Extreme Pressure Additives for Metalworking

Sulfurized additives are known for their anti-wear and extreme pressure properties. ARKEMA offers the TPS® range as the solution for industrial lubricants that require high performances.
Fully soluble in mineral and synthetic base oil, TPS (Tertiary alkyl PolySulfides) are high quality additives presenting clear yellow color, slight odor, low toxicity and low inflammability.

COMMERCIAL SPECIFICATIONS

Product / Method		TPS 20	TPS 32	TPS 37LS	TPS 44
Visual aspect	Visual	Limpid	Limpid	Limpid	Limpid
Sulfur content (weight %)	X fluorescence	≥ 20 / ≤ 23	≥ 29 / ≤ 32	≥ 35	≥ 42 / ≤ 46
Color (Gardner)	ASTM D 1544	≤ 5	≤ 10	≤ 10	-
Flash Point (closed cup)	ASTM D 93	≥ 121°C	≥ 121°C	≥ 100°C	≥ 70°C
Copper strip corrosion	ASTM D 130 (2%, 3h, 100°C)	≤ 1b	N/A	N/A	≤ 1b

N/A: not applicable

TRIBOLOGICAL PROPERTIES

Extreme pressure test with four ball machine are used to establish tribological characteristics of TPS® (1450 rpm; ambient temperature) according to ASTM D 2783.

Anti-wear tests with 4-ball machine (IP 239 method) are used to compare anti-wear properties of polysulfides (TPS® range): 40kg for 1h period are applied on the balls in tested lubricant.

The Reichert machine is used to conduct wear tests. Its principle consists in rubbing together two cylinders with orthogonal axes over a fixed distance, under a 300N load.

		Base oil	TPS 20	TPS 32	TPS 37LS	TPS 44
4 ball extreme pressure test ASTM D 2783	Welding load (kg)	126	315	500	500	400
	Last non seizure load (kg)	20	80	63	63	63
	Load Wear Index	15	50	72	70	64
4 ball wear test IP 239	Wear diameter (mm)	1,33	0,78	1.07	1,01	0,85
Reichert test	Wear scar (mm2)	31	4,0	9,7	9,6	2,6

Extreme pressure and anti-wear properties (5% by weight in a ISO VG32 paraffinic base oil)

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COPPER CORROSION

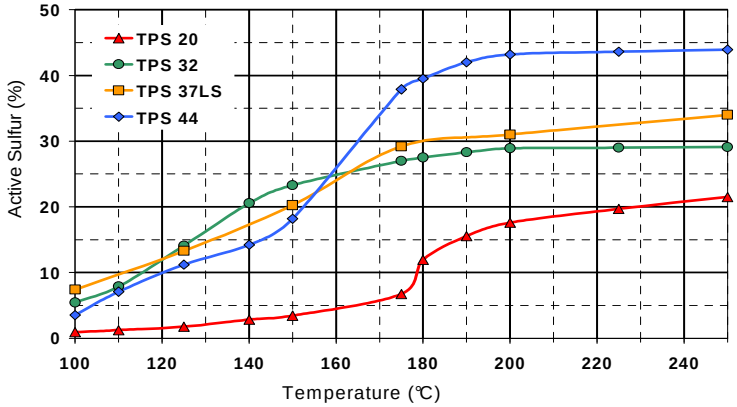
ASTM D 130 is used to evaluate the corrosive impact of an additive in a formulation. Tests are conducted for 3h at 100°C. Blends are formulated with 1- % equivalent sulfur in ISO VG22 paraffinic base oil. In order to limit the corrosion inhibitors could be added: dimercaptothiadiazole as sulfur scavenger or benzotriazole as surface passivator.

	TPS 20	TPS 32	TPS 37LS	TPS 44
Pure product	1a	4c	4c	1b/2a
+ dimercaptothiadiazole	-	0.3%	0.3%	0.08%
Test result with inhibitor	1a	1a/1b	1a/1b	1a
+ benzotriazole	-	0.1%	0.05%	0.01%
Test result with inhibitor	1a	1a/1b	1a/1b	1a

This chart indicates the usual necessary amount of inhibitor for each polysulfide in formulation containing exactly 1% Sulfur.

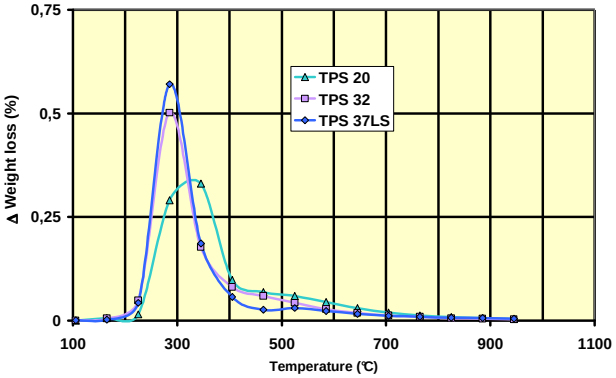
ACTIVE SULFUR

The knowledge of the reactivity of an extreme pressure additive is a key parameter to make the good choice between the different products. According to ASTM D1662 method, the active sulfur at various temperatures shows the sulfur release of the additive in presence of copper powder.



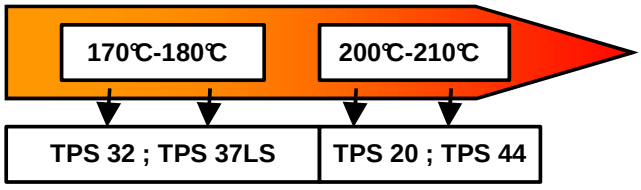
THERMAL STABILITY

Thermal behavior of additives is an other good indicator of performances and stability of the TPS®.
Figures show that trisulfides (TPS 20 and 44) present higher thermal stability than pentasulfides (TPS 32 and 37LS).



Thermogravimetry tests are performed with pure products under nitrogen flow at 20°C/min heating rate.

DSC start decomposition temperature



Differential Scanning Calorimetry tests are performed on pure products, in air at 3°C/min heating rate.

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ARKEMA Société anonyme au capital de 604 538 230 euros - 445 074 685 RCS Nanterre
- Date de parution : April. 2008