

SITRAM[®] REG

Regeneration and removal of corrosive sulfur
Preventive Maintenance



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Introduction

Rising costs and performance pressures are forcing many operators to increase the utilization capacity of their transformers. Moderately aged transformers and network couplers are increasingly being operated at higher rates and in many cases using nominal power for the first time. At the same time, operating downtimes planned for maintenance have been reduced or eliminated.

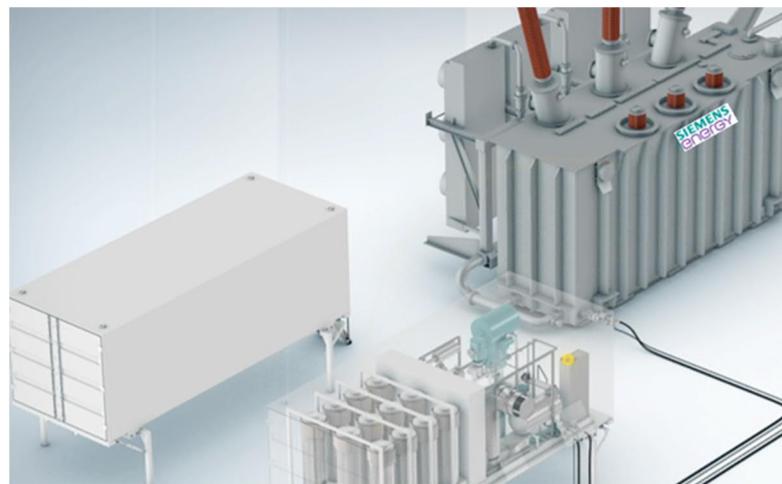
The escalating load has led to more rapid ageing of insulating oil and the solid insulation. This can result in a drastic degradation of the dielectric properties of the insulating oil, which seriously endangers reliable transformer operation.

SITRAM[®] REG, the online regeneration technology, can clean aged or corrosive transformer oil, restore its dielectric properties, and increase the transformer availability. Regeneration processes requires special equipment, high competence, and longtime experience of staff. Siemens Energy operators have experience in online regeneration of more than 300 transformers with different design, connections and at various ambient temperatures.

Features

SITRAM[®] REG is a modified reclamation process based on the IEC 60422 standard. Oil is circulated continuously through regeneration columns in the plant.

Highly effective adsorption agents (activated fuller's earth) absorb the soluble and insoluble polar impurities, degradation products as soon as corrosive sulfur compounds. The cleaned oil flows back into the transformer. This process cycle is carried in dependence of the size of the transformer and the condition of the insulating oil for several days up to weeks. SITRAM[®] REG is carried out without interrupting transformer operation.



SITRAM REG[®] is a mobile solution. Mounted in a container, available at the transformer's installation site.

Property	Limits values recommended for oil regeneration	
Acidity	Nominal system voltage > 170 kV	▶ > 0,15 mg KOH/g oil
	Nominal system voltage > 72,5 ≤ 170 kV	▶ > 0,20 mg KOH/g oil
	Nominal system voltage ≤ 72,5 kV	▶ > 0,30 mg KOH/g oil
Dielectric dissipation factor at 90°C and 40 Hz to 60 Hz	Nominal system voltage > 170 kV	▶ > 0,2
	Nominal system voltage ≤ 170 kV	▶ > 0,5
Sludge	Where perceptible sludge is detected	
Inhibitor	Inhibitor concentration < 40 % of original/initial value	
Additional parameters	High colour value, low interfacial tension, Presence of sediments or sludge, or both	
	Low passivator content	
Corrosive sulphur	Oil corrosiveness	

In additional to above mentioned limits recommends IEC 60422 Standard regeneration, when rapid deterioration or acceleration in the rate of deterioration was observed.

Recommended limits for mineral insulating oils after filling in new electrical equipment prior to energization				
Parameter	Unit	Highest voltage for equipment		
		After filling, prior to energization IEC 60422	IEC 60296 for unused mineral insulating oils	
		< 72,5 kV	72,5 bis 170 kV	> 170 kV
Colour acc. ISO 2049		max. 2,0	max. 2,0	max. 2,0
Acidity	mg KOH/g oil	≤ 0,03	≤ 0,03	≤ 0,03
Dielectric dissipation Factor at 90°C and 40 Hz to 60 Hz		≤ 0,015	≤ 0,015	≤ 0,010
Interfacial tension	mN/m	≥ 35	≥ 35	≥ 35
Breakdown voltage	kV/2,5mm	> 55	> 60	> 60
Water content	mg/kg oil	< 20	< 10	< 10
Corrosive sulphur		Non-corrosive		Non-corrosive
DBDS content	mg/kg oil	< 5		< 5
Experience values after implemented regenerations				
Parameter	Unit	Typical values prior to regeneration	Siemens values after regeneration	After three years
Colour acc. ISO 2049		4,5 – 6,0	≤ 1,0	1,0 – 1,5
Acidity	mg KOH/g oil	0,15 – 0,30	< 0,01	≤ 0,01
Dielectric dissipation factor at 90°C and 40 Hz to 60 Hz		0,050 – 0,500	< 0,005	≤ 0,008 – 0,010
Interfacial tension	mN/m	15 – 25	≥ 45	≥ 38 – 40
Breakdown voltage	kV/2,5mm	40 – 60	≥ 70	≥ 60
Water content	mg/kg oil	15 – 20	< 5	
Corrosive sulphur		Non-corrosive	Non-corrosive	Non-corrosive
DBDS content	mg/kg oil	30 – 300	< 5	< 5

After successful oil regeneration under optimum process conditions, even insulating oil that has been used for years still fulfills the limit values with long-lasting effects comparable with applied limit values for new oils after filling in new transformer. In addition, the essential parameters for the dielectric properties of the oil remain stable even years after regeneration treatment. If implemented in a timely manner, SITRAM® REG effectively and verifiably helps to extend the service life of transformers sustainably.

The term “fuller’s earth” describes a group of naturally occurring minerals with different constituents and properties. Siemens Energy SITRAM® REG technology applies only natural fuller’s earth mixture has high catalytic properties and is highly reactive with all kinds of corrosive sulfur compounds.

Benefits

- Improvement of transformer oil to “actual new oil quality”
- Long-time improvement of transformer insulation condition through excellent and long-lasting cleaning effect
- More economical compared to oil change
- Complete and long lasting removal of DBDS or another aggressive corrosive sulfur compounds
- Decrease of transformer failure possibility – reliability increase of old transformers
- Applied on energized transformers (no shutdown) – online regeneration process for units with oil amount ≥ 0,5 t tons
- Great and long-lasting cleaning effect
- Mobile solution – available to our customers at the transformer’s installation site

Scope of work / Deliverable

- SITRAM® REG delivery to customer’s site and Installation
- Connecting double-walled hoses, valves and cables, venting of hoses and starting up the plant
- Continuous reclamation of transformer oil
- Process accompanying oil tests in mobile laboratory
- Completing the process, topping up oil and adding inhibitor
- Draining and cutting hoses, hand over the transformer back to the customer
- Oil analysis in Siemens Energy laboratory in Nuremberg with final test report

Technical Details

Regenerate instead of oil change

Reclaiming the oil filling offers several advantages over conventional oil change. It causes the equilibrium conditions to shift and produces the immediate onset of diffusion of all embedded degradation products from the solid insulation to the surrounding insulating oil. During the regeneration cycle they are bound by the fuller’s earth and eliminated from the circuit.

In addition, treatment with SITRAM® REG provides a clear improvement in ageing stability – in the case of an oil change, up to 15% of the old oil and almost all embedded and deposited ageing residue products remain in the transformer and cause the rapid onset of ageing of the new oil filling – a problem that doesn’t even come up with SITRAM® REG.

The advantages over an oil change

- No service interruptions even for small transformers
- Saves resources
- Additional removal of moisture
- Great and stable long-term cleaning effect

Preventive Maintenance pays off

The degradation products embedded in the insulation system have a catalytic effect. Along with the high operating temperature, there can be a drastic decrease of remaining service life. Degradation of the solid insulation is irreversible and cannot be reversed by regeneration technology. As a result, regeneration should be carried out preventive as a rule. The timely, preventive use of SITRAM® REG is a crucial weapon in the battle against the reduction of service life. However, oil regeneration is also recommended for high-aged transformers that must continue to operate. The condition of the solid insulation is preserved in this way, counteracting progressive ageing.

Advantages of the application on energized transformers

During oil regeneration process, not only the transformer oil should be cleaned. Also solved and impregnated oil in cellulose and cellulose itself must be cleaned. Only in this case it is possible to keep the transformer oil purity at high level during the next years and achieve a long-lasting cleaning effect. Regeneration during transformer operation has advantages for the cleaning processes:

- A temperature difference between the windings and the surrounding oil increases the diffusion pressure
- Higher temperature and mechanical vibrations contribute to redissolving processes

Safety measures during SITRAM® REG regeneration process

Measures and equipment for oil leakages prevention

To guarantee highest transformer safety and always prevent oil losses during oil regeneration projects, an approved leak detector device using double walled hoses and solenoid valves is applied. Solenoid valves are installed at the four connection points of the flow and return flow. These valves are connected to the leak detector and central control system and immediately close by triggering of alarm. Special equipment such as air traps also ensure that no air bubbles getting into the transformer during oil regeneration process.



Installation for connection to the transformer tank bottom flange (from left to right): hose with dry disconnect coupling, air trap, solenoid valve, flange adapter DN80/DN40.

Fire protection concept

For Siemens Energy it is of primary concern that our regeneration plants provide a maximum degree of security. Because of this safety requirement our regeneration plants are equipped with a comprehensive fire protection system which includes optical smoke and flame detectors, temperature sensors, residual current monitoring device and automatically triggering extinguishing system for control cabinet and plant area. Furthermore, the fire protection system of SITRAM® REG can be integrated in safety chain of the customer.

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