Major project for DBDS removal from transformer oils successfully realised

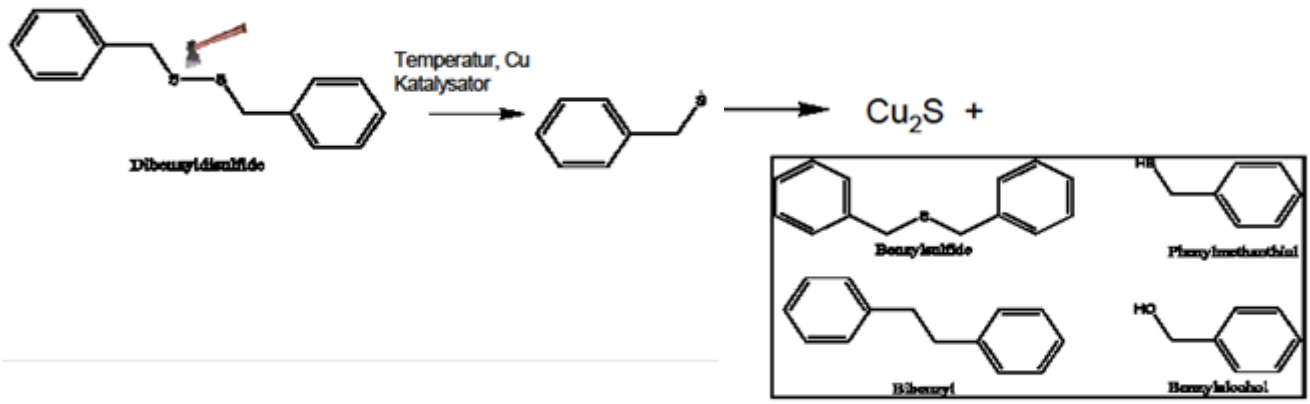
Background information

Sulphur can occur in insulation liquids in various forms and compounds. Some sulphur compounds evince anti-oxidising and metal-deactivating characteristics without being corrosive, while others react with metal surfaces and impact corrosively on metallic components in electric assemblies.

The presence of these corrosive sulphur compounds is associated with the failure of electrical equipment, particularly in the case of transformers with high operating or ambient temperatures, rubber bagging, and the use of non-coated copper conductors.

Deleterious impact by corrosive sulphur in such cases is imputed particularly to a highly specific corrosive sulphur compound, dibenzyl sulphide (DBDS).

Should this compound be present, formation of copper-sulphide deposits in or on the cellulose insulation may result, with associated arcing between adjacent sandwich windings or conductors on a winding.



A preventive measure still common and well known for coping with potentially corrosive operating materials is the addition of a metal deactivator based on benzotriazole derivatives (type 100 mg/kg oil) to the insulation oil. This process is intended to coat the relevant metal surfaces with a "protective layer", in order to prevent the formation or deposit of copper sulphide.

This deactivation process, however, does not always work in an optimum way, since in transformers under thermal stress the consequence can be a heavy depletion of the deactivator, so that a relatively large amount of time and resources must be spent in monitoring the transformer and adding deactivator, and moreover undesired side effects can occur (oxidative instability of the deactivator, oil-dependent, poor response characteristics).

An alternative becoming increasingly important is the direct removal of DBDS, using a targeted adsorption technology during on-going operation of the transformer.

Project and results
DBDS removal on a 350 MVA/400KV high-tension transformer from the firm of Amprion GmbH, having a total oil volume of 82 t.

As expected, it was confirmed that DBDS (dibenzyl disulphide) from transformer oils can be removed during on-going transformer operation using MRA technology from Starke & Sohn.

Illustrations 1 & 2: MRA 4x4 regeneration plant at Linde distribution station of Amprion GmbH

Starting from 185 ppm DBDS and a corrosive oil state, the project was successfully approved by Amprion with a final DBDS content of <0.5 ppm and a non-corrosive oil state; see Figure 1.

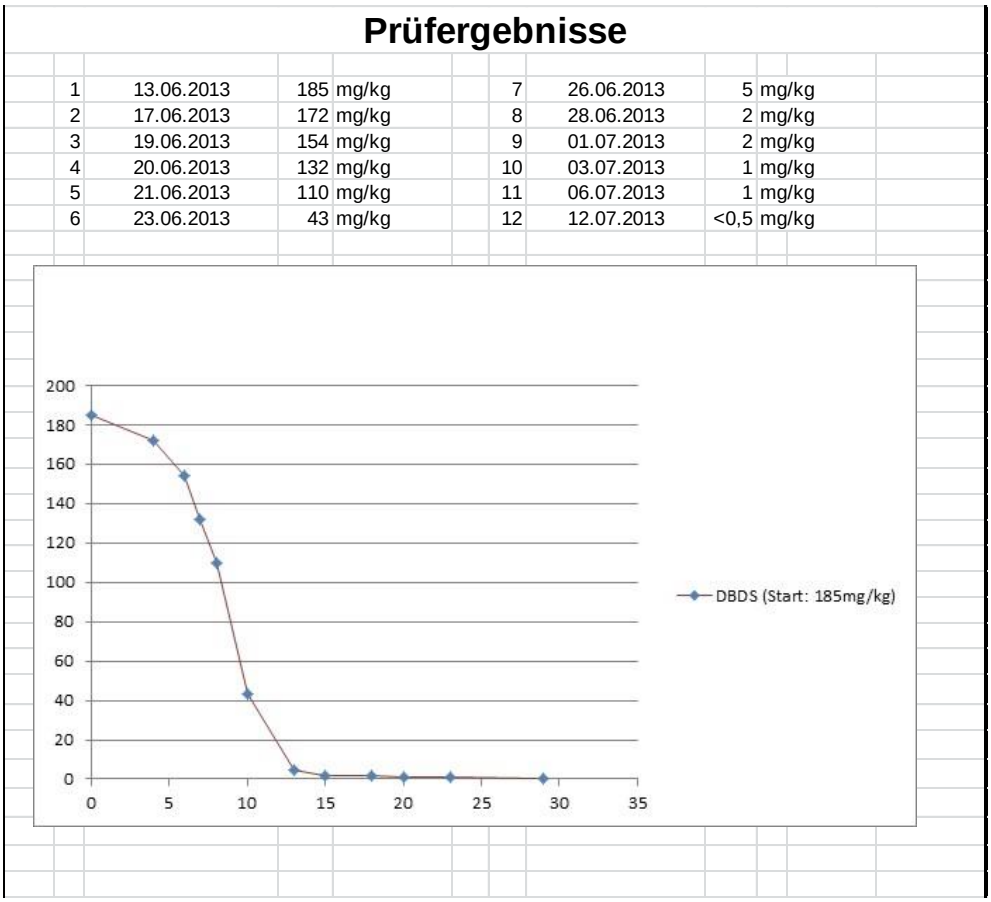


Figure. 1 – DBDS trend over the regeneration period (under DIN EN 62697-T1)

The maximum tolerated threshold values set in the relevant literature for DBDS of <5 ppm were more than significantly undershot, and in the concrete case are below the values of < 3 pp. guaranteed as binding by Starke & Sohn.

Information on potential DBDS removal and results from the process already presented at the Technical University of Graz in June 2012 (see Update 06 2012), shown to an interested audience for the first time with reference to smaller types of transformer, 16/20 MVA, 6,3/110KV, could now be successfully verified further in the course of the major project set out above.

MRA technology, with reference to the corrosive properties of operating oils, analytically determined using methods Ag silver-strip test DIN: 51353, pot. corrosive sulphur: IEC 62535 and DBDS: DIN EN 62697-1, can now be used as an efficient method of improving the oil condition (see also Figure 2 Test results before and after regeneration, and Figure 3 Visualisation of corrosive sulphurs).

Prüfergebnisse

Eigenschaft	Prüfmethode	Start Probe 1	Ende Probe 12	Grenzwert*	Einheit
		25821	25822		
Datum		13.06.2013	12.07.2013		
Farbzahl	ISO 2049	L0,5	L0,5		
Reinheit	VDE 0370	blank	blank	Bodensatz	
Neutralisationszahl	IEC 62021-1	<0,01	<0,01	<=0,15	mg KOH/g Öl
Durchschlagsspannung	IEC 60156	65,3	87,3	>=50	kV
Verlustfaktor bei 50 Hz	IEC 60247	0,0007	0,0008	<0,20	
Wassergehalt (20°C)	IEC 60814	3	3	<=5	mg H_2O/kg Öl
Dichte bei 20°C	DIN 51757	868		-	g/ml
Brechungszahl	DIN 51423	1,478		-	
Grenzflächenspannung	ASTM D971	45,4	48,9	>=22	mN/m
Inhibitorgehalt	IEC 60666	0,02	0,35	-	%
Ag-Silberstreifentest	DIN 51353	nicht korrosiv	nicht korrosiv	-	
pot. Korrosiver Schwefel	IEC 62535	korrosiv	nicht korrosiv	-	
PCB - Gehalt	DIN 12766-1,2	n.n.	n.n.	-	mg/kg
Dibenzyldisulfide	DIN EN 62697-1	185	<0,5	-	mg/kg

* Grenzwerte nach IEC 60422:2005 (DIN VDE 0370-2:2007-2)

Bewertung Das Öl entspricht nach der Regeneration den Anforderungen der IEC 60422. Das DBDS konnte vollständig eliminiert werden.

Figure 2 – Test results before and after regeneration

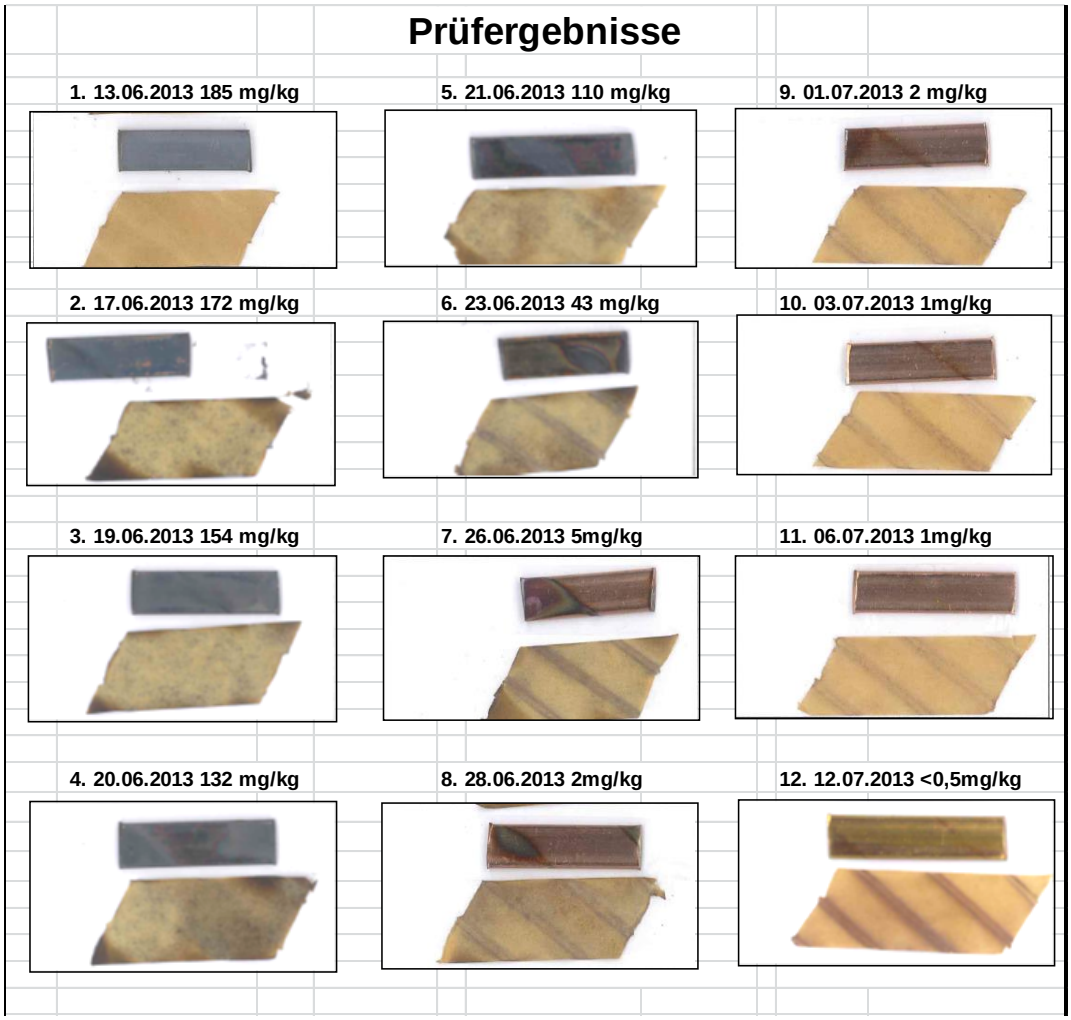


Figure. 3 – Visualisation of corrosive sulphurs

Summary
Thus MRA technology, with regard to the problems of BDS alone, offers an effective means of increasing the operational safety of transformers of every output category and size.

Illustrations 3 & 4: MRA 4x4 regeneration plant at Linde distribution station of Amprion GmbH