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FURAN TESTING **ASTM D 5837**

When the cellulosic insulation materials within a transformer undergo degradation some of the products formed are derivatives of the aromatic compound called furan. Furan is a heterocyclic aromatic system consisting of four carbons and one oxygen in a five membered ring with each of the carbons having a hydrogen attached, hence the molecular formula is C₄H₄O. The five most prevalent derivatives of furan that arise from the degradation of the cellulose and that are soluble in the oil to an appreciable degree are the following: 2-Furaldehyde ; Furfuryl alcohol ; 2- Acetylfuran ; 5-Methyl-2-furaldehyde ; and 5-Hydroxymethyl-2-furaldehyde.

Procedure:

The entire details of the procedure for determining the quantity of furanic compounds in an insulating fluid are given in the ASTM D 5837 method and are only briefly mentioned here. A sample of the oil is extracted with either another liquid such as acetonitrile or with a solid phase extraction (SPE) device. The extract is then analyzed using high performance liquid chromatography (HPLC). The five compounds mentioned above are separated on an appropriate column and each is detected by use of an ultraviolet detector that is adjusted automatically to the appropriate wavelength for each of the five components. Calibration solutions are made up for each of the components to be analyzed and these are used to standardize the instrument responses. From the data on the standard solutions, the extraction efficiencies for each component can be calculated and corrections can be made accordingly. The results are usually reported in terms of parts per billion (ppb).

Significance:

The five furanic materials normally analyzed in this procedure are aromatic compounds that arise from the degradation of the cellulosic materials within a transformer either by normal aging or from being involved with an incipient fault. Thus the amount of these products present in the oil might be a good indication of the condition of the cellulosic insulation. At the present time there have been no limits or normal values established for these components either individually or in combination. Research is being carried out to find if there are any useful correlations that can be used but at the present it might only be useful to follow trends rather than absolute amounts in the oil. Another test that can be used to assess the condition of the cellulose within a transformer is to determine the average degree of polymerization. However, this is an intrusive test that requires a sample of the cellulose. One has to take the unit out of service to obtain the sample and a portion of the unit is destroyed in the process. If a good correlation can be found between the average degree of polymerization and the concentration of the furanic compounds either individually or in combination, then this would have a number of advantages for evaluating the condition of the cellulosic insulation within a unit. First it is a non-intrusive procedure. Second it does not require interruption of service to obtain a sample. Third the laboratory analysis requires less time and it is a more sensitive determination. Efforts are progressing toward this end.