Mitigating Potential SF₆ Leaks

Through Early Leak Detection

Thomas Heckler, WIKA
Who we are and what we do …

We take care of your assets

Transmission & Distribution

High Voltage  Flow of electricity  Medium Voltage

Gas Density  Valves  Gas Analytics  Gas Handling
Baseline: SF₆ in Electrical Equipment – an Estimation

Gas zones in Service

WIKA has equipped more than 1,000,000 gas tanks worldwide with:

- 750,000 Gas Density Monitors
- 200,000 Gas Density Indicators
- 50,000 Gas Density Switches
- 25,000 Gas Density Transmitters

Baseline banked SF₆ in electrical Equipment

- At least 2,0 Mio. Gas zones are in service
- Average fill pressure = 6 bar (abs)
- Average Density = 40 g / l or 40 kg / m³
- Average Volume Gas Zone = 700 l

Conclusion

- Mass per Zone = 40 kg/m³ x 0,7 m³
- Mass per Zone = 28 kg/Gas zone
- Bank SF₆ = Zones x Mass
- Bank SF₆ = 2,0 Mio. Zones x 28 kg/ Gas zone
- Bank SF₆ = 56.000.000 metric kg
- Bank SF₆ = 56.000 metric tones

Bank SF₆ = 56.000 metric tones equal to 1.276.800.000 metric tones CO₂ eq.

Source: Sold Instrumentation WIKA & Market Information
Global annual consumption of SF₆

**Estimated SF₆ mass in the equipment**
- Bank SF₆ = 58.000 metric tones
- Bank SF₆ = 1.322.400.000 metric tones CO₂ eq.

**Some simple figures**
- 10 % of Bank SF₆ = 132.240.000 metric tones CO₂ eq.
- 2,5 % of Bank SF₆ = 33.060.000 metric tones CO₂ eq.
- 1 % of Bank SF₆ = 13.224.000 metric tones CO₂ eq.
- 0,5 % of Bank SF₆ = 6.612.000 metric tones CO₂ eq.

**Conclusion**
- Proactive leak detection reduces the contribution to CO₂ Emissions even more
- More precise methods for leak detection allow emission reductions

Source: Update on global SF₆ emission trends from electrical equipment – Edition 1.1, 01.07.2010, Ecofys GmbH Germany
Global Concentrations of SF₆

Global SF₆ Concentration

CAGR % .... Compound average growth rate

Source: Sulfur hexafluoride data from the NOAA/ESRL halocarbons in situ program.
Sulfur hexafluoride (SF6) hemispheric and global monthly means from the NOAA/ESRL.
Recent data (less than 1.5 years) are considered preliminary.
Average Values are calculated based on the global monthly means.
John F. Kennedy: We chose to go to the moon ....

SF₆ Emission Pyramid

Proactive

Advanced Embedded Sensor Technology

0.5%

0.8% to 2.3%

Electronic Instruments

Reactive

0.8% to 2.5%

Mechanical Instruments
Why going online?

Benefits of SF₆ online monitoring as part of a proactive strategy

- **Predictive Maintenance**
  - Keep equipment in safe condition
  - Proactive maintenance strategies vs. reactive strategies from online monitoring ensure that switchgear is in safe condition
  - Detect issues during warranty period and get them fixed
  - Prepare Pareto profiles of top leakers to optimize maintenance strategies and avoid any potential issues of non-switching

- **Simplified emission reporting**
  - Accurately capture SF₆ gas usage across entire gas tank fleet online and in near real time providing fully auditable system
  - Avoidance of human error or poor calibration of weighing equipment as part of the reporting process
  - Improve ecological and environmental standing
  - Know precisely how much gas is needed to fill any given tank (no over fill or under fill)

- **Multiple parameter sensors are essential for a proactive CBM strategy**
  - Transmitters with integrated pressure, temperature & moisture sensors minimize overall costs for the monitoring
  - Digital Communication safes costs for wiring significantly
Result of world wide VoC (Voice of the Customer)

Why advanced sensor technology?

- **Humidity (One Embedded Sensor)**
  - Root Cause (Humidity / Oxygen / Energy)
  - Dielectric Strength influenced dramatically
  - Acidic Atmosphere ($SO_2$, $HF$, $SOF_4$, …)

- **Pressure (One Embedded Sensor)**
  - High Precision Sensor 0,06 % FSD
  - High Sampling Rate allow identification tanks effected by PD events
  - Basis of the density calculations

- **Temperature (Three Embedded Sensors)**
  - 2 Temperature sensors exposed to the gas
  - 1 Temperature sensor close to ambient
  - Thermal Image (Thermodynamics)

- **Density (calculated; Density = F (p,t))**
  - Operational Safety
  - Early / Proactive Leak Detection
John F. Kennedy: We choose the moon …. 

Proactive Emission Monitoring

- Combined Gas Density-Humidity Transmitter, digital, MODBUS, (Option: DNP 3.0) - RS485
- High Accuracy of the density signal 0,5 % of full scale over a wide temperature range
- Excellent Long-term Stability
- Early Leak Detection (Operational Safety)
- Leak Trending (Maintenance & Emission Reporting)
- Early Moisture Detection (Operational Safety)
Advanced Technology is the foundation for sound reporting

Nationwide Emission Reporting

- Precise Information
  - Density
  - Humidity
- Early Leak Detection
  - Reduces Emissions
  - Allow planned outages
- Software
  - Modular Concept
  - Software Platforms
- Reporting
  - Substation Level
  - Utility Level
  - Nationwide Level

Advanced embedded Sensor technology SOP (start of production) in spring 2013
Samples are currently tested in pilot substations worldwide
Advanced Technology is the foundation for sound reporting

Identify & Fix

- Precise Information
  - Density
  - Humidity

- Early Leak Detection
  - Reduces Emissions
  - Allow planned outages

- Software
  - Modular Concept
  - Software Platforms

- Reporting
  - Substation Level
  - Utility Level
  - Nation Wide Level

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Measure

- Precise Information
  - Density
  - Humidity

- Early Leak Detection
  - Reduces Emissions
  - Allow planned outages

- Software
  - Modular Concept
  - Software Platforms

- Reporting
  - Substation Level
  - Utility Level
  - Nation Wide Level

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Advanced Technology is the foundation for sound reporting

Control the corrective action

- Precise Information
  - Density
  - Humidity

- Early Leak Detection
  - Reduces Emissions
  - Allow planned outages

- Software
  - Modular Concept
  - Software Platforms

- Reporting
  - Substation Level
  - Utility Level
  - Nation Wide Level

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Advanced Technology is the foundation for sound reporting

Zero Emission Initiative

- **Precise Information**
  - Density
  - Humidity

- **Early Leak Detection**
  - Reduces Emissions
  - Allow planned outages

- **Software**
  - Modular Concept
  - Software Platforms

- **Reporting**
  - Substation Level
  - Utility Level
  - Nation Wide Level

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Zero Emission Initiative - USA

- Precise Information
  - Density
  - Humidity

- Early Leak Detection
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- Software
  - Modular Concept
  - Software Platforms

- Reporting
  - Substation Level
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Advanced embedded Sensors technology SOP (start of production) in spring 2013

Samples are currently tested in some pilot substations around the globe
Precise Information is mitigation potential!

Conclusion

- **Precise Information**
  - Density (early leak / emission reporting – Fix it now and not later)
  - Humidity (additional Information = asset protection)

- **Significantly improve the accuracy of the reporting**
  - In all levels of the reporting scheme

Example:

*(Based on Bank SF₆ = 1.276.000.000 metric tons CO₂ eq.; see page 4)*

Accuracy of the reporting is based on the instrumentation (gauges, leak detectors, transducers, scales, cameras)

A threshold of 10 % of the nominal density means: 132.240.000 metric tones CO₂ eq is emitted before you act.

2,5 % Accuracy allows reporting in a level of **±33.060.000** metric tones CO₂ eq.

0,5 % Accuracy allows reporting in a level of **±6.612.000** metric tones CO₂ eq.
Thats all - Thank you

Questions?