DISCUSSION OF THE PAUL J. GRIFFIN, EILEEN FINNAN AND LANCE R. LEWAND PAPER,

"CASE STUDIES"

José Mak
Armando Bassetto F.

Companhia Paulista de Força e Luz (CPFL)

We wish to commend the authors for another very informative paper. We agree with the authors that oil tests should be used in conjunction to detect problems in power transformers. Along with this line, we wish to make some comments concerning the use of oil tests.

We believe that the furfural analysis can be of much use for the assessment of the impact that power transformer loading may have on the solid insulation aging and on the detection of incipient faults involving the solid insulation.

In the past, loading above nameplate was considered to be as overloading. This criterion has changed, and loading guides now allow hottest-spot temperature to reach very high temperatures (140 º C). Though such a temperature can be maintained for only a few hours, there may exist a doubt concerning how deleterious would such high temperature levels be to a specific transformer unit whose insulating paper cannot be so dry as in brand new condition, or whose oil is becoming acidic. Situations comparable to this may require a practical decision which can involve much money – to be made in a short length of time. In such cases, furfural analyses can be a cheap, handy and reliable tool. For example, the furfural content can be closely monitored before, during and after high temperatures are reached due to high loads.

The values can be compared, and arrangements can be made whether to make the loading policy more aggressive or more cautious. If the data indicate that loading is degrading paper too fast due to the synergistic effects caused by heat, water, oxygen and oil acids, a step back as for loading policy has to be given. The degrading agents have to be minimized so that heat due loading can be the almost exclusive one. We like to emphasize that heat a 'positive' aging effect. Heat is usually a consequence of loading which for its turn is the only feasible transformer operators have available to pay back the investment their companies have made on the transformers.

Concerning the detection of incipient faults involving the solid insulation, high temperatures may be of much assistance in showing if significant hot spots due to poor contact, poor welding etc. are occurring. At lower temperatures, they could have more serious effects since they cold be dissimulated among the so many different variables existing in a transformer. At higher temperatures, a furfural analyses becomes a very good complement of dissolved gas analysis. The potential problems can be accelerated and be solved much earlier than they usually would be if the units were maintained at lower temperatures.

Heat also has another ‘positive’ effect. Water migrates from the solid insulation to the oil due to temperature increase. If the transformer is wet, the percent water saturation of the oil can be surpassed when the unit cools, and the dielectric strength can be seriously reduced. A practical approach to this problem and to aging acceleration is to conduct an energized oil treatment. Several can be obtained from this procedure: the oil can be reclaimed, degassed and dried; the water content of the solid insulation can be reduced; the transformer operating reliability increases.

The assessment of the water content of the solid insulation was a crucial item whose solution was not available until recently. Fortunately Sokolov and Vanin proposed a very practical method. We have recently conducted a field test to determine the limiting parameters to put the method in practice CPFL operating condition. The unit chosen was a 25MVA unit, 138-11.9 Kv, with approximately 8500 liters of oil. A heater was connected in parallel with the transformer to increase the oil temperature from 35-45ºC to 70ºC at an oil flow of 400 liters per hour. The unit’s fans were set to start working when the oil temperature reached 70ºC. Trough we expected to maintain the oil temperature in the range 65-70ºC, we knew that we would probably not succeed in doing so. However, we wanted to determine the major difficulties we would face in practice before we had to spend more money on this type of test. After seven days of heating, the oil temperature ranged 50-60ºC while the ambient temperature ranged 15-25ºC.

The test was useful to determine that the setting of the traditional electromechanical thermometers is time consuming. The use a modern temperature monitoring system would be extremely useful. Now we are planning to close some transformer coolers and use a higher oil flow. Though a load transfer load from nearby substation could be an option to heat the transformer under test, this is not usually possible because several substations on CPFL power system are n ot linked to each other at the low voltage side.

The author’s statement on the degradation of furfural by oxygen has led us to ask a few questions. Is furfural stable at normal oil temperature in an acidic, wet an oxygen saturated oil? Do water and the oil acids play a degradation effect on furfural? If so do they work synergistic with oxygen? Would more stable products be formed from furfural degradation, which could be used as paper aging indicators? Would the authors like to share some information on these questions?