Performance Comparison of Dielectric Properties in Vegetable Oils

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Abstract: Power Transformers are essence of any substation. The insulating oil plays a major role in operation and cooling of Power Transformer. Since decades, paraffin and naphtha based oils are used as insulating media in any power transformer. Now a days, due to non-biodegradability of these paraffin and naphtha based mineral oils, many countries has banned their use .A comparative study has been made to compare the properties of these oils with naphtha based oils.

1. Introduction

Oil used in Power Transformers serves both as insulating medium as well as coolant. The effect of increase or decrease in temperature has a direct effect on these properties. Since years, naphtha based oils extracted from petroleum products are used as cooling medium in these Power Transformers. These oils are non-bio-degradable and not environment friendly. Oil spillage from Transformer oil pit or tank directly goes in to nearby water bodies and hinder with aquatic animals. Generally a fault is observed around a temperature of 250 °C. Oils viz soyabean oil, mustard oil, coconut oil and olive oil were taken and the temperature of these oils were increased up to 290 °C . After increasing temperature, thermal degradation of insulating paper was observed.

2. Experimental Method

2.1 coconut oil

First, the temperature of coconut oil was raised up to 251 °C. Insulating paper or Kraft paper which is generally made up of cellulose is dipped in to this heating oil. Temperature was measured using infra-red thermometer.

2.2 Soyabean Oil

Here again, a temperature of soybean oil was raised up to 251 °C. Insulating paper was dipped in to this heating oil and its property was observed.
2.1. Mustard Oil
Same way, Mustard oil was taken temperature up to 251°C was reached and insulating paper was dipped.

2.2. Olive Oil
Temperature of olive oil was also raised up to 251°C and insulating paper was dipped at this high temperature.

2.3. Transformer Oil
Now paraffin and naphtha based mineral oil used in transformer was also observed after raising its temperature up to 251°C.

3. The Dissolved Gas Analysis
All these unfiltered and untreated oils were taken and Dissolved Gas analysis was done on a chemito kit which identifies 6 main gases including CO, CO\(_2\), C\(_2\)H\(_4\), C\(_2\)H\(_2\), C\(_2\)H\(_6\) and CH\(_4\).

4. Results and Discussions
From heating vegetable oils and transformer oils both to a temperature of 251°C, thermal fault was generated. Generally paraffin based oils discharges gases like CO, CO\(_2\) and CH4. On reaching such high temperature and dipping cellulose based insulating paper, we find that the paper did not burn in vegetable oil. Further, on dipping the same insulating oil in naphtha based mineral oil which is conventionally used in transformers, it gets burned. From these results, we find that vegetable oils have better insulating properties as compared to naphtha based mineral oils. Many tests have already been performed and results show that vegetable oils have high fire point and flash point as compared to naphtha based mineral oils. The results obtained from DGA analysis is discussed hereunder:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>CO Concentration in ppm</th>
<th>CO(_2) Concentration in ppm</th>
<th>Vegetable oil in which DGA analysis done</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.27</td>
<td>71.08</td>
<td>Coconut oil</td>
</tr>
<tr>
<td>2</td>
<td>23.04</td>
<td>68.34</td>
<td>Ground Nut oil</td>
</tr>
<tr>
<td>3</td>
<td>1.7174</td>
<td>137.506</td>
<td>Mustard Oil</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>108.42</td>
<td>Olive oil</td>
</tr>
</tbody>
</table>

Now depending up on electrical and thermal fault, gases viz. CO, CO\(_2\), C\(_2\)H\(_4\), C\(_2\)H\(_2\), C\(_2\)H\(_6\) and CH\(_4\) are generated. These vegetable oil were unfiltered and untreated so on heating these oils, basically carbon dioxide and carbon monoxide gases were released. A comparative graphical analysis is as shown hereunder:

5. References
[1] Briand, L. C., Daly, J., and Wüst, J., "A unified framework for coupling measurement in objectoriented systems", IEEE Transac[1].CIGRE-Study committee B3 & committee D1 Colloquium from 9th-11th September, Brisbane on 'State of art review on Managing vegetable oil filled transformers'


