Increased Instrument Uptime with Improved Methanizer for Dissolved Gas Analysis

Application Note

Dissolved gas analysis (DGA)/Transformer oil gas analysis (TOGA)

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Abstract

A nickel catalyst methanizer that was previously poisoned by transformer oil gas was replaced by a Polyarc methanizer on an Agilent 7890 gas chromatograph (GC) analyzer equipped for dissolved gas analysis under ASTM D3612-C. The analyzer met or exceeded the performance criteria from the ASTM method in all aspects. The Polyarc's two-stage oxidation-reduction catalyst system eliminated unplanned downtime due to methanizer failures. These improvements led to considerable cost and time savings, and increased sample throughput.

Introduction

Dissolved gas analysis (DGA) is an important method for the determination of pending or current faults within a power transformer. Specifically, as a transformer ages, the oil that insulates and cools components can begin to degrade. The analysis of several dissolved gases (H_2, N_2, O_2, CO, CO_2, C_2H_2, C_2H_4, C_2H_6, C_3H_8, C_3H_6, C_4H_8) can give early indicators of faults and transformer stability.

Gas chromatography (GC) with thermal conductivity detection (TCD) and flame ionization detection (FID) with a methanizer is the technology of choice for this analysis. In the most common method for DGA, ASTM D3612-C, the oil sample is heated and the gas above the liquid (the headspace) is sampled into a GC for separation and detection.

Figure 1. Power Transformer

The introduction and propagation of new transformer oils have led to increased performance requirements for methanizers that convert CO and CO_2 to CH_4 for FID quantification. Specifically, many labs have struggled with frequent methanizer failures due to catalyst poisoning from these oils.

The Polyarc reactor introduced by ARC in October 2015, is the latest improvement to methanizer designs and utilizes advances in nanoengineered catalysts and 3D metal printing to improve robustness, resist poisons, and improve performance and ease of use. Here, we demonstrate how the replacement of a nickel catalyst methanizer with a Polyarc can improve DGA analysis and reduce instrument downtime leading to more sample throughput.

Experimental

An Agilent 7890 equipped with an FID, TCD, bypass valve, and headspace sample introduction was configured for ASTM D3612-C. The following parameters are provided for guidance, but the reader

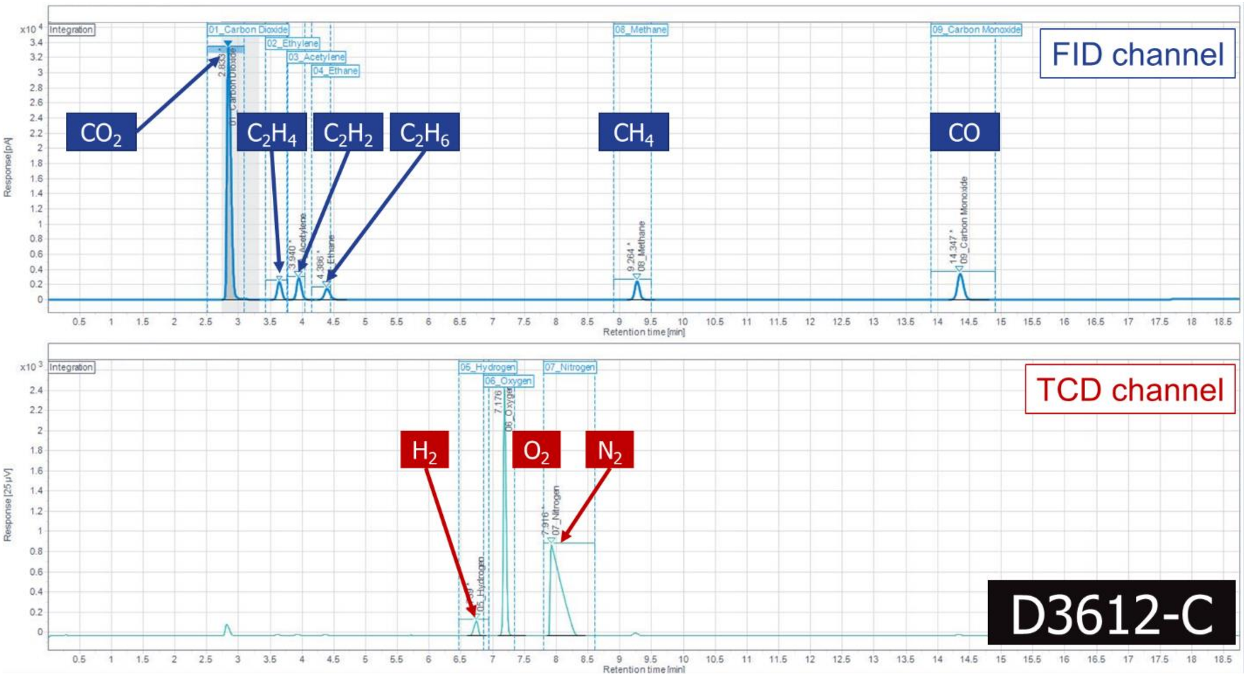

Figure 2. D3612-C chromatogram with Polyarc

is directed towards the official [ASTM method]() for complete details. The poisoned nickel catalyst methanizer was removed from the system and replaced with a Polyarc reactor. There were no additional changes to the instrument or method.

GC conditions

Headspace sample	70 °C
Transfer line	150 °C
Equilibration	30 min.
Bypass valve	120 °C
Oven	40 °C (3 min), 24 °C/min to 170 °C (2 min), 24 °C/min to 250 °C (5 min)
Columns	5A Plot (30 m × 0.53 mm × 50 µm) Carboxen-1006 (30 m × 0.53 mm)

FID conditions

Temperature	315 °C
H_2	1.5 sccm (36.5 sccm total with Polyarc)
Air	350 sccm
Makeup	5 sccm (He)
Sampling rate	20 Hz

Polyarc methanizer conditions

Setpoint	293 °C
H_2	35 sccm
Air	2.5 sccm

Results and Discussion

Figure 2 shows the chromatogram from an oil calibration standard after installation of the Polyarc methanizer. Hydrocarbons and carbon oxides are detected by the Polyarc/FID (top) and permanent gases (hydrogen, oxygen, and nitrogen) are detected by the TCD (bottom). Hydrocarbon and oxide peaks were gaussian with baseline separation. Integrated areas were consistent with previous results for carbon dioxide, carbon monoxide, methane, ethane, ethylene, and acetylene, indicating the methanizer was operating with full conversion to methane. Calibration curves were used to determine partition coefficients.

Instrumental precision was determined to be within the specifications set by the ASTM methods for all compounds from multiple runs. Accuracy exceeded the 10% per constituent performance requirement as specified in the ASTM method. In addition, the Polyarc methanizer exhibited a large increase in resistance to poisoning from transformer oils. Specifically, the nickel catalyst methanizer was failing 1-2 times per week without warning, presumably due to chemicals present in the transformer oils that poisoned the nickel catalyst. In the same application and GC, the Polyarc gave consistent performance 3 months after installation. Thus, the switch to the two-step oxidation-reduction Polyarc methanizer reduced catalyst failures, leading to increased instrument uptime and sample throughput and eliminating the need to rerun samples after unplanned failures. The increased robustness of the Polyarc is directly the result of superior catalysts and the additional oxidation step before reduction.

Conclusions

The Polyarc methanizer is a drop-in replacement for a nickel catalyst methanizer in ASTM D3612-C. The performance meets and exceeds that of a nickel catalyst for the analysis of transformer oil, with the additional benefit of extended lifetime and resistance to poisons. This robustness leads to less unplanned downtime, more sample throughput, and increased revenue.

Contact Us

For more information or to purchase a Polyarc® system, please contact us at 612-787-2721 or contact@activatedresearch.com.

Please visit their website for details and additional technical literature.

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