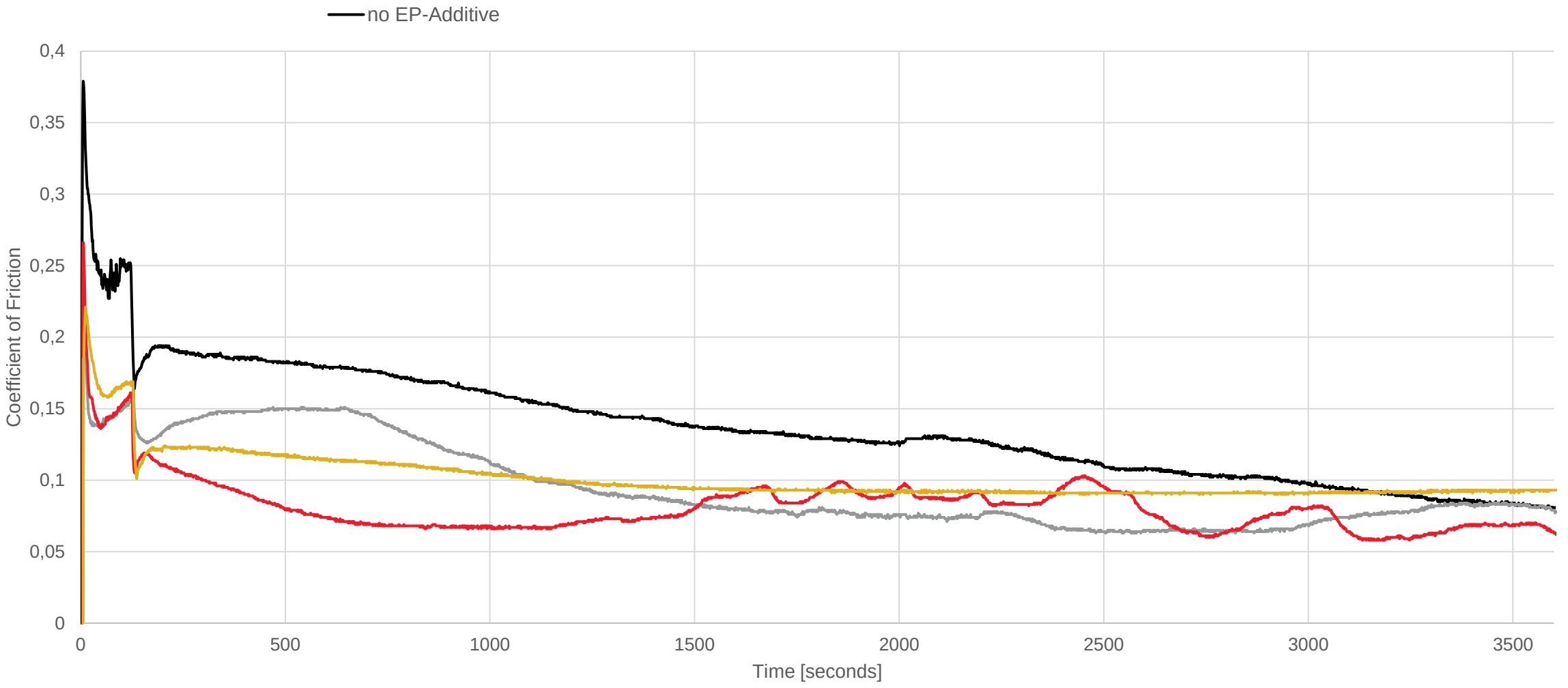
SRV Friction and Wear Tribometer





- Steel ring oscillating on steel disc, both 100Cr6 (AISI 52100; HRC 62)
- Normal force 200 N, oscillation frequency 50 Hz, stroke 1 mm, test duration 1 hr, temperature 25°C
- 10% semisynthetic concentrate in water
- Continuous lubricant supply to the contact zone by lubricant container
- Simulates the tribological conditions of metal forming and stamping processes

SRV Tribometer Test Results



Summary and Conclusions

- Sulfur carriers are effective EP-Additives in emulsifiable metalworking fluids, providing numerous advantages:
  - The higher load carrying capacity and lower noise meters indicates a fast formation of protective EP layers and less tool wear in cutting processes.
  - Sulfur carrier containing semisynthetic metalworking fluid emulsions showed a significant reduction of torque in thread forming and thread cutting processes with different materials. This results in lower friction and lower energy consumption in the machining process. Additionally, the lower mechanical stress for the tool ensures longer tool life.
  - The low and smooth curve of the coefficient of friction in the SRV test also demonstrates the beneficial effects of suitable sulfur carriers when using MWF emulsions for metal forming or stamping processes.
- Sulfur carriers show clear advantages compared to other types of EP additives:
  - Effective decrease of adhesive and abrasive wear
  - Low environmental impact
  - Non-hazardous to humans and to the environment

LANXESS has expanded its capacity on EP additives and offers technical expertise and support for the development of metalworking fluid formulations with superior performance characteristics

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