Advancements in Dissolved Gas Analysis: Data Quality

Dr. Zachary H Draper & Dr. James J Dukarm

INTRODUCTION

There is more to DGA interpretation than comparing the latest gas concentrations to limits in a table or plotting them in a triangle or pentagon to identify the apparent fault type. We have found that the whole DGA history of a transformer must be considered when interpreting its most recent DGA results.

Trend evaluation and accurate assessment of short-term changes require accuracy and low measurement variability of gas data. Data quality problems must be recognized and dealt with before an interpretation is attempted. Below we point out some of the most common data quality issues.

DATA MANAGEMENT

As a result of the historical importance of DGA data, proper organization and preservation of DGA data are extremely important. In addition to archiving the lab reports, keep the data in tabular form in a database or, for small volumes of data, a spreadsheet. A well-organized database supports sorting and filtering for graphical and statistical analysis.

Use a unique and permanent ID to identify transformers, oil compartments, and the oil sample data belonging to them. Substation and unit number are not a suitable ID, for the same reason that the dentist doesn't identify you by your department and job title. Large transformer fleets may require company-assigned asset numbers to avoid possible serial number duplication across manufacturers.

Disciplined chain-of-custody practices provide correct IDs of transformers and compartments to be sampled, ensure that oil samples are labeled correctly, and guarantee that analysis results returned by the lab are attributed to the right transformers and oil compartments.

DATA INCONSISTENCY OR INACCURACY

Gas loss that is deliberate, such as by head space pressure regulation or use of a desiccant breather, needs to be accounted for as discussed in our other article [1]. Unintended gas leakage from a transformer – often detectable by a O_2/N_2 ratio persistently above 0.2 when it should be lower – should be remedied as soon as possible, both to keep DGA effective and to prevent moisture ingress. After oil degassing, it is advisable to exclude samples from DGA interpretation for 6-12 months due to the false upward trends created by diffusion of gases from winding paper into the bulk oil.

Accuracy and repeatability of gas data are only partly up to the laboratory. Unrepresentative oil samples can lead to inconsistent and highly variable gas data regardless of the quality of laboratory measurements. A study by a large USA electric utility [2] shows that using extra care and a moisture / temperature probe to ensure collection of representative
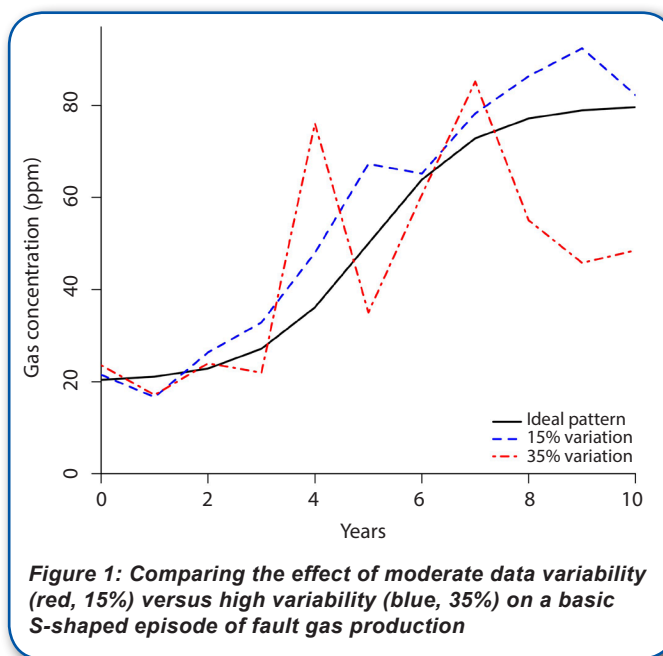

Figure 1: Comparing the effect of moderate data variability (red, 15%) versus high variability (blue, 35%) on a basic S-shaped episode of fault gas production

oil sample can reduce data variability considerably. The figure (Figure 1) illustrates the effect of moderate variability (±15%) versus high variability (±35%) on the data from a basic S-shaped gassing event.

Moderate variability is experienced with consistently good sampling practice and a good laboratory. High variability is easily attainable if there is a problem with sampling practices.

Table 1: Common Data Quality Issues	
Equipment ID	Transformer and oil compartment properly identified?
$O_2 / N_2 > 0.2$	Sample exposed to air or transformer leaking
$C_2H_2 / H_2 > 2$	Contamination from LTC
Large change	Sampling problem, typo, or misidentified sample
Oil degassed	Exclude gas data from trending for 6 months afterwards
Change of lab	Possible baseline shifts

The table provides a summary of some common data quality problems. Sections 5.1 and 5.2 of IEEE C57.104-2019 [3] contain a detailed discussion of data quality assessment.

REFERENCES

[1] "Advancements in Dissolved Gas Analysis: Accounting for Gas Loss," Electricity Today, March 2020
[2] T. Rhodes, "Using field moisture probes to ensure drawing a representative oil sample," in 82nd Annual International Doble Client Conference, Doble Engineering Company, March 2015.
[3] "IEEE Guide for the interpretation of gases dissolved in mineral oil filled transformers", IEEE Std C57.104-2019.