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DISSOLVED GAS ANALYSIS FOR OIL TRANSFORMER

Transformers are major power system equipment. Their reliability not only affects the electric energy availability of the supplied area, but also affects economical operation of a utility. Thus the utilities need to keep a track of the health of the transformer and also develop a diagnosis system. One of diagnosis methods is dissolved gas analysis (DGA), which is by detecting certain level of gases generated in oil-filled transformer.

The insulation oil used in power transformers is a combination of liquid transformer oil and solid impregnated cellulose. Deteriorated insulation and ageing are the two major causes of incipient faults. The major causes of ageing and deterioration of insulation are thermal stresses, electrical stresses, mechanical stresses, and moisture [1].

DGA is the most common techniques for transformer fault diagnosis [2] [3]. DGA can provide the early diagnosis needed to increase the chance of finding an appropriate maintenance. By examining the insulating oil of transformers, ratios of specific gas concentrations, their generation rates, and total combustible gases are often used as the attributes for classification by diverse DGA approaches. These gases are hydrogen (H_2), methane (CH_4), ethylene (C_2H_4), ethane (C_2H_6), acetylene (C_2H_2), carbon monoxide (CO), and carbon dioxide (CO_2).

The key step in using DGA is correctly diagnosing the fault that generated the gases. Abnormal electrical or thermal stresses cause insulation oil to break down and to release small quantities of gases.

Value for each of the key gases is recommended to be trended over time so that the rate-of-change of the various gas concentrations can be evaluated. Hence, DGA requires routine oil sampling for on-line gas monitoring, at least once a year [4]. Basically, any sharp increase in key gas concentration is indicative of a potential problem within the transformer. Parameter of key gas concentration and potential fault type is given in the table 1.

Table 1. Key gas concentration and potential fault type[2]

Gas Description		Key Gas Concentration (in ppm)		
		Normal Limits* (<)	Action Limits** (>)	Potential Fault Type
Hydrogen	H_2	150	1,000	Corona, Arcing
Methane	CH_4	25	80	Sparking
Acetylene	C_2H_2	15	70	Arcing
Ethylene	C_2H_4	20	150	Severe overheating
Ethane	C_2H_6	10	35	Local Overheating
Carbon monoxide	CO	500	1,000	Severe overheating
Carbon dioxide	CO_2	10,000	15,000	Severe overheating
Total Combustibles	TDCG	720	4,630	

* As the value exceeds this limit, sample frequency should be increased with consideration given to planned outage in near term for further evaluation.

** As value exceeds this limit, removal of transformer from service should be considered.

Reference:

[1] Sun, Huo-Ching, et al. "A Review of Dissolved Gas Analysis in Power Transformers". 2012. Energy Procedia 14: 1220-1225.

[2] IEEE C57.104 Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers (1991)

[3] IEC 60599 Mineral Oil-Impregnated Electrical Equipment in Service – Guide to the Interpretation of Dissolved and Free Gases Analysis (1999)

[4] NFPA 70B Recommended Practice for Electrical Equipment Maintenance (2013)

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