Properties of Ageing Mineral Insulating Oils in Service

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Chian Yaw started to work for Nynas Pte Ltd (Singapore) in May 2008. During the period of 2008-2014, he worked as Regional Sales Manager for South East Asia and parts of North East Asia, including Taiwan and Japan. Starting January 2015, Chian Yaw embarked on his new role as Head of Technical Development & Market Support for Asia Pacific, and continued to be based in Singapore. This position covers a variety of applications for Nynas specialty mineral oils and particularly that of insulating oils.

Prior to working in Nynas, Chian Yaw has worked in several application developments, technical and commercial roles with Eastman Chemicals, Dow Chemicals, DuPont Dow Elastomers, 3M and ICI Polyurethanes.

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Abstract

The electricity grid infrastructure in the hitherto industrialized world was to a large extent built up with a peak in investments around 1960-1980. This means that a flotilla of power transformers is now starting to reach projected lifetime of around 40 years. During the last couple of decades, there has also been an ongoing deregulation and privatization of electricity generation and distribution which has led to higher utilization of existing equipment. The demand for planned asset management, investments and reliability of power delivery, has also increased. To ensure that aging equipment is working satisfactory and will do so for yet some time, there has been a growing interest in aging behaviour of power equipment. Yet, there is little information openly available on how the insulating materials in transformers behave over longer periods of time. Such information is valuable both from the perspective of transformer maintenance/asset management, and as background data to make informed choices on which type of insulating liquid to employ in new equipment.

In this study, there is a total of 144 individual samples from separate transformers (all samples collected around the same time for analysis), of which 113 are inhibited and 31 uninhibited. The inhibited oil samples came from transformers in the Nordic region, whereas the uninhibited samples came mainly from the Middle East. The transformers ages span from only a few years up to 45 years. The samples were analysed for acidity, interfacial tension, dielectric loss (DDF) and peroxide content. The inhibited samples were also analysed for inhibitor content. These parameters except peroxide content are standard measurements, but little information exists on how they relate to each other statistically. The peroxide measurements were performed according to a method Nynas developed and which should tell us more about the oxidation behaviour and the efficiency of oxidation inhibitors. From one point of view, it makes sense to treat all samples together regardless of whether they are of inhibited or uninhibited type (or trace inhibited). After all, both types are mineral oils with some sort of built-in system to fight oxidation. In the case of inhibited oils, it is mainly the added antioxidant (inhibitor) that fulfils this function. In the uninhibited oils, it is natural organic sulphur compounds resulting from a specific refining process and which serves the same function.

From the standards governing the oxidation stability properties of insulating oil (such as IEC 60296 and ASTM D3487), it is easy to measure in the laboratory the increasing oxidation stability performance from uninhibited to trace inhibited to inhibited oils. However, one question this paper is looking at is whether the same observations can be made for oil in service.