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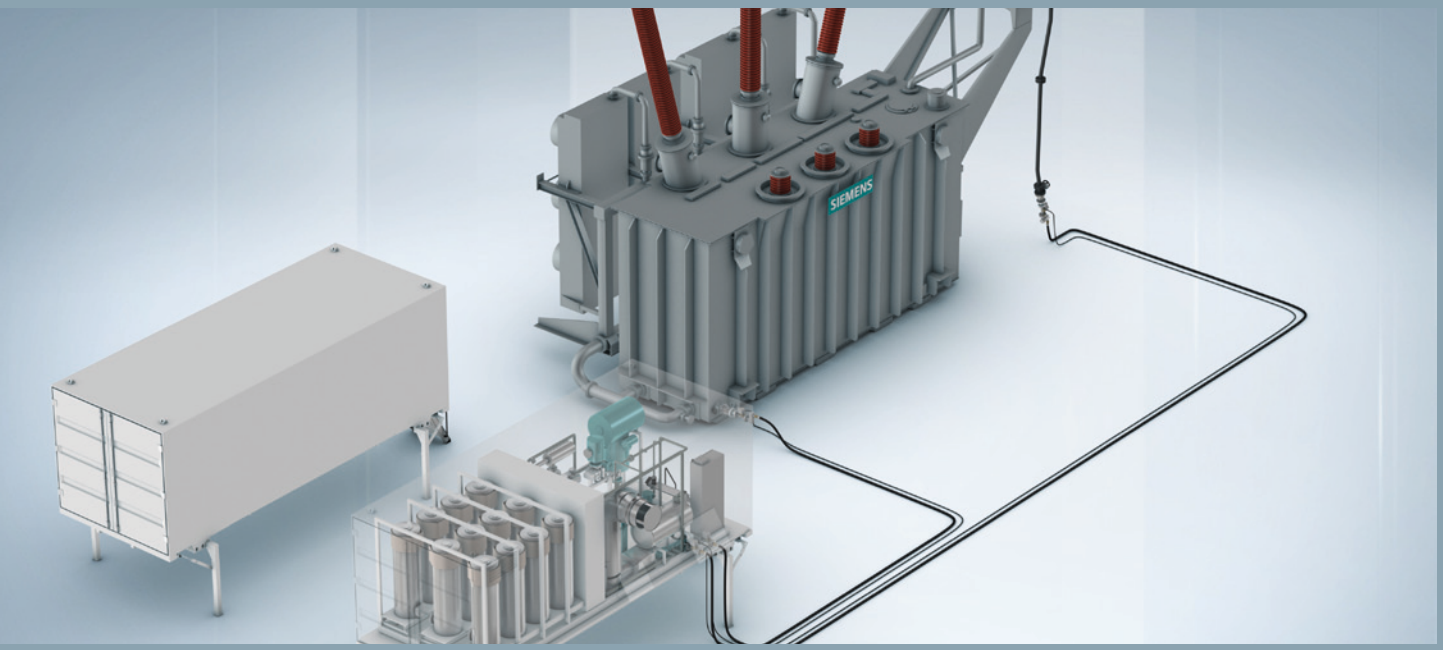
Transforming regeneration into system reliability

SITRAM® REG from TLM™ – Transformer Lifecycle Management™

Answers for energy.



For lasting regeneration of transformer oil

Rising cost 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 completely 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.

We developed the SITRAM® REG technology to clean contaminated oil and restore its dielectric properties. SITRAM® REG is a modified reclamation process based on the IEC 60422 standard. Oil is circulated continuously through regeneration columns. An oil change is not required.

Highly effective adsorption agents (activated fuller's earth) absorb the polar impurities and degradation products from the aged transformer oil. The cleaned oil flows back into the transformer. This cycle is carried out depending on the size of the transformer and the ageing condition of the insulating oil for several days or weeks. SITRAM® REG is carried out without interrupting transformer operation.

Whenever and wherever you need us

SITRAM® REG is a mobile solution. Mounted in a container, it is available to our customers at the transformer's installation site. Used like this as needed saves considerable investment costs above all.

The advantages at a glance

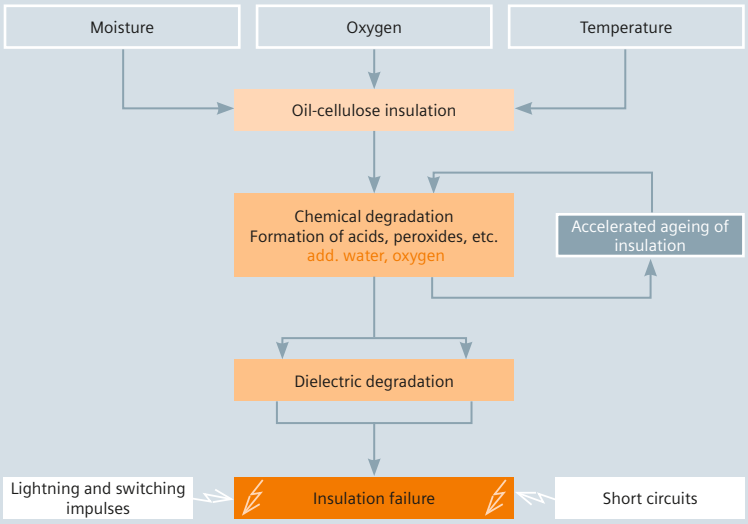
- Improves the quality of insulating oil to that of new oil
- Prolongation of the lifetime and increased reliability of old transformers
- Preventive action against the progressive insulation ageing process
- Sustainable improvement in the condition of the insulation
- Suitable for all power transformers
- Economically independent of the current price of new oil
- No service interruptions
- Great and long-lasting cleaning effect

Siemens extends the life of your transformers, reduces your costs and increases system reliability. With SITRAM® REG.

▶ Sludge deposits make the windings age more rapidly and impair the reliability of the transformer.

▶▶ For more than 100 years oil-cellulose dielectrics have stood the test of time in transformer construction. However, the ageing of the oil and the cellulose negatively impact one another and ultimately lead to failure.

Ageing processes in the transformer's insulating system:



SITRAM® REG – a clean solution all around

Regenerate instead of oil change

Reclaiming the oil filling offers several advantages over a 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 adsorption agent 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.

Last but not least, environmental considerations clearly advocate regeneration rather than disposal of the old oil. The (separated or generated) waste products remaining in the fuller's earth decompose through oxidation after the reclamation process. Only water and non-toxic gases are produced.

The advantages over an oil change

- No service interruptions
- Saves resources
- Additional removal of moisture
- Great and stable long-term
- cleaning effect
- Optional desludging possible

Optional desludging

Inferior oil quality, high utilization rates and missed preventive maintenance measures lead to the formation of oil sludge in the transformer. Unaddressed this causes a rapid failure of the insulating system and impairs cooling.

The freshly regenerated insulating oil possesses excellent sludge-dissolving properties at sufficiently high temperatures. In the course of an optional desludging process, oil sludge that has already been deposited in the transformer can be dissolved and removed from the transformer.

Advantages of the application on energized transformers

- A temperature drop from the windings to the surrounding oil increases the diffusion pressure.
- Mechanical vibrations contribute to redissolving deposited sludge.

SITRAM® REG is part of the SITRAM® family, which includes modular solutions that allow the availability and service life of your transformers to be maintained at a high level. Together we'll identify a fitting solution for your requirements.

Property	Limit values recommended for oil regeneration
Acidity	≥ 0.15 (mg KOH/g oil)
Dielectric dissipation factor at 90 °C and 40 Hz to 60 Hz	≥ 0.20 for power transformers and reactors with a nominal system voltage above 170 kV
	≥ 0.50 for power transformers and reactors with a nominal system voltage below 170 kV
Inhibitor content	Inhibitor concentration < 40% of original value
Combination of acidity and interfacial tension	Acidity > 0.06 mg KOH/g oil and IFT < 30 mN/m
Sludge	Where perceptible sludge is detected reclaim oil
In addition to the mentioned criteria, IEC 60422 recommends regeneration when rapid deterioration or acceleration in the rate of deterioration are observed.	

◀ A meticulous oil analysis is important for optimal workflow planning

◀◀ Recommended regeneration limits according to IEC 60422

Preventive application 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.

Safety and process control

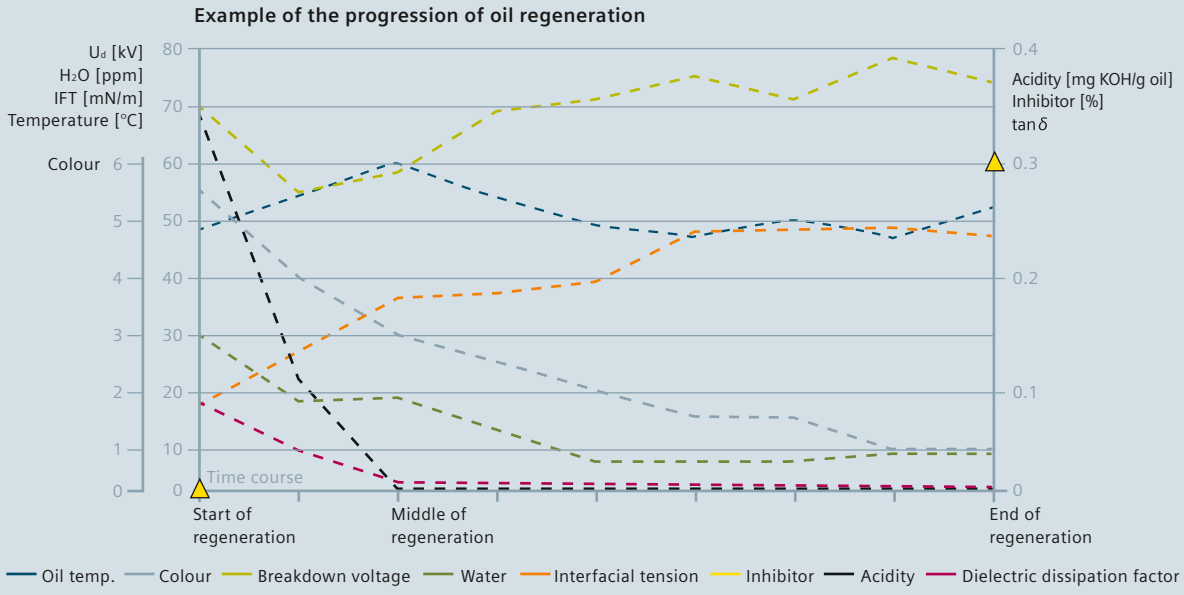
We have equipped SITRAM® REG with numerous safety measures. For example, continuous measurement and comparison of the volume of oil fed in and out, measurement of the filling level in the transformer, quick-acting pneumatic valves for the system and transformer as well as air traps at connecting points.

Process control is also designed to be intrinsically safe. In the case of a malfunction or system failure, the system automatically powers down to a secure state. Telemonitoring can also accompany the reclamation process. Once started, automation and process control make unattended operation possible during certain process phases.

Oil analysis included

By precisely controlling the properties of the oil, the regeneration process can be planned and managed accurately. After the insulating oil and solid insulation have been cleaned, the insulating oil is degassed and inhibited. Inhibition is an important step in increasing the oxidation stability of the cleaned oil and slowing down the ageing dynamics of the oil-cellulose insulation. It is expressly recommended in the IEC 60422 standard.

The process goes hand in hand with analyses that check the regeneration process – both in the mobile system as well as in the insulating oil laboratory at Siemens' transformer plant.



The diagram depicts the development of important oil parameters during regeneration of a 216-MVA generator step-up transformer with approx. 40 tons of high-aged insulating oil (duration approx. 2–3 weeks).

SITRAM® REG – a clean solution all around

If implemented in a timely manner, SITRAM® REG effectively and verifiably helps to extend the service life of transformers sustainably.

Recommended limits for mineral insulating oils after filling in new electrical equipment prior to energization

Property	Unit	After filling, prior to energization IEC 60422		
		Highest voltage for equipment		
		< 72.5 kV	72.5 to 170 kV	> 170 kV
Colour (on scale given in 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/2.5 mm	> 55	> 60	> 60
Water content	mg/kg oil	< 20	<10	<10

Experience values after implemented regenerations

Property	Unit	Prior to regeneration	After regeneration	After three years
Colour (on scale given in ISO 2049)		4.5	1.0	1.0 – 1.5
Acidity	mg KOH/g oil	0.24	< 0.01	0.02
Dielectric dissipation factor at 90 °C and 40 Hz to 60 Hz		0.090	< 0.005	0.008
Interfacial tension	mN/m	19.5	≥ 45	> 40
Breakdown voltage	kV/2.5 mm	60.5	≥ 75	68
Water content	mg/kg oil	19	< 10	

After successful oil regeneration under optimum process conditions, even insulating oil that has been used for years still fulfils the limit values with long-lasting effects comparable with applied limit values for new oils after filling in new transformers. 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.

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