“Pictures” the Emissions of Storage Tanks with the Use of Infrared Cameras

The Sniffers nv, Belgium
Agenda

• Intro TS
• Possible techniques
• Examples and Case studies
• Lessons learned
• Q&A
Short review of The Sniffers

1. The Sniffers is a service company which has 2 main focus area’s:
   1. Emission - and energy loss reduction management
   2. Pipeline inspection and – management services
2. Founded in 1991
3. Real take off was in 2002 with 4 persons
4. Today we operate with between 110 and 140 employees, mainly field operators
5. Our focus market are Europe and Middle-East
6. Looking now to expand to Asia/(Latin-)America and EEU
7. Today we have project references in more than 20 countries
8. ISO 9001 and VCA** certified since 2003
9. In January we finalized our first Acquisition: Leak Consultancy, Dutch company
10. Today our shareholder structure is:
    1. 80% the Carlyle Group (US)
    2. 20% private
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Possible Techniques

1. On storage tanks, we can execute the following inspection services:
   1. Infrared screening and concentration determination
      1. Screening of the tanks with a portable infrared gas imaging camera
      2. All (bigger) emission sources are visualized by this camera
      3. All emission sources are reported and transferred to a maintenance report
   2. Thermographic Screening
      1. Screening of the tanks with a portable infrared thermo camera
      2. With this camera, we can image hot spots, corrosion failures, ....
Infrared screening

1. IR screening with infrared camera GF320 from FLIR and/or EyeCGAS from Opgal is an effective way to find the significant leakers on a cost-efficient way.

2. Concentration determination of all found leaks: The concentrations of all found leaks can be measured with a FID TVA1000B to quantify these leaks or with the High flow sampler technique.

3. The measured ppm values are converted to emission loss (kg/year) and these calculations are based on the EPA Correlation method 21 SOCMI factors or quantification through the HFS sampling method.
Thermography

1. Inspection done by level 2 Certified operator (highest level for thermograph inspections)
2. A thermographic study can be performed to investigate the state of the insulation
3. Temperature deviations between different connecting parts may indicate insulation defects.
4. A thermographic camera detects radiation in the infrared range of the electromagnetic spectrum.

FLIR T620 & T640

High performance thermal imaging with on-board 5MP visual camera, interchangeable lens options with autofocus, and large 4.3” touchscreen LCD.

These thermal cameras combine excellent ergonomics with superior image quality, providing the ultimate image clarity and accuracy plus extensive communication possibilities.

Highest IR Resolution in Its Class – Crisp thermal images with 307,200 pixels (640 x 480) for the best detection, pictures, and temperature measurements from long range.
5. The radiation intensity has been measured with a thermal camera. The radiation intensity depends mainly on the radiant power, emissivity of the screened object and the temperature. The amount of radiation emitted by an object increases with temperature.

6. Temperatures of objects can be measured from a distance, these parameters have to be corrected. The temperatures mentioned in this report have been corrected.

7. Deriving temperatures from the color scale is only possible for an indication of temperature.
Thermography

- Visible light: $0.4 \mu m < \lambda < 0.7 \mu m$
- Infrared radiation: $0.7 \mu m < \lambda < 1000 \mu m$
- Thermal infrared: $0.7 \mu m < \lambda < 14 \mu m$

IR-Cameras detect radiation in two bands:
- MW - Mid Wave: $2 - 5 \mu m$ [prev.: SW shortwave]
- LW - Long Wave: $8 - 12 \mu m$
Imaging applications in 5 - 8 µm range are not possible due to atmospheric absorption (H₂O and CO₂)
Possible extra Deliverables

### Repair Order

- **Site:** Skippers
- **Unit:** MOL
- **Section:** None
- **Drawing:** VWWT-006-P-203
- **Stream:** Acetan-6
- **Service:** Gas / vapour
- **Stream composition:** Acetan (dimethylisonon, prepanen-2)
- **Teatvity class:** Organic gases or vapours C0
- **Equipment name:** Relief Valve
- **Source name:** Relief Valve (outlet), Outlet
- **Source location:** Size 20 IN
- **Detection equipment:** HVM 600 RID, TDS
- **Calibration medium:** Methane (sandgas)
- **Calculation method:** Correlation Soem
- **Historical measurement data**

<table>
<thead>
<tr>
<th>Date</th>
<th>PRM</th>
<th>Loss log.</th>
<th>Operator</th>
<th>Source information</th>
<th>Repair Action</th>
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</thead>
<tbody>
<tr>
<td>01/02/2006</td>
<td>100</td>
<td>0.000</td>
<td>TM</td>
<td></td>
<td></td>
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<tr>
<td>10/07/2006</td>
<td>100</td>
<td>0.010</td>
<td>TM</td>
<td></td>
<td></td>
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<tr>
<td>10/08/2006</td>
<td>95</td>
<td>0.011</td>
<td>TM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Maintenance Information

- **Repair period:**
- **Repair action:**
- **Repair date:**
- **Repair cost:** 0.60
- **Repair executor:**
- **Gasket/Sealing:**
- **Repair frequency:** 0 (in days)
- **Pre-information days:**
- **Replace packing:**
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Infrared screening

3.2.3.1 Specifications: Tank FB-753

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>29/03/2013</td>
</tr>
<tr>
<td>Time</td>
<td>09h00u – 09h30</td>
</tr>
<tr>
<td>Product in tank</td>
<td>Ethylene (liquid)</td>
</tr>
<tr>
<td>Temperature of the tank</td>
<td>-100°C</td>
</tr>
<tr>
<td>Wind speed</td>
<td>3 m/s</td>
</tr>
<tr>
<td>Wind direction</td>
<td>North East</td>
</tr>
<tr>
<td>Cloudiness</td>
<td>Low</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>3°C</td>
</tr>
</tbody>
</table>

Figure 3-3: Scheme tank FB-753

* 2 emission locations were found at on the roof, at the breather valves
Infrared screening

1. Visual inspection
2. IR inspection
3. High resolution mode inspection
Some examples

Propane Tank (propane)

Leak invisible with the naked eye!!
Some examples

1. Propane Tank (propane)

But with an infrared leak camera …
Lessons learned: ex other movies
Thermography

Weather Conditions on 29/3/2013:

Temperature (outside)  4,5 °C
Wind  light breeze from north-eastern direction
Wind speed  2,3 m/s
Cloudiness  low - medium
Relative humidity  25%

Used devices:

- **Infrared camera**
  
  Equipment  Flir Systems
  Type  T-640, serial number 55901349
  Lens  29° and 45°
  Resolution  640 x 480
  Range  depending on the situation
  Calibration  55901349/2013

- **Temperature measurement**: The ambient temperature during the measurements is recorded by a data logger and processed in the evolution of the images.

  Equipment  ATAL
  Type  ATV-11
  Calibration Certificate  867375k63767

- **Anemometer**: The wind speed is determined at various locations by an anemometer

  Device  Extech
  Type  AN100 AAS
  Calibration Certificate  AF Company
Thermography

2.2.2 Screening Positions

Each tank has been screened from different positions.

2.2.2.1 Tank FB-753

Figure 2-1: Screening positions Tank FB-753
Thermography

Thermographic Screening

- Ice has been formed

Thermogram

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Distance</td>
<td>15.0 m</td>
</tr>
<tr>
<td>Atmospheric Temperature</td>
<td>4.5 °C</td>
</tr>
<tr>
<td>Emissivity</td>
<td>0.90</td>
</tr>
<tr>
<td>Reflected Temperature</td>
<td>-5.2 °C</td>
</tr>
<tr>
<td>Ar1 Average Temperature</td>
<td>-1.1 °C</td>
</tr>
<tr>
<td>Ar2 Average Temperature</td>
<td>-0.4 °C</td>
</tr>
<tr>
<td>ArS Average Temperature</td>
<td>9.0 °C</td>
</tr>
</tbody>
</table>

Analysis & Recommended action

- The average temperature of Ar1 en Ar2 is 10.0°C lower than the connected wall (Ar3). Ice is formed on the wall of the tank. Deviation

Recommendation: Follow up – Plan a new inspection
Thermography

Analysis & Recommended action

- The average temperature of Ar1 is ca. -0.9°C and the average temperature of Ar2 is ca. -2.1°C. It is recommended to follow up these locations and to plan a new inspection. Deviation
Other Case study ex.

- TANK LEVEL MEASUREMENT
Other Case study ex.

- example Corrosion under insulation
Other Case study ex.

- CONDITION MONITORING CAT CRACKERS
- INSPECTIONS EVERY MONTH
Other Case study ex.

- CONDITION MONITORING FURNACE
- INSPECTIONS EVERY MONTH
Other Case study ex.

- Example: Insulation forgotten after maintenance
Other Case study ex.

- CONDITION MONITORING FURNACE
- INSPECTIONS EVERY MONTH
Other Case study ex.

- ‘BEFORE’ AND ‘AFTER’ INSPECTION OF INSULATING COMPOUND APPLICATION
Other Case study ex.

- Example electrical inspection
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Lessons Learned

1. Infrared Imaging:
   1. “fast” screening (SMART LDAR) is relative
   2. Experiences and certifications are very important due to:
      1. Screening during Loading and/or in normal operation
      2. Wind
      3. Sun
      4. Level of Volume in the storage tank
   3. Ideal tool for preventive maintenance and priority setting
   4. Good tool for the storage tanks there we don’t need to access the roof and screen from distance
Lessons Learned

1. Emission detection by infrared gas imaging:
   1. Ideal tool to analyse efficiency of breather valves and storage tanks
   2. More realistic calculations can be realized with High flow sampler technology
      1. The high flow sampler device is a portable, intrinsically safe device which is doing measurements based on a flow rate – concentration combination and therefore is the only technique able to calculate actual emission losses coming from a leaking equipment.
Lessons Learned: legislation on gas imaging on storage tanks

1. The Netherlands and Belgium:
   1. Previous years, tests are being done with Optical IR gas camera’s, DIAL and SOF
   2. In the Netherlands: several storage tanks camera’s are since 2 years now obligate to screen the storage tanks with Infrared gas imaging camera.
   3. In Belgium: government is now reviewing the different techniques for storage tank inspection on emissions together with Fedicchem and Sniffers
Lessons Learned

2. Thermography:
   1. Experiences and certifications are very important due to:
      1. Influences reflections
      2. Wind
      3. Sun
   2. Ideal tool for preventive maintenance and priority setting
   3. The more measurements, the better the historical data will support your maintenance program
Leasons learned

IMPORTANT FACTORS

- Surface emissivity
- Type of material
- Surface texture (roughness)
- Angel of measurement
- Radiation wavelenght
- Background radiation
- Determined by radiant heat from objects in the environment
- Material temperature
KEY BENEFITS

- No-touch diagnostics
- Enables measurements on hot, moving, electrically charged, and remote objects
- Real-time, thus fast. Up to 50 frames/sec
- Results presented in two-dimensional view
- Enhanced interpretations based on comparison with surrounding surface areas
- Accurate within +/- 1 °C
- Thermal sensitivity < 0.04 °C
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Q & A

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Thank you

Let’s optimize your tank management program together