

The Siemens logo is printed in blue on the side of a white hard hat.The Siemens logo is displayed in a bold, teal, sans-serif font.The Siemens tagline 'Ingenuity for life' is written in a black, cursive script font.A teal-colored horizontal bar serves as a background for the title and sub-header text.

Customer Services for Transformers

# Material Test Laboratory

A small icon consisting of a grid of dots with a central square, representing monitoring and diagnostics.

Monitoring & Diagnostics

## Introduction

Transformers are one of the most important power supply elements. The life span of a transformer is largely determined by the composition of the cellulose insulation and insulating oil. Of all the materials used they are the ones which are subjected the most to operation-dependent ageing processes.

In a complex interaction with oil and paper temperature, moisture and oxygen lead to the formation of gases, acids, sludge and again to moisture which catalytically accelerates the ageing process.

## Features

Siemens Customer Services has numerous methods available for reliably determining the different influencing factors and with that the current condition of the transformer.

- Dissolved Gas Analysis (DGA)
- Inspection of the characteristic chemical and dielectrical oil values
- Furan analysis
- Determination of the polymerization degree of paper
- Preparation of electro technical material specifications for solid insulating materials, electrically and magnetically conductive materials and insulating liquids

## Benefits

- Prevent costly breakdowns
- Minimize idle time
- Extend the life of a transformer to well over today's usual life span of 25-30 years

## Scope of work / deliverable

The results of our assessments are properly documented in reports.

- Laboratory reports according ISO 17025
- Customer data bases
- Audit reports
- Failure investigation reports

## Technical details

### Dissolved Gas Analysis (DGA)

Through the natural ageing of oil and insulating parts and especially under the influence of thermal and/or electrical faults, fault gases soluble in oil are being built. The rate of gas formation increases and the type of gases varies under faulty conditions, e. g. thermal overload and/or electrical stress. The type of failure can be ascertained from the amount and type of the fault gases, the gas production rates and the ratio of the gases to each other. Various assessment schemes are available for the interpretation. On the basis of the trend development of the gas concentrations it is possible to forecast the seriousness and criticality of the fault.

### Degree of Polymerization (DP) and furan analysis

The DP value of the Kraft insulating paper is a measure for the number of polymerized glucose rings. A reduction in this value signifies ageing and with that a reduction in tensile strength.



New cellulose has a degree of polymerization (DP value) of 1000 –1100. In contrast cellulose which has aged has a DP value of only 150 –200. The sampling for DP – taking of paper samples is however only possible when the transformer is taken out of service.

During aging of the solid insulation, a decrease in the DP-value takes place and various decomposition products of cellulose are built, e.g. furan compounds. These furanes compounds are partly soluble in oil and their analysis is relatively easy. The furanes are an indication for the ageing status of the solid insulation. Their formation is, however, influenced by numerous factors like e.g. oil values, type of oil and paper, moisture content etc. .

No exact direct correlation between furan content and DP value is possible. A trend analysis based on the development of furanes to characterize the thermal behavior is however useful and gives information about the thermal behavior of the solid insulation over years.

#### Characteristic oil value

For the maintenance of the dielectric and physical-chemical parameters of an insulating liquid there are a number of important oil values. Some of them are:

- Colour and appearance
- Breakdown voltage
- Water content
- Acidity
- Dielectric dissipation factor
- Interfacial tension
- Inhibitor content

**Approval of new insulating liquids**  
The choice of the right insulating liquid for the desired application and for a long lasting fault free service is based on careful investigations. Current international standards, as well as long year experience and close collaboration with the suppliers are the base of successful work.

**Testing of transformer materials**  
Transformers contain besides insulating fluid also conductive materials (copper, electrical steel) and solid insulating materials (paper, press-board, laminated board and laminated wood). The insulating cellulosic materials are also subjected to considerable ageing processes during the service life of the transformer which can usually be a number of decades.

We carry out inspections to examine the condition of these materials and with that offer our customers the possibility of being able to plan any necessary maintenance measures early. Inspections of solid insulating materials, conductive metallic materials (grain oriented electrical steel and copper materials), coating materials and sealing materials are carried out.

- Solid insulating materials
- Copper materials
- Grain-oriented electrical steel
- Sealing materials
- Coating materials
- Auxiliary production materials

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