Identifying stray gas phenomenon

It should be noted that it is difficult to distinguish this "stray gassing" from an actual fault. Baseline oil analysis of the virgin oil is inevitable, as the stray gases can start forming while it is still in transit in containers. Certain makes of oil are more prone to this phenomenon like Nynas Nitros

ASTM D7150-13 [5] published in 2013 stated the standardized test methodology for the determination of gassing characteristics of insulating liquids under thermal stress i.e. stray gassing.

Thermal or electrical stress cause the formation of compounds to form molecular hydrogen and hydrogen gases. Compatibility of various parts of the transformer should be established – epoxy-based glues, paints used in the transformer inside walls etc. if deviated from the standard materials this can cause adverse chemical reactions with the oil and insulation materials and metals.

There is no clear indication of what levels of stray gassing are acceptable for new oil and when stray gassing should be a concern. Tests have shown that oil in contact with oxygen produce higher levels of hydrogen compared to other combustible gases. Establishing a gassing fingerprint for stray gassing activity is especially useful for transformer known to be filled with oil that display stray gassing properties – with this we can distinguish between stray gassing and classic transformer faults.

Gases	Test sample	DE suggested limits
H_2	1150	590
CH_4	558	120
CO	878	450
CO_2	1470	1580
C_2H_2	0	0
C_2H_4	16	8
C_2H_6	498	120

Table 7: Laboratory stray gassing test results for samples sparged with air zero [8].

Gases	Test sample	DE suggested limits
H_2	636	250
CH_4	683	80
CO	638	115
CO_2	1188	385
C_2H_2	0	0
C_2H_4	14	6
C_2H_6	592	36

Table 8: Laboratory stray gassing test results for samples sparged with nitrogen [8].

If a transformer is producing greater than normal combustible gas levels, and any combustible gas exceeding specified levels should prompt additional investigation. Sampling frequency should be increased to monthly.

Its important to note that stray gassing will not affect oil quality. The severity of the stray gassing is determined by the magnitude and number of gases that exceed their limits. Large amounts of gas can be removed by degassing of the unit, stray gassing may plateau or may continue after degassing

Please note that the other parameters (Dielectric strength, Moisture, Acidity, IFT, DDF) did not change in the sample

Parameter	**Measured**	**Limit**
DS (kV)	80	≥50
Moisture (ppm)	5	≤20
NN (mgKOH/g)	0,02	≤0,15
IFT (mN/m)	41	≥22
DDF @ 90°C	0,00376	≤0,20

Table 10: Oil quality indicators for in-service equipment of category A (IEC 60422:2013)

Please note that in table 12 and 13 – transformer 1 displayed stray gas tendencies and transformer 2 – was verified by on-site testing to have an active partial discharge fault.

The DGA analysis as per comparison.

Gases	Transformer 1	Transformer 2
H_2	1251	196
CH_4	182	16
CO	216	437
CO_2	532	881
C_2H_2	ND	ND
C_2H_4	4	12
C_2H_6	171	8

Table 12: EL stray gassing test results.

Gases	Transformer 1	Transformer 2
H_2	1347	283
CH_4	191	26
CO	223	579
CO_2	618	839
C_2H_2	ND	ND
C_2H_4	5.1	8.3

Please note that according to studies uninhibited oil are more prone to stray gas tendencies than inhibited oil

To be sure of the diagnosis maybe you can send a sample for stray gas analysis – otherwise just resample and see what the production rate per day is.

If significant quantities of gases are formed below its threshold temperature, this gassing tendency would be stray gassing.

This phenomenon is related to oxygen content of oil and metals (even stainless steel)

At 120 °C the main gas produced was hydrogen followed by methane

At 200° C the main gases formed are methane and ethane

Hydrocarbon gas generation was related to water content of paper, thus related to the water content of oil – it could not have been established if the water were a by-product of the chemical reaction breakdown of the oil chain