DGA (Dissolved Gas Analysis) diagnostic method reveals internal carbonization in oil-filled high voltage extruded cable terminations

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The widespread use of extruded cable systems in the range of 138 to 500kV throughout the world has placed increasing focus on effective and economic diagnostic methods for such cables and accessories. DGA is potentially one such emerging diagnostic method for oil- filled extruded terminations. This paper covers the successful application of DGA, as validated by the relationship of dissolved gases in the termination oil, particularly acetylene to the tracking/carbonization pattern observed at the transition between the cable insulation and cable insulation semi-conductive screen of a 38 years old 138kV termination. The pattern was evidenced by the presence of carbon by means of SCM instrumentation. This was attributed to the poor preparation of the transition at the end of the cable insulation semi-conducting screen that lacked the degree of smoothness and proper chamfering essential at high voltage levels. Steep chamfer creates gap between cable insulation and stress cone. The incursion of any gases e.g., from the crosslinking process or otherwise into the gap can understandably lead to PD activity that can eventually result in a failure. It should be noted that fairly high concentrations of methane were observed in some terminations, but the isobutylene was consistently high at all terminations, both resulting from the peroxide crosslinking process.

Of the 12 terminations involved in the present investigations, only one showed significant concentrations of acetylene, including other hydrocarbon gases associated with acetylene. Recognizing that acetylene is related to tracking/carbonization of oil from which it emanates, this termination was dissected, including one of the 11 terminations that did not show any acetylene at all to make comparison. The latter was found to be absolutely clean and devoid of any carbonization evidence. Unlike HPFF oil-paper terminations, extruded cable terminations with considerably reduced radial and axial fields should not show any or minimal, if any, acetylene. This is also supported by laboratory load-cycling test performed on essentially the same 138kV termination design, 12 hour 100^0C heating and 12 hour 100^0C cooling and 1.7 rated voltage. The results of this investigation demonstrate that the DGA diagnostic method, which has achieved great success in transformers and HPFF (high pressure fluid-filled) cable systems, particularly HPFF terminations, holds great potential for oil-filled extruded cable terminations. Based on the present investigations coupled with previous work by the upper range of acetylene and other related gases are proposed.