Risk information – Property

Corrosive sulphur in transformer insulating oil

Introduction

Liquid immersed transformers typically employ mineral oil as an insulating medium for the transformer windings. There are certain circumstances under which impurities in the insulating oil can reduce the lifespan of the transformer. Specifically the presence of corrosive sulphur in the oil can result in a sudden and undetectable transformer failure that can lead to a fire and/or explosion. Since the year 2000 there have been a significant number of large power transformer failures worldwide that have been attributed to the presence of corrosive sulphur in the insulating oil. Many of the failed units were only 5 to 7 years of age.

What is corrosive sulphur?

"Elemental sulphur and thermally unstable sulphur compounds in electrical insulating oil that can cause corrosion of certain transformer metals such as copper and silver"
– ASTM D 2864.

Why is corrosive sulphur such a problem?

- Reacts on contact with copper windings
- Does not require heat to promote reaction (although heat accelerates the process)
- Can result in deposition of copper-sulphur compounds, weakening the transformer insulation
- Weakened insulation can result in arcing and subsequent transformer failure.

What are the risk factors?

Understandably, the mere presence of corrosive sulphur compounds in insulating oil is the single largest contributing factor. Despite this, many transformers operate successfully with a small level of sulphur present. There are a number of other factors that appear to increase the likelihood of a failure:

- High operating temperatures (i.e. within the upper region of the specified transformer operating range)
- High loading
- Closed conservators
- Unvarnished copper windings.

Why do some oils contain sulphur?

Historically a small amount of naturally occurring sulphur has been left after the oil refining process to assist with protection from oxidation. This is especially important in open systems that experience increased levels of oxygen.

Figure 1: Typical Oil Filled Transformer

Am I at risk?

Not all oils have sufficient levels of corrosive sulphur to initiate corrosion of the copper windings. Anyone concerned with the possibility of a sulphur related transformer failure should contact their oil supplier to determine if they are at risk. At this stage there are a number of oils from NYNAS that are considered to have high levels of sulphur compounds. Oil sample analysis can also be conducted to detect the presence of corrosive sulphur.

If the transformer(s) on your site are the property of the electricity network operator then you should contact their representative for confirmation of the type of oil used and if corrosive sulphur is a possible exposure.

Figure 2: Oil Filled Transformer Fire (Source NRC Canada)

What can I do?

If you determine that one (or more) of the transformers on your site are susceptible to a sulphur related failure then there are a number of options available to mitigate the risk.

1. Replacement of the insulating oil
2. Addition of a passivator to the oil.

By adding a passivator to the oil, a protective layer is formed on the surface of the copper windings, preventing further corrosion. Note that neither of these options listed above can repair damage that has already occurred to the transformer insulating paper. Of the two options, oil replacement is considered to be safer as it will also remove any of the corrosive copper sulphides that have already formed in the oil.

Further information

NYNAS Naphthenic website, http://www2.nynas.com/naph/start/

ASTM D2864-10 Standard Terminology Relating to Electrical Insulating Liquids and Gases, ASTM 2010.

Maintenance of Electrical Power Transformers, Vero Risk Improvement Guide.