REOIL® Transformer oil regeneration
Ekofluid expert in transformer oil treatment

Ekofluid is a manufacturing and servicing company specializing in high vacuum oil treatment and oil regeneration equipment. The company has an ISO 9001 certified quality system as well as ISO 14001 certified environment system. Servicing unit also holds the SCC safety management system certification. Since its establishment, Ekofluid has been focused on the mid-market segment providing a broad range of high-quality components. Its products are being used by all energy sectors such as transmission and grid operators, power generation companies, transformer servicing companies as well as numerous industry customers. The technology of oil regeneration and oil treatment has been originally developed at Fluidex (South Africa), more than 30 years ago. Thanks to research and dedication, at Ekofluid we have taken one step further to innovate and improve significantly on the existing Fluidex design of oil regeneration and oil treatment equipment establishing our REOIL and FILOIL brands.

Description of offered services

Ekofluid servicing division offers three types of services. Transformer oil treatment, transformer oil regeneration, and removal of corrosive sulfur from transformer oil. We provide all services on site with our REOIL and FILOIL equipment. Ekofluid fleet consists of oil regeneration and oil treatment units. Our team of trained experts accompanies each unit to ensure flawless operation of the equipment. Our units are capable of treating all types of mineral based transformer oils. All equipment is mobile and therefore suitable for intervention on site.

Description of oil regeneration process

Most power equipment is using transformer oil for its dielectric properties for cooling, insulating, and protecting the active parts. Transformer oils are highly refined oils that consist mainly of a mixture of hydrocarbons. Over time, oxidation byproducts start to form in the oil. Increases in oxidation byproducts result in the increase of acidity (neutralization number) and decrease the interfacial tension of the oil. At this stage, sludge starts to form, and oil is losing its dielectric properties because it is getting old. To prevent further deterioration of oil and possible damage to the active part of the transformer, oil needs to be regenerated. Oil regeneration equipment regenerates oil in steps. At the inlet of the equipment, oil is filtered through a coarse filter to prevent any particles from entering the equipment. It is then heated to the desired temperature to elevate the regeneration effect. After the oil has been heated, it enters the back section of the equipment. Oil is pumped through the back section which houses columns with sorbent media. It is in this section where the oil is stripped of impurities and ageing byproducts. Oil is then pumped through a vacuum breaking valve into the degassing section where it is dehydrated and degassed.

Treated oil is then pumped back to the transformer by the outlet pump. After a given period, sorbent in the back section of the equipment achieves full saturation and is no longer able to regenerate oil. At this stage, the sorbent needs to be reactivated (restored to its original state) to be able to regenerate oil again. Reactivation stage starts by draining the columns in the back section of saturated oil. After the oil has been drained, a vacuum is created and maintained throughout the whole reactivation process in the back section. Then by selective use of heating elements on the top parts of individual columns, the reactivation process is initiated. During the process, the impurities are removed from the sorbent which restores it to its original state. This entire process can be repeated many times until the sorbent starts to lose its properties and needs to be replaced.

Technical characteristics of oil regeneration equipment

All transformer oil regeneration equipment operated by Ekofluid is fully automatic controlled by a PLC system and visualized by a SCADA system. As a standard all units consist of 9 column modular sections each housing approximately 1200 kilograms of sorbent. Transformer oil regeneration equipment is capable of regenerating all mineral based transformer oil and has the ability to reactivate sorbent media for continuous operation onsite. All units are placed in a standard 6 meter long ISO containers that are specifically modified to accommodate the units. Each unit is transported by a truck onsite and it is attached to its own wheel base. The weight of individual units is 12 000 kilograms. In case of a specific requirement the unit can be lifted of the wheel base and put into a specific position.

Performance values of oil regeneration equipment

The level of contamination differs from transformer to transformer. The ageing process, as well as the utilization of a transformer, make it difficult to determine when and how will oil age to the point that it loses its dielectric properties. Regardless of the level of con-
tamination, oil regeneration always delivers the result required by the IEC 60422 standard for mineral insulating oils in electrical equipment. However, our REOIL regeneration technology goes one step further and significantly improves on the values required by the IEC 60422 standard, with the returning oil having properties almost identical to those put into the transformer for the first time.

### Carrying out oil regeneration process onsite

Before the beginning of the regeneration process the responsible staff member always carries out an onsite inspection to ensure the accessibility of the transformer and the possibility of connecting of oil regeneration equipment to the transformer. Number of key factors need to be checked and measured, such as local power source availability, flange sizes for connection, distances from and to the transformer, check valves below the conservator and any other factors that might play a role in the subsequent oil regeneration service. After a successful onsite inspection exact dates for connecting and disconnecting of equipment are set. On the date of the connection to the transformer oil regeneration equipment is brought onsite and connected to the transformer. The connection process takes several hours to ensure that all safety requirement is fully met. After a successful connection oil regeneration process begins. Oil regeneration last from number of days up to several weeks depending on the oil contamination but mainly on the total quantity of oil inside the transformer. Once the oil quality inside the transformer has been determined by our staff to be satisfactory the last phase of the regeneration process is started. In the last phase the oil is inhibited to improve its anti-aging capabilities. Oil is then inspected in a certified laboratory to ensure that it meets the requirement of IEC 60422 standard for mineral insulating oils and equipment is than disconnected from the transformer and moved offsite.

<table>
<thead>
<tr>
<th>Property (Unit)</th>
<th>IEC 60422</th>
<th>Before regeneration</th>
<th>After regeneration</th>
<th>10 years after regeneration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown voltage (kV/2,5 mm)</td>
<td>&gt;60</td>
<td>49</td>
<td>95</td>
<td>81</td>
</tr>
<tr>
<td>Dielectric dissipation factor at 90 °C</td>
<td>&lt;0.01</td>
<td>0.0823</td>
<td>0.0008</td>
<td>0.0029</td>
</tr>
<tr>
<td>Acidity (mg KOH/g)</td>
<td>&lt;0.03</td>
<td>0.15</td>
<td>0.010</td>
<td>0.018</td>
</tr>
<tr>
<td>Water content (ppm)</td>
<td>&lt;10</td>
<td>35</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Interfacial tension (mN/m)</td>
<td>&gt;35</td>
<td>27</td>
<td>49</td>
<td>41</td>
</tr>
</tbody>
</table>

### Safety as a key factor in oil regeneration services

Ekofluid sees safety as one of the key factors to successful oil regeneration. It is precisely for this reason our onsite teams are specially trained to operate under strict safety guidelines to ensure maximum safety of all equipment present on site. All our personal is certified according the SCC safety guidelines. In order to maximize safety onsite our oil regeneration and oil treatment devices have implemented numerous safety features to minimize the possibility of risk. Fast closing electrics safety valves on the side of the transformer and on the side of oil regeneration equipment ensure that in case of a malfunction the transformer is completely sealed off therefore preventing any leakage of oil into the environment.

Manual overheating protection inside the oil regeneration equipment ensures that in case of a software malfunction or misuse oil is not overheated and damaged. Entire oil regeneration equipment servers as an oil catch pan with level switch inside preventing of any leakage of oil into environment in case of a local malfunction of the unit. Constant monitoring of temperature, flow and vacuum parameters across the equipment ensures that in case of an unforeseen situation the equipment switches itself into a fail-safe mode. It is also very important to note that our personal never leaves the site during the operation of the equipment and therefore all our equipment is under constant supervision during its operation.