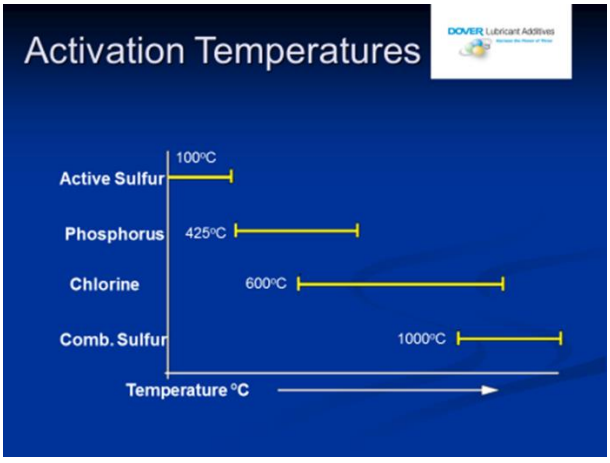
DOVER Chemical Corporation
A Subsidiary of ICC Industries Inc.

A Tutorial and Review of Dover Chemical Sulfur Additives for Metalworking

DOVER CHEMICAL is a global leader of manufacturing and supplying sulfurized EP additive technology to the Metalworking industry.

Extreme Pressure (EP) additives form a chemical bond with metal surfaces, allowing the proper cutting and shaping of hard-to-machine ferrous and exotic alloys. There are several forms of EP additives, based on sulfurized, chlorinated, and phosphated chemistries, each with their own activation range – below.



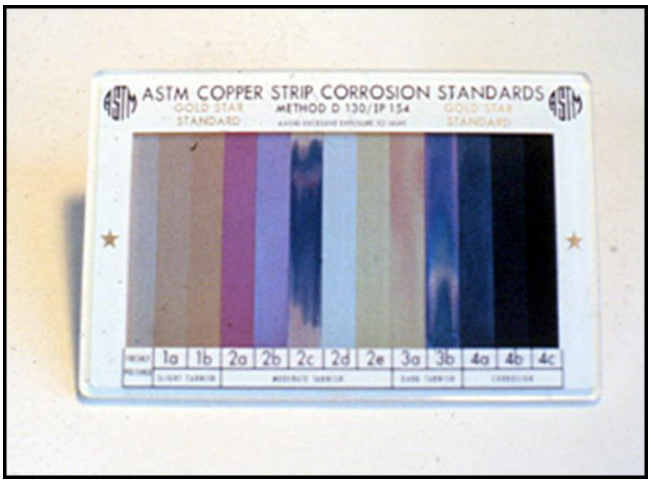
Take the example of active sulfur. One may place a drop of an active sulfur-containing additive, such as MAYCO BASE 1540, on a polished copper rod setting on a lab bench. Return a few hours later and notice the black stain. This is the reason active sulfur is not used on nonferrous alloys.

Active vs. Inactive Sulfur

These terminologies are also referred to as staining and nonstaining, or free vs. combined.

Testing for the presence of active sulfur is usually performed by ASTM D-130 method.

A polished copper rod is inserted in enough test fluid to submerge the metal. The vessel is heated for three hours at 100°C. At the test end, the rod is rinsed in solvent and staining is compared to the standard below. In MW, we typically focus only whether the rod matches 1a or 1b – nonstaining, or 4b or 4c – staining.



Active sulfur can be incorporated into a product by using dissolved elemental sulfur (≤1%) and/or using an additive which contains a high level of total sulfur in its composition (>11%).

Active sulfur due to its low temperature of activation, is critical in the machining of tough alloys and stainless steels.

As mentioned already, use of active sulfur can be detrimental to nonferrous alloys, and care must be taken to avoid use and/or contamination in design, manufacturing, and packaging.

When active sulfur is required, small amounts will provide large machining benefits. Treat levels can be anywhere between 0.25 – 5.0%

Types of Sulfur Additives

There are several methods used to place sulfur on a hydrocarbon backbone.

- Use of powder sulfur
- Use of molten sulfur
- Use of H_2S gas

Each method has its advantages and limitations, however, resulting performance is nearly the same.

Sulfurized animal fat, grease, ester, or oil

- Pros – inexpensive; adds lubricity to EP
- Cons – level of sulfur limited to ~ 20%

Sulfurized vegetable fat, grease, ester, or oil

- Pros – inexpensive; adds lubricity to EP
- Cons – level of sulfur limited to ~ 20%

Sulfurized hydrocarbons

- Pros – High levels of sulfur, up to 40%
- Cons – no lubricity; maybe sulfur fallout

Sulfurized mineral (petroleum) oil

- Pros – inexpensive; low odor
- Cons – level of sulfur limited to ~ 1%

Many times, a sulfurized additive will contain several types of hydrocarbons. This allows the chemist to incorporate the desired level of lubricity (wetting), the proper level of EP sulfur, and use a viscosity range suitable for the targeted application. Note when introducing to the customers, some machining may preclude the use of animal-containing entities, due to the future machined part use in the medical field, or due to local religions.

How and When to Use Sulfur Additives

Questions to ask Sales and Marketing

- Will the application involve stainless steels? – then most likely **yes**
- Will the application involve copper, brass, bronze, or aluminum? – then **no**
- Will the needed product be a water dilutible coolant? Then in most cases, **no**, as sulfur in water systems will lead to microorganism problems. Also the cooling of the water may prevent the combined (inactive) sulfur from reaching its activation temperature.
- Will the machining operation be drilling or tapping? Then **yes**, and use low viscosity additives that contain lubricity
- Will the application be a heading or forming operation, Then **yes**, and typically high levels of sulfur additive is required, such as 25-50%
- The formula already contains sufficient levels of lubricity; should a sulfurized ester be used. Possibly **no**. Use of sulfurized hydrocarbon may be better.
- Customer is located in a region that experiences cold winter temperatures. Sulfur additives still OK – **yes**. Reinforce indoor storage and offer products containing sulfurized hydrocarbons and/or vegetable-based backbones.

DOVER CHEMICAL SULFURIZED ADDITIVES

Product	Vis @ 100°F, SUS	Vis @ 40°C, cS	Vis @ 210°F, SUS	Vis @ 100ºC, cS	% Sulfur	% Active	Lubricity %	Use *
Lard Oils and Esters – Nonactive Sulfur								
Base 10SE	102	21	42.5	9	10	0	90	G, R, D, GD
Base 101	1100	230	125	25	10	0	90	G, TP, TH
Maysperm 2011LV	1750	370	200	40	10	0	90	G, H, S
Mayco Base 1351	1775	375	175	35	10	0	65	G, D, H, R
Maysperm 2011	3500	750	300	55	10	0	90	G, TP, TH
Mayco Base 1210	5500	1150	425	85	10	0	90	G, R, H, S
Base 10L	6100	1155	425	85	10	0	90	G, R, H
Lard Oils and Esters – Active Sulfur								
Base 12 SE	110	20	40	5	13	3	87	G, TP, GR, S
Base 4212	325	70	70	15	17	7	83	G, TP, GR, S
Mayco Base 4220	650	135	80	15	18	6	82	G, TP, GR, S
Base 107	1600	265	160	30	17	6	83	G, H, TH, TP
Base 18V	2000	315	165	67	18	7	82	G, H, TH, S
Base 44	2800	525	175	35	14	2	85	G, TP, TH
Mayco Base 1362	2900	575	245	50	17	6	60	G, TP, TH, H
Base A-92	3200	610	270	60	15	5	85	G, H, S, TH
Compound 17/40	3300	710	300	65	20	10	66	G, H, S, TH
Mayco Base 1217LV	5000	1050	335	75	17	6	83	G, H, S, TH
Base 14L	9000	1700	525	120	13	3	87	G, H, S
Mayco Base 1214-G	9500	2300	650	140	16	6	84	G, H, S
Synthetic Hydrocarbons – Active Sulfur								
Mayco Base 1535	400	90	69	11	31	20	0	G, TH, TP, GD
Mayco Base 1540	500	100	70	15	38	27	0	G, TH, TP, GD

*The following applications have been successfully performed with the noted additive. This is not a finite list. Other sulfurized additives may be substituted within the active and nonactive families

G – General Machining

TP – Tapping

TH – Threading

D – Drilling

H – Heading

S – Stamping

GD – Gun Drilling

GR – Grinding

R – Rolling