



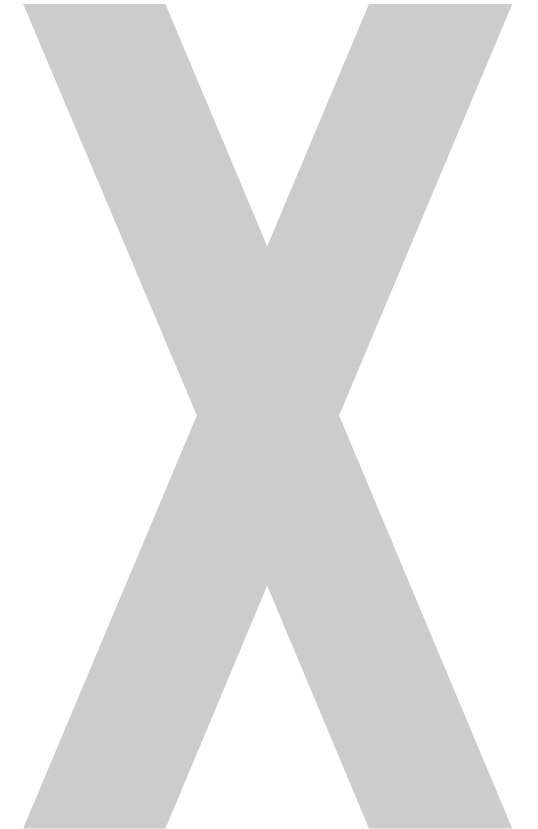
Advantages of Sulfur Carriers as EP Additives in Metalworking Fluids

Wilhelm Rehbein

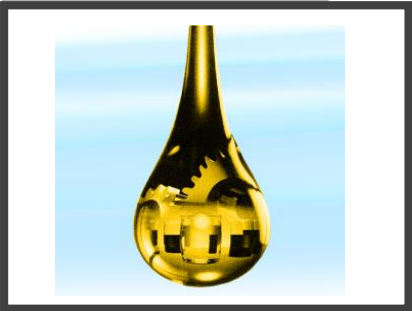
Lubricant Expo, Essen, Germany, September 6th – 8th

Agenda

- Sulfur carriers definition
- Sulfur carriers and chlorinated paraffins – technical and H&S aspects
- Laboratory and field test results
- Summary and conclusion

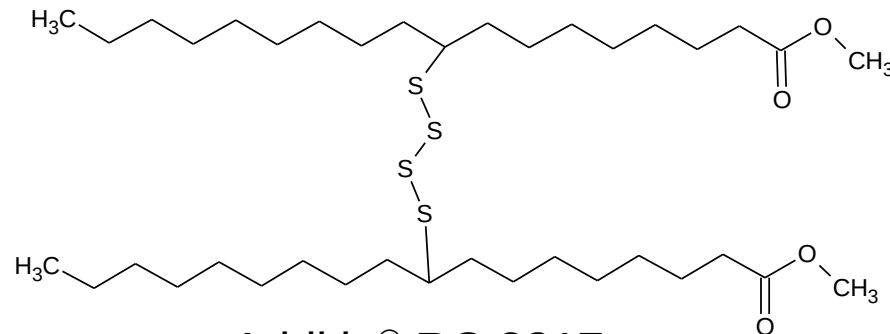


What are Sulfur Carriers?

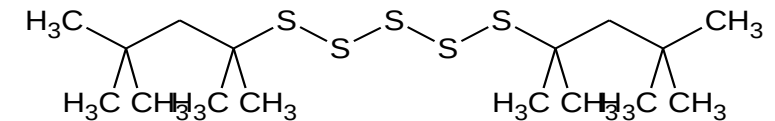


“Sulfur Carriers”

- 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



Additin® RC 2317



Additin® RC 2540

Comparison of EP-Additives, technical Aspects

Chlorinated Paraffins

- Effective EP-additives at low machining speeds
- Thermal decomposition at higher machining speeds and temperatures leads to increased tool wear
- Hydrolysis in presence of moisture, formation of hydrochloric acid
- Compatible with most MWF additives
- Colorless and odorless
- Low costs but high disposal costs in some regions

Sulfur Carriers

- Sulfur carriers with different activities and polarities available
- Outstanding efficiency over a broad temperature range
- Performance can be even increased by using synergistic combinations with overbased sulfonates, polycarboxylates and other polar compounds
- Support fast chip breaking, prevent formation of long chips
- Compatible with most MWF additives
- Light color and low odor
- Standard waste oil treatment, no additional disposal costs

Comparison of EP-Additives, H&S Aspects

Chlorinated Paraffins

- Short chain chlorinated paraffins (SCCPs) banned in many countries – persistent, bioaccumulative and suspect of causing cancer
- Intentions to ban or restrict the use of medium chain chlorinated paraffins (MCCPs) by the European Union and the United Nations Environment Program (Stockholm Convention on Persistent Organic Pollutants)
- Discussions about a ban of MCCPs and long chain chlorinated paraffins (LCCPs) in the US
- Chlorinated paraffins are GHS categorized as very toxic to aquatic organisms with long lasting effects

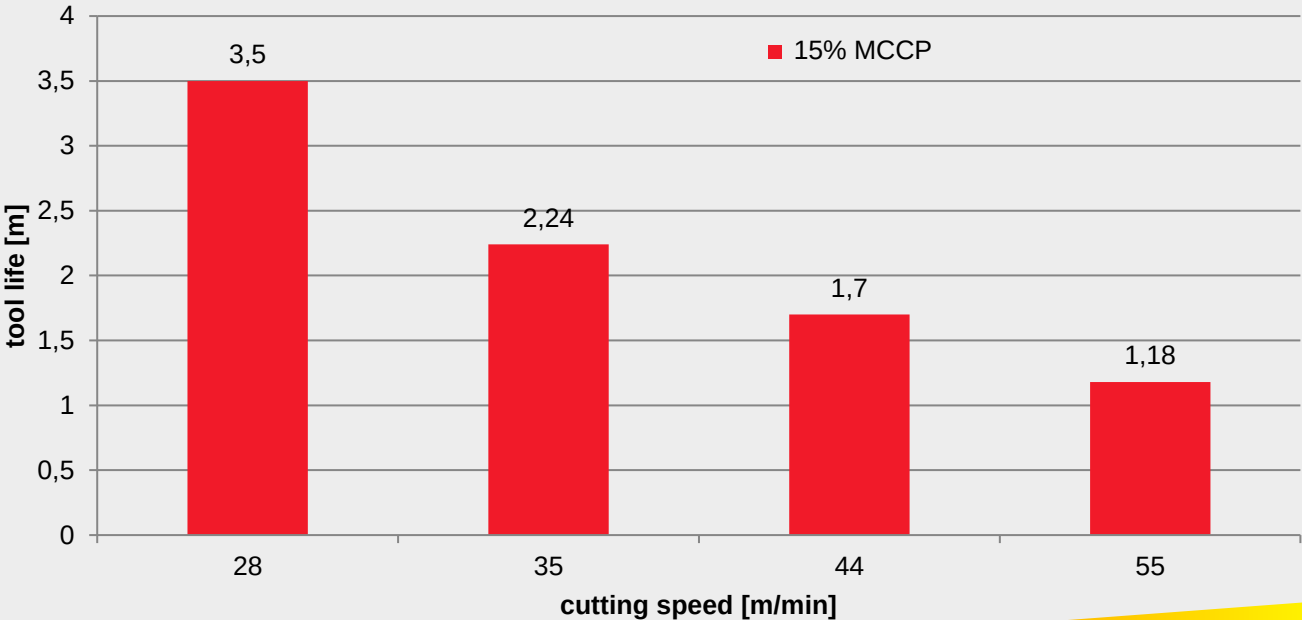
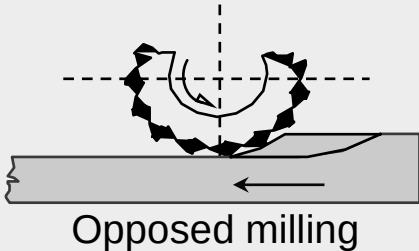
Sulfur Carriers

- No hazard classification
- Some sulfur carriers are partially made from renewable raw materials
- Some sulfur carriers are suitable formulation components in EU Ecolabel and US VGP compliant formulations

Laboratory and Field Test Results

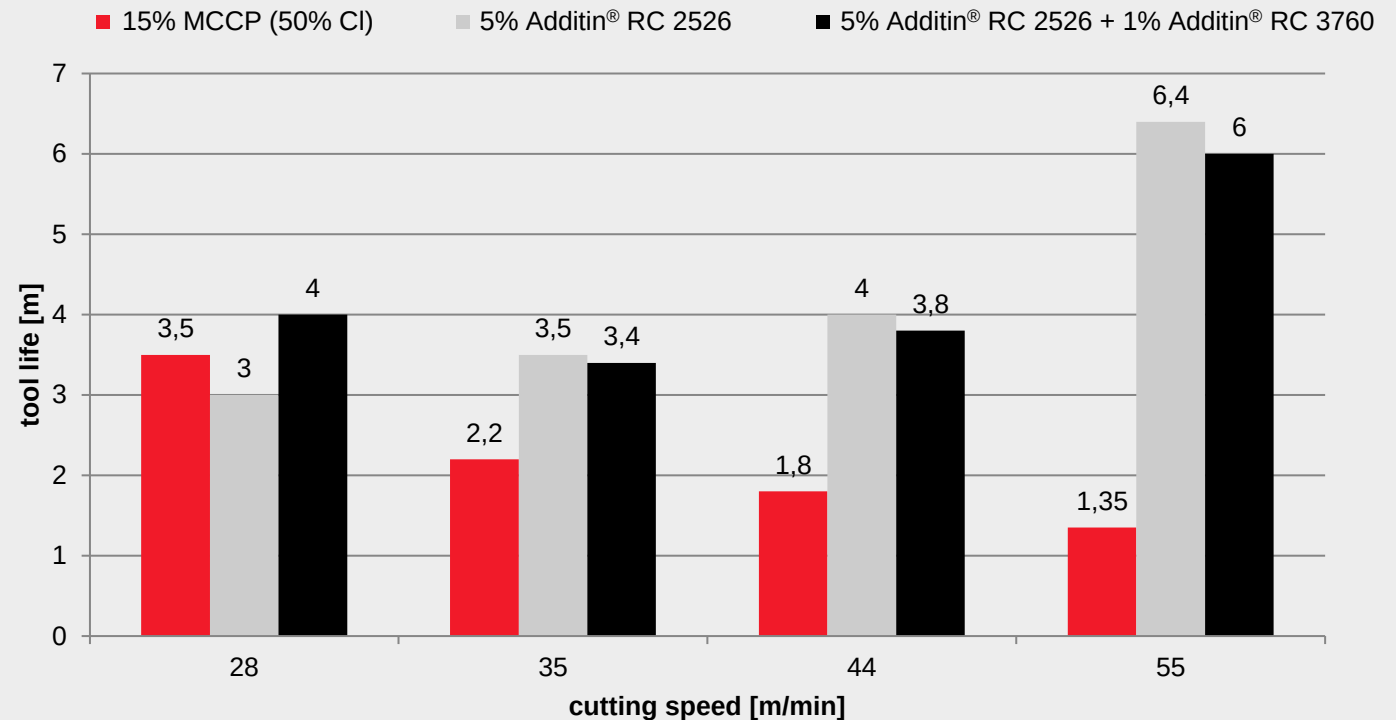
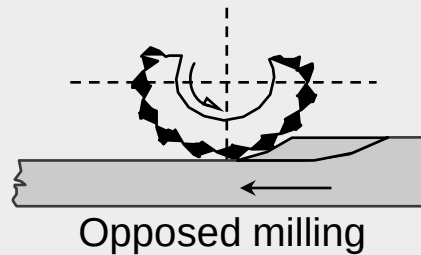


Milling with Chlorinated Paraffin, Influence of Cutting Speed



Tool		Cutting fluid	Workpiece	Conditions	
HS 10-4-3-10 (1.3207), TiN-coated, re-ground, 65 HRC		Base oil: grp.III, 16 cSt @ 40°C CLP: C ₁₄ -C ₁₇ medium chain chlorinated paraffin, 50% chlorine	42CrMo4V (1.7225; AISI 4140) R _m = 1040 N/mm²	a _e = 4 mm d _f = 100 mm V _c = 28 – 55 m/min	f _z = 0.31 mm h _{CU} = 120 µm

Influence of Additives on Tool Life

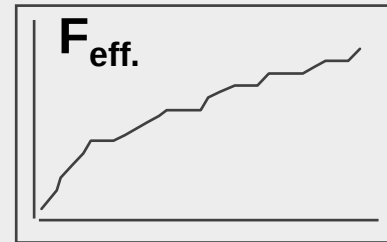
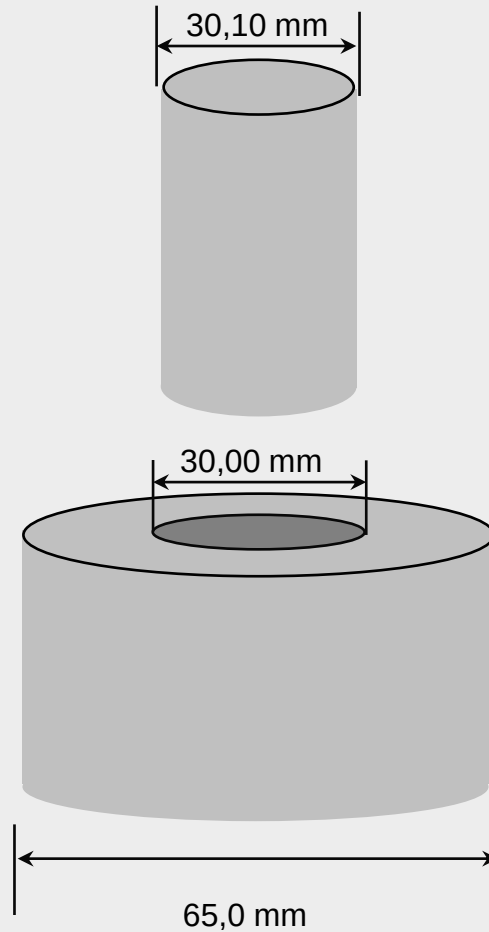


Tool		Cutting fluid	Workpiece	Conditions	
HS 10-4-3-10 (1.3207), TiN-coated, re-ground, 65 HRC	$\alpha = 11^\circ$	Base oil: grp.III, 16 cSt @ 40°C CLP: C ₁₄ -C ₁₇ medium chain chlorinated paraffin, 50% chlorine	42CrMo4V (1.7225; AISI 4140) R _m = 1040 N/mm ²	a _e = 4 mm d _f = 100 mm V _c = 28 – 55 m/min	f _z = 0.31 mm h _{CU} = 120 µm
	$\gamma = 0^\circ$ $\lambda = 5$				

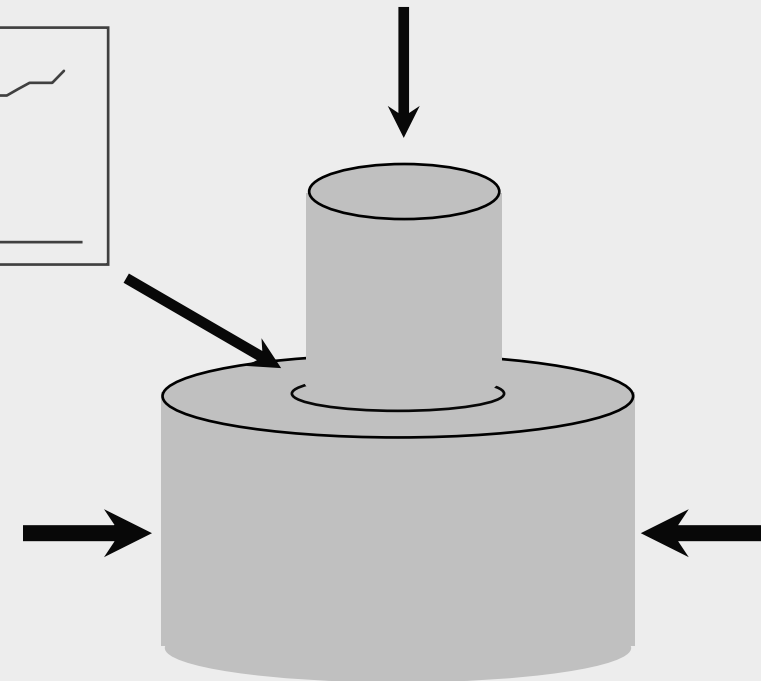
Press-In Test / Procedure

Oversized bolt
Bearing steel
Material: 100Cr6
(1.3505 / ASTM 52100)
 $R_z = 1\mu\text{m}$

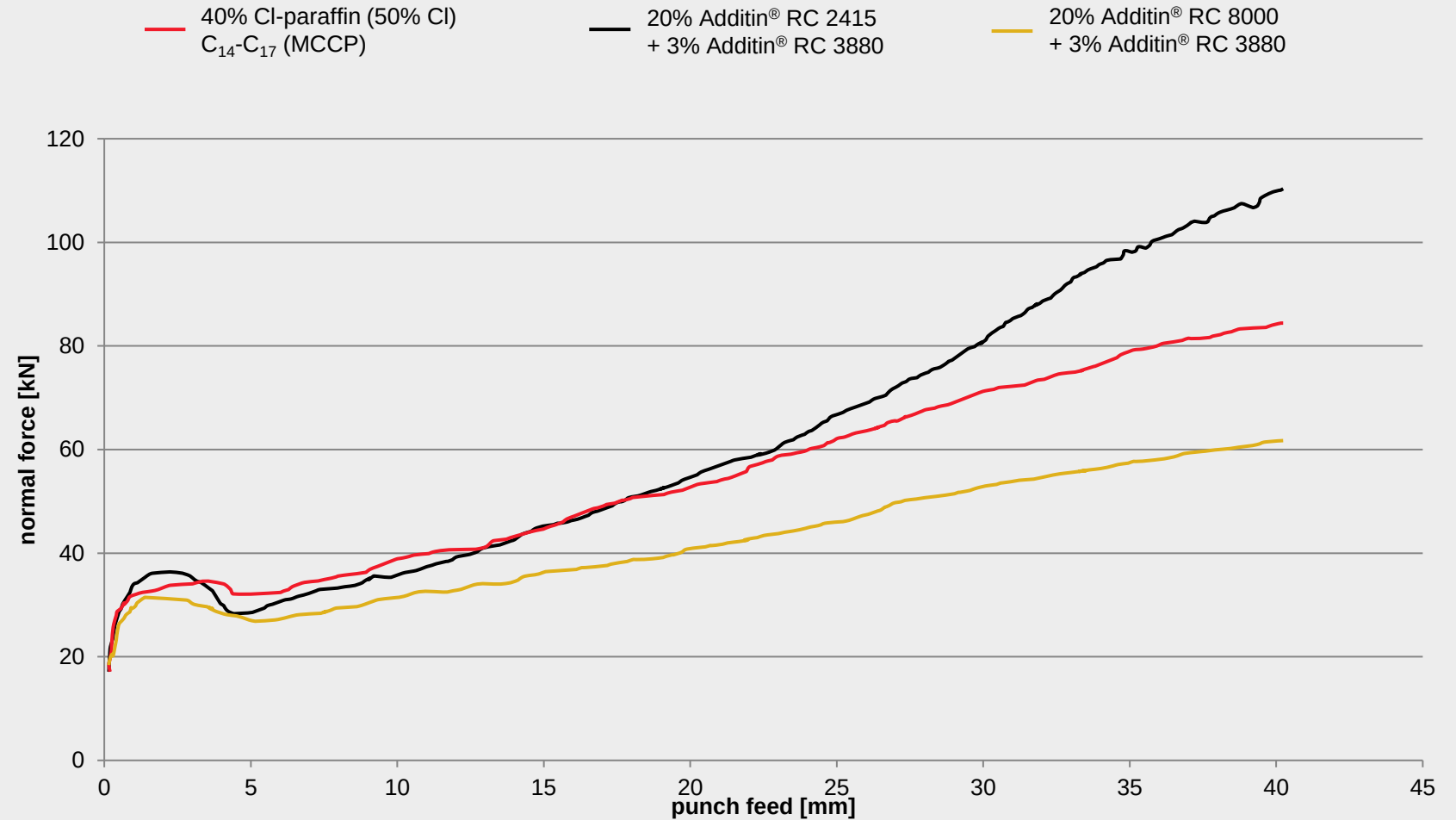
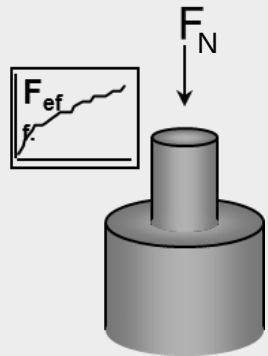
Die
Heat treatable steel
Mat.: 20MoCrS4
(1.7323 / AISI 8620)
 $R_z = 1\mu\text{m}$



$F_{\text{max}} = 300 \text{ kN}$
(approx. 67000lbs)



Press-In Test / CLP vs. Sulfur Carriers



Summary and Conclusion

- Sulfur carriers outperform chlorinated paraffins in many aspects:
 - Excellent performance even at high machining speeds which can be further improved by synergistic combinations with other additives
 - Different molecular structures make them easily adaptable to multiple applications
 - No increase of tool wear at high machining speeds and temperatures
 - Better toxicological and ecotoxicological profile
 - No need for expensive waste treatment
- The performance of chlorinated paraffins decreases with increasing machining speed or temperature due to chemical decomposition
- By combining suitable sulfur carriers and other lubricant additives it is possible to adjust the characteristics of metalworking fluids to the specific demands of the processes and to even exceed the performance of chlorinated paraffins containing cutting and forming lubricants
- **LANXESS has considerable technical expertise and offers consulting to help guide you in developing CLP replacement formulations with superior performance characteristics**

LANXESS

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Energizing Chemistry