TechTalk

Dissolved Gas Analysis – What do the gasses tell us?

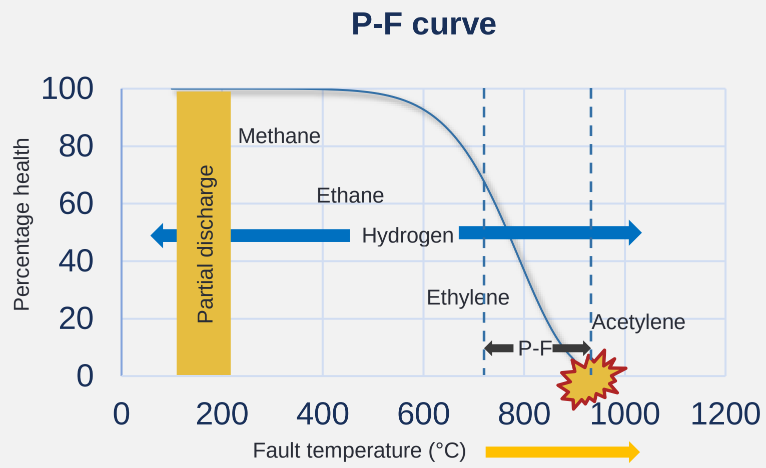
Compiled by Tom Dalton | April 2022

Gassing of insulating oil

Gassing of insulating oil is a common occurrence in an operating transformer. However, each gas has a story to tell. In terms of risk, each gas has a personality. The oil (a complex hydrocarbon), when stressed with heat or electrical activity will breakdown into simpler gases. These are also known as hydrogen, carbon monoxide, carbon dioxide, methane, ethane, ethylene and acetylene. Although oxygen and nitrogen may be identified in an analysis, they are not directly linked to a fault.

The diagram below displays the individual gases and how they relate to the health of an oil filled transformer.

- As the fault temperature increases the health initially remains intact, but eventually there will be a point of "no return".
- This will depend on the component involved and the potential for failure. In essence, there are two types of faults: kinetic and thermal faults. The gases involved in kinetic related faults develop in elevated and high quantities of hydrogen and acetylene (typically from partial discharge and arcing). Thermal faults develop when there are elevated high levels of methane, ethane, ethylene and acetylene (typically from high contact resistance and bad connections).
- Carbon monoxide and carbon dioxide are the result of the degradation of paper based insulation. Generally the ratio CO2/CO will indicate whether it is fault related or ageing or over loading or cooling related.



If we consider the P-F curve in relation with a thermal fault; the further right we go the smaller the P-F region will become.

Note that hydrogen will be produced right the way through the temperature range and is not temperature specific.

Final thoughts

The higher the temperature the greater the risk, and closer to a failure. Thus, it can be said that the temperature of the fault will determine the P-F window and the amount of damage that is occurring.

Diagnostic tools

Absolute values are influenced by many factors: typically the oil type or manufacturer; fault type and surface area; amount of current (loading) and materials involved. Thus, an absolute value is not too helpful. However, it is of value to know that a parameter break has occurred before applying any diagnostics tools. Colour coding is useful in that it highlights results that are problematic.

Ratios allow the absolute values to become more understandable as they will show a condition irrespective of the absolute values being slightly inaccurate. Inaccuracies can originate from many of steps in the process. One of these is the lab accuracy, and analysis from different labs can vary greatly. However, be aware that with ratios there will always be an answer; thus, it is important that the gases have **exceeded** a limit before applying them.

The most common are:

- Methane / Hydrogen: Showing low temperature faults and partial discharge.
- Ethane / Methane: Showing faults in the low to medium temperature range, typically 300°C to 500°C.
- Ethylene / Ethane: Showing faults in the medium to high temperature range; typically 500°C to 900°C. Ensure that acetylene remains 0°C.
- Acetylene / Ethylene: Showing faults in the high to extremely high range; typically > 700°C. If acetylene is present it could be indicating discharge. Significant discharge (both PD and arcing) will have high values of hydrogen associated.
- Carbon dioxide / Carbon monoxide: Showing faults that involve paper-based insulation. In general, values below 5 would indicate fault-related conditions; but note that there will be other gases such as methane, ethane and ethylene present. Values above 11 are associated with overloading, insufficient cooling and age-related conditions. Minimal other gases would be present, for example methane may be present in elevated values.
- Hydrogen: Is a precursor to many faults and must be seen as a warning indicator. If this gas rises in value and is typically over 150ppm (parts per million) there is a good indication of a fault developing; it generally appears in all thermal faults and in generous quantities in partial discharge and arcing activity.

Duval diagnostic triangles and pentagon are good tools to determine temperature and fault progress. Production per day is also used to track progression and a limited element of risk.