

Transformers (Mobile Oil Regeneration) in Practice

Sharing practical knowledge and networking
within the „transformer family“

STARKE & SOHN GmbH
MINERALÖLWERK
Aue • Hannover • Niebüll



In exclusive partnership with:



Seminar "Transformers in Practice"
26th of January 2024 – Wageningen, NL
Mr. Dipl.-Ing. Dirk Flor (Managing Director)

Transformers in Practice – operation, control, maintenance

- Challenges for all transformer operators (asset management)
 - ensure the best performance and availability of assets (transformers)
 - supervise transformers (constantly, regularly, e.g. the oil, the „blood“)
 - evaluate the data, define actions, schedule & budget, find partners, & do it
- „The Maintenance Bible“ - IEC 60422:2013
 - Mineral insulating oils in electrical equipment – Supervision and maintenance guidance
 - Limits for mineral insulating oils
 - » Recommended limits for mineral insulating oils after filling in new electrical equipment
 - » Recommended limits for the classification of the condition of oils in service
 - „good“ => oil in normal condition; continue normal sampling
 - „fair“ => oil deterioration detectable; more frequent sampling recommended
 - „poor“ => oil deterioration abnormal; schedule effective actions

Transformers in Practice – IEC 60422 – actual recommendation

New Project of TC 10 - Webinars on new or updated standards

Our first Webinar is on

Mineral insulating oils in electrical equipment – Supervision and maintenance guidance (IEC 60422)

Date and Time

1.Feb. 2024 13:00 CET

Registration:

https://iec.zoom.us/webinar/register/WN_zoLnZd_cRL2_d--6_Wzr3A

REPLY NOTIFY

Notified from : <https://collaborate.iec.ch/#pages/workspaces/95864/documents/>

In Practice – What is Mobile Transformer Oil Regeneration ?

- comparable to a human „blood dialysis“
- bypass operation without production stop
- most effective & holistic system cleaning
- provides an oil which is originally conformed with IEC 60296 acceptable quality
- processes which remove physical and chemical contaminants (combination of filtration, vacuum drying, adsorption: physisorption + chemisorption)



In Practice: MRA Mobile Regeneration Asset – Technology

- longterm operational experience
- continous optimization
- own development & engineering
- constant investment, three assets / rigs



In Practice: guidelines – IEC 60422 – poor limits / guaranteed values / average reached values

	170 – 400 kV (category A)*	72,5 – 170 kV (category B)*	guaranteed values after MRA-regeneration	average values after MRA-regeneration
Breakdown voltage [kV]	< 50	< 40	>/= 75	80
Dielectric dissipation factor tanδ at 90 °C	> 0,2	> 0,5	</= 0,005** (0,01)	0,003
Acid number [mg KOH/g]	> 0,15	> 0,2	</= 0,01	</= 0,01
Surface tension [mN/m]	< 20 / < 22 uninhibited/inhibited	< 20 / < 22 uninhibited/inhibited	>/= 40	44
Water content [mg/kg]	> 20	> 30	</= 5** (10)	4
Corrosive sulfur	corrosive	corrosive	not corrosive	not corrosive
DBDS (mg/kg)***	>= 5	>= 5	</= 3	</= 1

*source: DIN EN IEC 60422:2013(VDE 0370-2), extract table 5, ***extract table 3, before operation: <5ppm

**if an oil temperature of >/= 45 ° C will be ensured during 70% of the oil regeneration process

In Practice – services for the energy industry – some references



In Practice: > 555 projects, > 18.300 t, range: 35 to 600 MVA

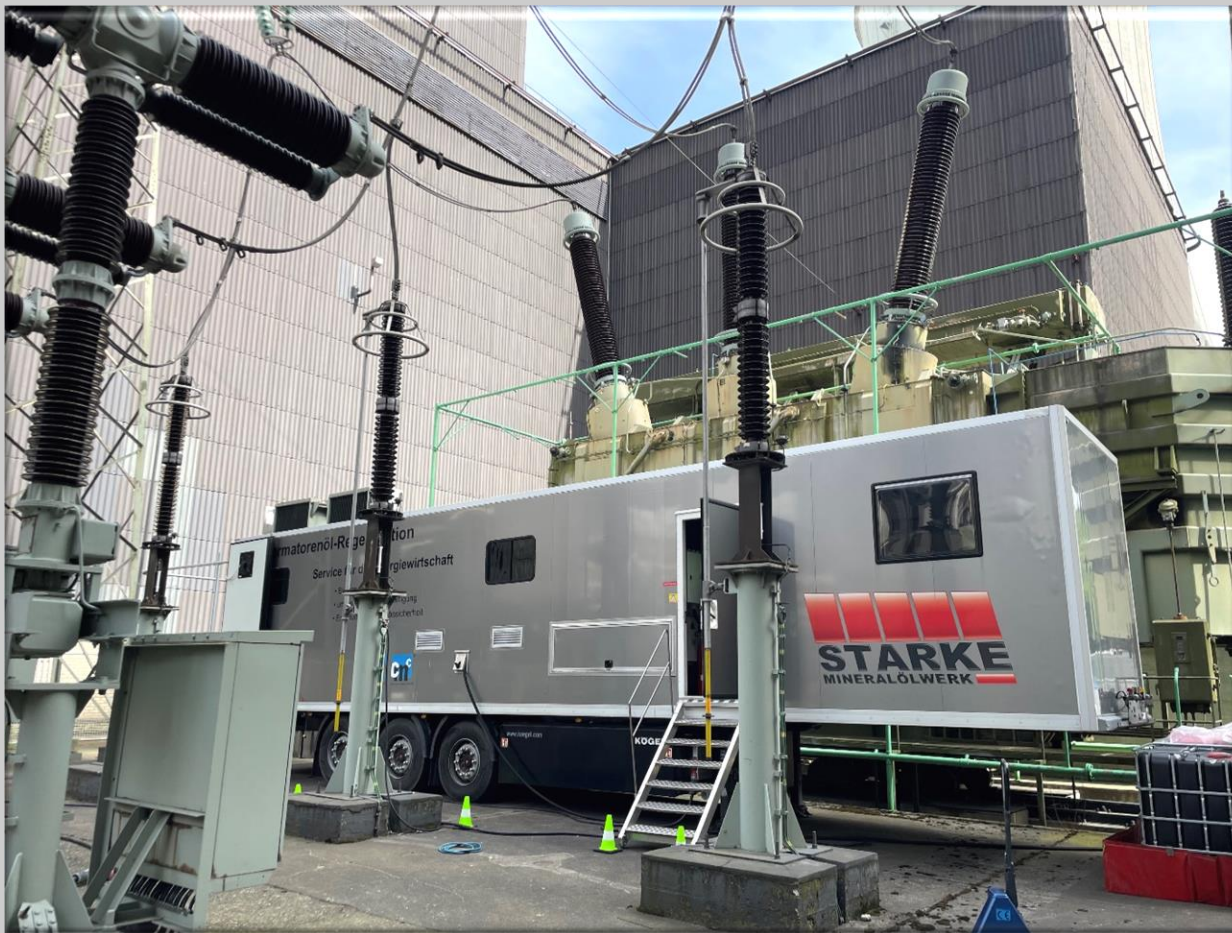
updated reference list - realized projects MRA-Technology			
power-, generator step-up-, network intertie-transformers, reactors, projects between 2010 - 2022			
number - Anzahl	system voltage - Bemessungs - Spannung OS [kV]	power range - Bemessungs- Leistung [MVA]	effective action - Art der Behandlung
> 80	> 380	200 - 600 MVA	regeneration &/or DBDS-elimination
> 120	> 220	100 - 550 MVA	regeneration &/or DBDS-elimination
> 140	> 110	30 - 200 MVA	regeneration &/or DBDS-elimination
> 100	> 30	3 - 80 MVA	regeneration
> 115	< 30	1,6 - 35 MVA	regeneration

please note:

- * more than 555 projects has been successfully realized since 2010
- * more than 18.300 tons of transformer oil mobile regenerated since 2010
- * all kinds of assets w ithin the system voltages & pow er ranges has been covered
- * all kinds of different locations has been served: pow er plants (nuclear, conventional, hydro), substations, railway lines, steel-, aluminium-, paper- & chemical plants and many more...

In Practice: mobile regeneration at hard coal power plant

transformer project: Acec 1969 (refilled 1993), 438 MVA, 220kV, 100 t oil, 11 days



In Practice: mobile regeneration at hard coal power plant

see feature: special collection trays for IBCs with process oil and top-up oil



In Practice: mobile regeneration at a run-of-river power plant

transformer project: ELIN 1991 ,MVA, ...kV, 38,5t oil, 9 days



In Practice: mobile regeneration at a run-of-river power plant

special challenge: crossing the river Danube by crane with mobile rig to reach location



In Practice: mobile regeneration at a brown coal power plant

plant project: 26 transformer, 25-600 MVA, 20-110 kV, 20-90 t oil, 3 rigs, few weeks, 24/7



In Practice: mobile regeneration at a brown coal power plant

special challenges: size of rigs & local spaces



In Practice: mobile regeneration at a brown coal power plant

special challenges: size of rigs & local space...in combination with local traffic..



In Practice: mobile regeneration at a brown coal power plant

special attention: health & safety...also with regard to local traffic..



In Practice: mobile regeneration at a brown coal power plant

expected result: ...all service technicians & rigs „survived“ & customer satisfied...



In Practice: mobile regeneration at a TSO substation

transformer project: ELIN 1973, 333 MVA, 380 kV, 50 t oil, 12 days



In Practice: mobile regeneration at a TSO substation

special challenge: „critical inspectors“ on site



In Practice: mobile regeneration at a TSO substation

result: conviction, confirmation & business partnership



In Practice: mobile regeneration at a DSO substation

transformer project: SGB 1990, 40 MVA, 120 kV, 14 t oil, 7 days



In Practice: mobile regeneration at a DSO substation

see action: sometimes customers providing helping hands



In Practice: mobile regeneration at DSO „inhouse“ transformers

transformer project: BBC 1979, 40 MVA, 110 kV, 21 t oil, 6 days

transformer project: Lepper Dominit, 31,5 MVA, 110 kV, 22 t oil, 9 days



challenges:
in the middle
of the city



In Practice: mobile regeneration at railway transformers

transformer projects: several in row, 3918 kVA, 15 kV, ca. 1 t oil/each, 1-2 days



In Practice: mobile regeneration at railway transformers

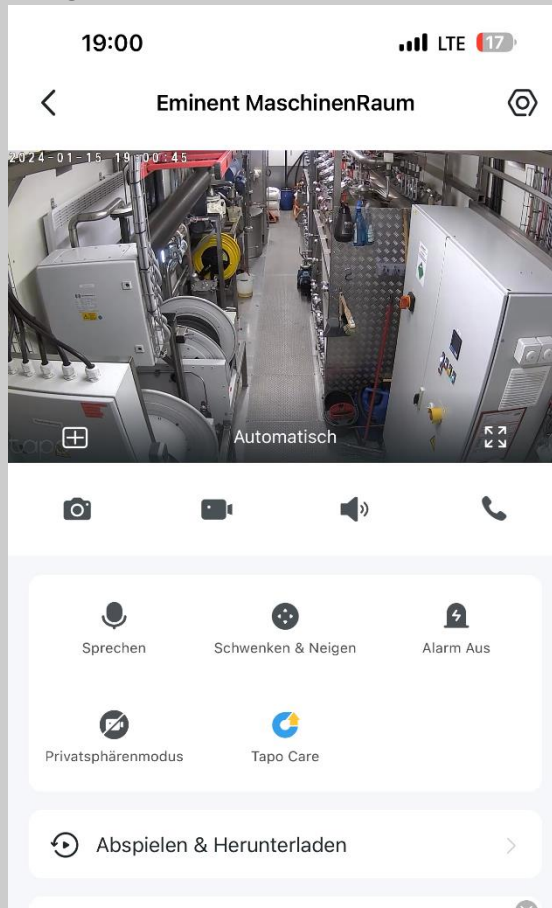
special challenge: schedule several locomotives in a row



In Practice: mobile regeneration – special safety equipment

supervision, control & operating: videos and alert systems, 24/7, 2 fixed & mobile video systems per rig, failure alerts per SMS, VCN – Virtual Network Computing

Video



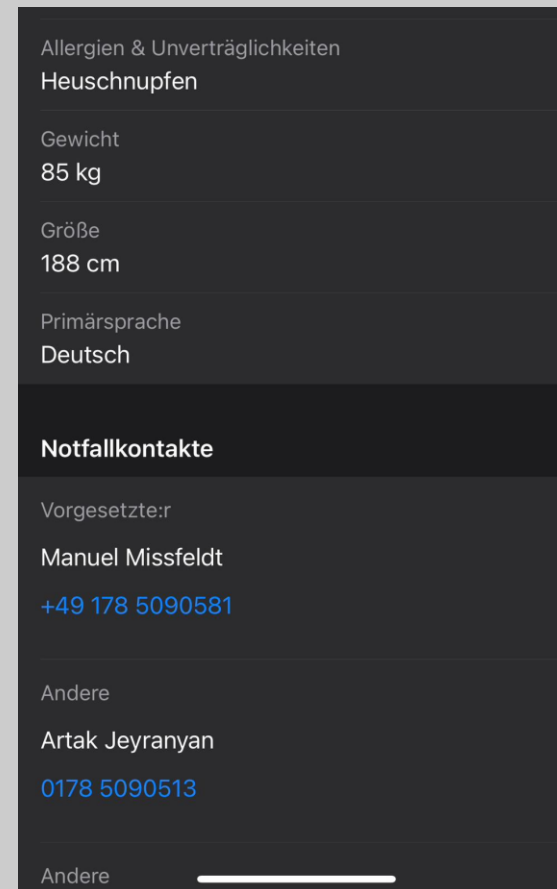
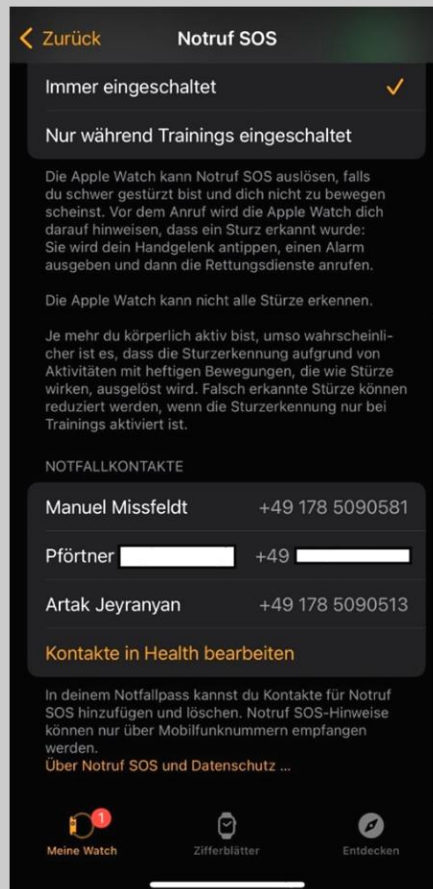
SMS



In Practice: mobile regeneration – special safety equipment

supervision, control & operating: alert systems for staff/technicians, 24/7, in case of overthrows (SOS-customer-manager)

SOS-contacts



personal hints

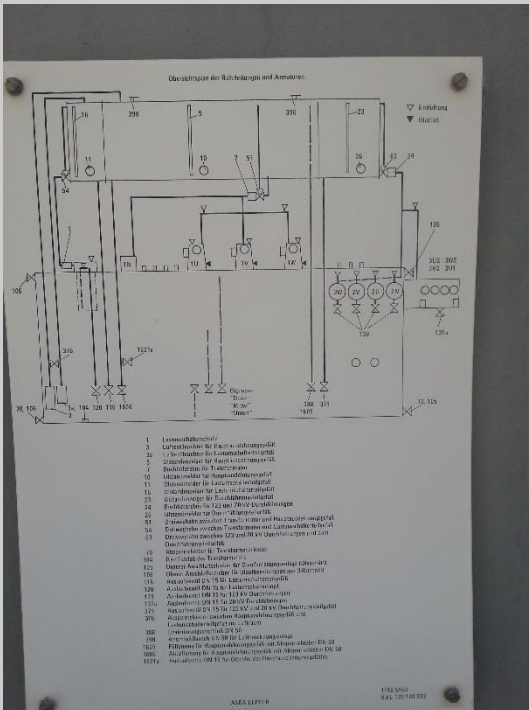
In Practice: mobile regeneration – special safety equipment

especially for PCB containing oils: additional exhaust treatment units



In Practice: mobile regeneration – what to do in advance ?

- For all transformer projects
 - check oil analysis figures & PCB, refer to IEC 60422
 - check transformer data (trafo plate, piping plan, drawings)
 - check location – accessibility & power supply – site visit free of charge



ASEA LEPPER

NETZTRANSFORMATOR 3 PHASEN

Typ	K001 100 300400	Manufactur	50 Hz	Relativleistung	OS 10 MS 20 US
Part. Nr.	1114 181	Teilnummer	0641	KE	10V 60V 10V 20V 10V
Bezahl.	1000	Strom	DB	LI	10KV 10KV 10KV 10KV 10KV
Verarbeitung	IEC 76	Art	LT 5		

Nennleistung MVA	Nennspannung kV			Nennstrom A			Schaltleistung VA pro
	OS	MS	US	OS	MS	US	
100	250	120	120	250	850	1000	1000
50	125	60	60	125	425	500	500
25	62.5	30	30	62.5	212.5	250	250

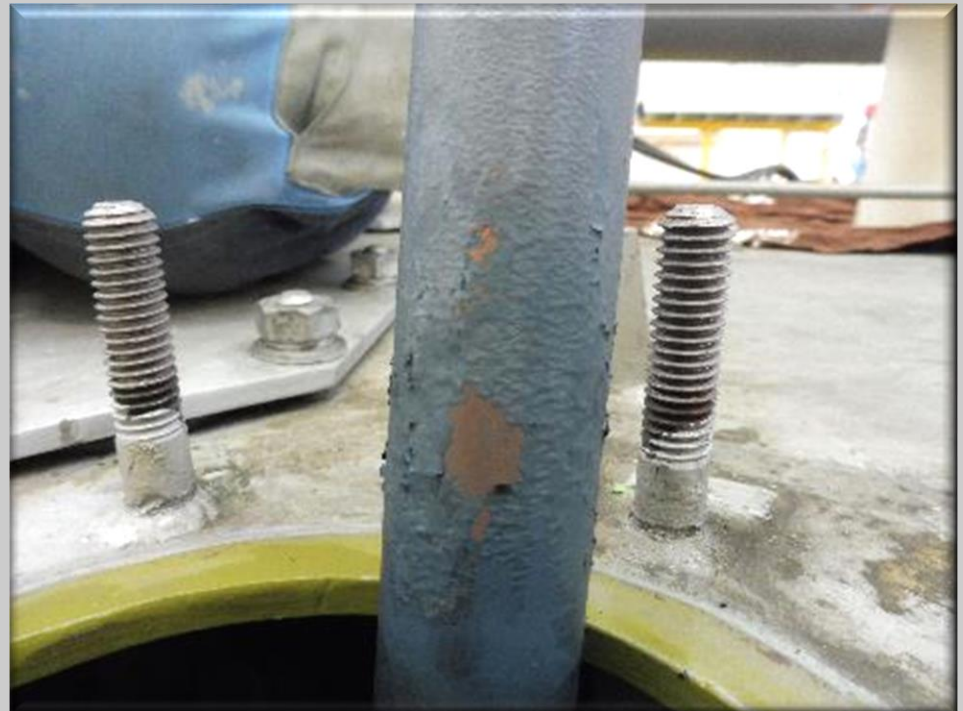
Kurzschlussleistung %	Kurzschlussstrom			Dauerstromleistung			Kurzschlussstrom
	OS MS	OS MS	MS US	OS MS	MS US	MS US	
Staffelung 1	100	100	100	100	100	100	100
Staffelung 10	100	100	100	100	100	100	100
Staffelung 20	100	100	100	100	100	100	100

Staffelung	kV	Arbeits	Arbeits	Stromrichter	Wieder
1	400.0	218	100.0	100.0	100.0
2	400.0	218	100.0	100.0	100.0
3	400.0	218	100.0	100.0	100.0
4	400.0	218	100.0	100.0	100.0
5	400.0	218	100.0	100.0	100.0
6	400.0	218	100.0	100.0	100.0
7	400.0	218	100.0	100.0	100.0
8	400.0	218	100.0	100.0	100.0
9	400.0	218	100.0	100.0	100.0
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96	400.0	218	100.0	100.0	100.0
97	400.0	218	100.0	100.0	100.0
98	400.0	218	100.0	100.0	100.0
99	400.0	218	100.0	100.0	100.0
100	400.0	218	100.0	100.0	100.0

34.01

In Practice: mobile regeneration – please do not forget DBDS

- for all transformer projects
 - check oil analysis figures, including DBDS, see IEC 60422 (or you might be surprised)



In Practice: mobile regeneration – in the Netherlands

transformer project: you still have the choice to be the first one !



Thank you very much for your attention