DIRECT INJECTION - HPLC ANALYSIS FOR THE DETERMINATION OF FURANIC COMPOUNDS IN OIL AS MARKERS OF SOLID INSULATION DEGRADATION IN POWER TRANSFORMERS

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The presence of 2-furaldheyde (2-FAL) and related furanic compounds in insulating mineral oils is correlated to thermal degradation and mechanical properties of the Kraft paper used as solid insulation in large electrical equipment (e.g. power transformers). Besides 2-FAL, the main compounds formed by paper degradation are 5-(hydroxymethyl)-2-furaldehyde (5-HMF), 2-furfuryl alcohol (2-FOL), 2-acetylfuran (2-ACF), 5-methyl-2-furfuraldehyde (5-MEF). Nevertheless, 2-FAL is usually the molecule which is found at higher concentrations in the oil, since it is the compound of final degradation of 5-HMF, 2-FOL, 2-ACF and 5-MEF.
The presence of the above-mentioned compounds in the oil is therefore an indication of the health status of solid insulation in power transformers, and their detection represents an important tool for planning maintenance procedure throughout the whole lifetime of the electrical equipment. In order to perform accurate and reliable surveillance of the degradation state of paper, simple, robust and fast analytical methods are required. As regards the determination of furanic compounds in mineral oil, the International Standard IEC 61198 details the analytical methods to be used, which are basically based on a L/L or SPE extraction, followed by HPLC-UV.
The aim of this work is to study the feasibility of the determination of 2-FAL, 5-HMF, 2-FOL, 2-ACF and 5-MEF by direct injection HPLC-UV analysis, without any sample pretreatment.
The method has been developed on a core-shell C18 column, evaluating the effect of sample volume injected, in order to avoid column saturation due to the direct injection of oil. Eluent composition as well as gradient programming have been tuned in order to ensure fast analysis time, and the resolution between 2-FAL and 2-FOL peaks for which the column exhibits similar selectivity. A proper washing procedure has been developed in order to remove the organic compounds which characterize the typical oil profile.
Precision of the method has been calculated by analyzing oil samples from in-service transformers. Accuracy was tested inside three round-robin tests (2012-2014).