DSI Sulfur Inhibitor:

How A Multi-Directional Approach Can Stop Corrosive Sulfur in Transformer Oil

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Corrosive Sulfur problems threaten service disruptions and financial loss

Power Transformer Winding Damage
Sulfur occurs naturally in transformer oils. Several types of sulfur can combine with dissolved metals in the oil – usually copper. The resulting metal-sulfur salts form deposits in cellulose insulation, eventually causing dielectric breakdown.
Research has shown that there are several types of sulfur involved, but dibenzo-disulfide (DBDS) is one of the most aggressive.

Dibenzyl Disulfide
The traditional method of treating this problem: “Copper Passivators”

Copper passivators form a protective layer on copper surfaces to prevent Cu\(^+\) ions from reacting with sulfur.

Benzatriazole: the most commonly used copper passivator
However, simply adding a metal passivator is a “One Size Fits All”, “Band-aid” approach that doesn’t solve the problem.
So why doesn't a Copper Passivator Solve the Problem of Corrosive Sulfur?

Stopping “Corrosive Sulfur” (metal-sulfur salt deposits) in a transformer is more than just passivating the copper surfaces. It requires a comprehensive approach, for three reasons.
First - There are many different copper alloys present in every transformer.
We know that each copper alloy reacts differently to different passivators:

<table>
<thead>
<tr>
<th>Passivator</th>
<th>Type of Copper</th>
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<tbody>
<tr>
<td>Benzotriazole</td>
<td>Brasses</td>
</tr>
<tr>
<td>Tolyltriazole</td>
<td>Bronzes</td>
</tr>
<tr>
<td>Tetrazole Cmpds.</td>
<td>Wire copper</td>
</tr>
<tr>
<td></td>
<td>Buss bar copper</td>
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<tr>
<td></td>
<td>Other Cu types</td>
</tr>
</tbody>
</table>
A mixture of metal passivators is needed to protect the different types of copper present in a transformer.
Second, research has shown that copper is not the only problem.

Dibenzo disulfide combines with all of the different metals in a transformer, not just copper.
In addition to copper, other metals in a transformer are reactive, too.

Iron, aluminum, zinc, nickel, and magnesium also dissolve in oil and combine with sulfur, causing sulfur salts and problems for your transformer:

\[
\begin{align*}
\text{Ni} + \text{S} & \rightarrow \text{S} \\
\text{Mg} + \text{S} & \rightarrow \text{MgS} \\
\text{Zn} + \text{S} + 2\text{O}_2 & \rightarrow \text{ZnSO}_4 \\
2\text{Al} + 3\text{S} + 6\text{O}_2 & \rightarrow \text{Al}_2(\text{SO}_4)_3 \\
\text{Fe} + \text{S} + 2\text{O}_2 & \rightarrow \text{FeSO}_4 \\
\text{Zn} + \text{S} & \rightarrow \text{ZnS} \\
2\text{Al} + 3\text{S} & \rightarrow \text{Al}_2\text{S}_3 \\
\text{Fe} + \text{S} & \rightarrow \text{FeS}
\end{align*}
\]
These other metals respond poorly to copper passivators, if at all.

Therefore, simply adding a copper passivator doesn't stop metal-sulfur salt deposits.
Third: Oxidation

Research and field tests show a correlation between oxidation stability and corrosive sulfur problems (1,2)

“The Role of Corrosive Sulfur in Transformers and Transformer Oil” - L. Lewand, Doble Engineering

“Corrosive Sulfur in Transformer Oil” - Siemens Technical Bulletin
Transformers with sulfur-metal salt deposits tend to have oils with weak oxidation stability.
Simple copper passivators don’t address the relationship between oxidation and metal-sulfur deposits.

Copper passivators do not protect oil from oxidation.
DSI's Sulfur Inhibitor uses a multi-directional approach to stop sulfur problems and protect transformers.
DSI Sulfur Inhibit works in three ways:

1) A blend of several metal passivators protects **all** types of copper in the transformer.
2) Chemical reactions change corrosive sulfur (DBDS) into non-corrosive types.
3) A mixture of powerful antioxidants stops the oxidation-sulfur reaction link.

DSI Sulfur Inhibitor is the only product that does all this!
First: DSI Sulfur Inhibitor has a mixture of copper passivators to treat all copper alloys.
Second:

DSI Sulfur Inhibitor has chemical additives that react with corrosive sulfur and change the molecular structure to non-aggressive types.
When added to a corrosive oil, DSI Sulfur Inhibitor can reduce the concentration of Dibenzo Disulfide by more than 25%! 

Sulfur Inhibitor changes DBDS to a non-corrosive type of sulfur
Third:

DSI Sulfur Inhibitor has a Powerful Blend of Antioxidants to slow oxidation in paper and oil
DSI Sulfur Inhibitor attacks the link between corrosive sulfur and the oil's oxidation stability. No other product does this.
DSI Sulfur Inhibit stops oxidation in its tracks.
DSI Sulfur Inhibitor Works!

Lab tests on corrosive oil treated with DSI Sulfur Inhibitor show a reduction in dibenzyl disulfide (average = 26%)

DSI Sulfur Inhibitor has protected hundreds of transformers since 2005, with many repeat customers!

All corrosive oils that have been treated were turned non-corrosive.
Field Test Results on Sulfur Inhibit additive mixture show:

No Long-term problems found with material compatibility – paper, oil, plastics, conductors, etc.
Summary:
Corrosive Sulfur problems cannot be solved by simply adding a copper passivator.

- A copper passivator doesn't treat all of the different types of copper available in a transformer
- Copper passivators don't protect other types of metals present
- Copper passivators don't change the aggressive sulfur compounds to noncorrosive ones
- Copper passivators don't address the link between sulfur corrosion and oxidation stability.
DSI’s Sulfur Inhibitor Solves the Corrosive Sulfur problem.

Protect all coppers and all other metals

Stop Oxidation of oil and paper

Change corrosive sulfurs to non-corrosive types
References:

“The Role of Corrosive Sulfur in Transformers and Transformer Oil” - L. Lewand, Doble Engineering

“Corrosive Sulfur in Transformer Oil” - Siemens Technical Bulletin

“Dibenzyl disulfide (DBDS) as corrosive sulfur Contaminant in used and unused mineral insulating oils” Riccardo Maina, Sea Marconi Technologies

TJH2B Laboratory Reports 11585543 – 1158555, October 20, 2006, TJH2B Laboratories.


DSI’s Sulfur Inhibitor is a proven solution to corrosive sulfur problems in transformers. Sold since 2005, now protecting hundreds of transformers worldwide. Proven in laboratory and field studies. Every treated oil was changed to noncorrosive status.
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