EPA Conference May 2014
Long Beach
Switch gear population

More than 500 utilities operate more than 460,000 substations’

Substations' are filled with more than 60,000 metric tons of SF$_6$
SF₆ concentration globally

CAGR % ….Compound average growth rate 4.3 % 2001 ... 2006 | 4.6 % 2006 ... 2013
F-Gas-Regulation 842/2006

16e. ‘leakage detection system’ means a calibrated mechanical, electrical or electronic device for detecting leakage of fluorinated greenhouse gases which, on detection, alerts the operator;

- **WIKI introduced a test port in 2009**
  - Test port simplifies calibration of monitoring equipment

- **F-Gas-Regulation 842/2006 14.04.2014**
  - Leak detection system for detection of F-gases
  - Effects all new switchgear put in service after 2017
**USED** SF₆ is contaminated

Permissible Exposure Limit’s (PEL, OSHA US)

8-hour time weighted average (TWA)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Symbol</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur dioxide</td>
<td>SO₂</td>
<td>2.00 ppm</td>
</tr>
<tr>
<td>Hydrofluoric acid</td>
<td>HF</td>
<td>3.00 ppm</td>
</tr>
<tr>
<td>Disulfur decafluoride</td>
<td>S₂F₁₀</td>
<td>0.01 ppm (Very Toxic)</td>
</tr>
</tbody>
</table>

**Occupational Safety & Health Administration**
Humidity causes disasters

- Demage of expensive assets
  - HV substation CAPEX in exceed of ~ 1,0 Mio. €

- Power Outages
  - Costs can pile up to many millions

- Toxic substances
  - Disulfur decafluoride
  - Sulfur dioxide
  - Hydrofluoric acid

Note: The higher the volume fraction of the water vapour the more de-composition product‘s you will find.
Analysis of gas quality

- Humidity
- Sulfure Dioxide
- Percentage of SF6
- Hydrofluoric Acid
- Disulfur decafluoride

GA11 – Gas Analyzer (Field)

FTIR - Laboratory
FTIR - Gas analysis used SF$_6$ (Switch gear)
Benefits of monitoring of SF$_6$

- Predictive Maintenance
- Simplified emission reporting
- Precise sensors are essential for sound information
WIKÄ’s online monitoring solution

- **3 Temperature sensors**
  - 1 sensor is exposed to the gas
  - 1 sensor @ pressure sensor
  - 1 sensor is close to ambient

- **Integrated pressure sensor**
  - Accuracy 0,06 % f.s.d.

- **Calculated density signal**

- **Integrated humidity sensor**

- **RS485**

- **MODBUS**

- **DNP3.0 upon request**
Density is the ratio of the mass & volume – no direct measurement!

\[ \rho \cdot V = n \cdot R \cdot T \]

Common Gas Equation, Note: SF6 is not an ideal gas

\[ V = \frac{m}{\rho} \]

\[ M = \frac{m}{n} \]

\[ p = \frac{R \cdot T}{M} \cdot \rho \]

Density is proportional to pressure

Term is constant
SF₆ Gas Excellence

Value of the digital products
SF₆ Gas Excellence

Value of the digital products

Nominal = 93.7 ppmₑ ≈ -23.0°C ($t_{\text{Frost}}$)

Average = 87.5 ppmₑ ≈ -23.7°C ($t_{\text{Frost}}$)

Last 24 hours of a period of 4 weeks

- GDHT-20
- Chilled mirror system
SF₆ Gas Excellence
Resolution & flat lines

- **Tank** = 12,000 litres
- **Initial density** = 30,086 g/l
- **Initial mass** = 361,032 Kg

About one month
SF₆ Gas Excellence

Improve visibility

About one month

- Tank = 12,000 litres
- Initial density = 30,086 g/l
- Initial mass = 361,032 Kg
- Mass emitted after one year = 27,594 kg

After 365 days 7.6% of the gas mass is lost

About one month
High resolution = fast information

SF₆ Gas Excellence

- Initial density: 30,086 g/l
- Initial mass: 361,032 Kg
- Density lost in one day: 0.0063 g/l
- Mass emitted in one day: 0.0756 kg
- Mass emitted after one year: 27,594 kg

- After 365 days 7.6% of the gas mass is lost

- Tank: 12,000 litres

3 Days Δ = 0.019 g/l
Comparison of methods

![Graph showing comparison of methods with temperature and accuracy]
Drivers for online Monitoring

- **Health & Safety**
  - De-composition products are toxic
  - Gas Handling & transportation of aged (used) gas requires gas analysis

- **Operational Safety**
  - Isolation level must be monitored (Density)
  - Precise sensors allow pro-active monitoring

- **Emission Control**
  - Traditional monitoring is reactive
  - Digital transmitters allow accurate pro-active maintenance based on the actual condition of the asset
  - Simplified emission reporting

- **Regulations**
  - EU requires a leak detection system – calibrated mechanical or electronic device of SF6 which alerts the operator
  - Online monitoring allows fully auditable reporting by third parties
See us @ .....

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