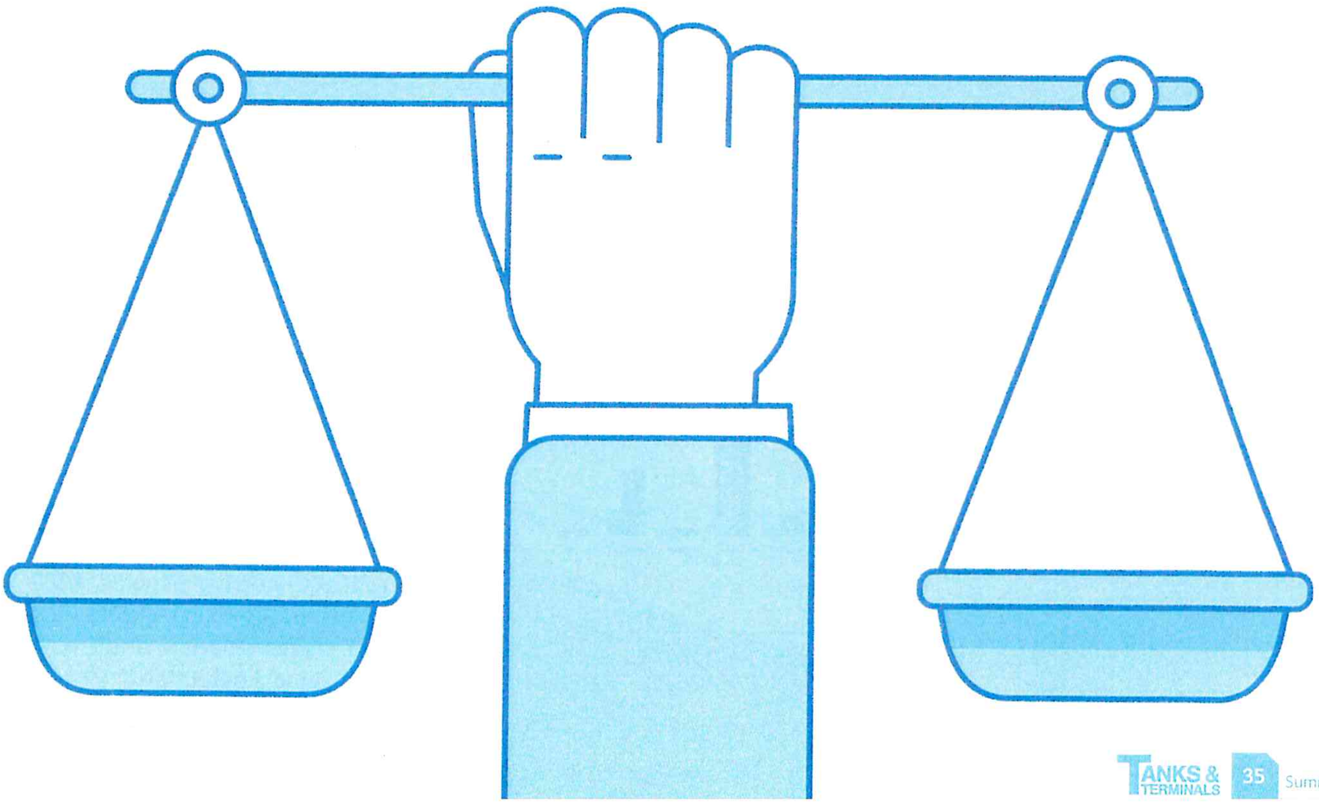
FINDING THE RIGHT BALANCE

Bart Wauterickx and Bas Hermans, The Sniffers, Belgium, explain how a combination of measurement techniques can help ensure a complete leak detection survey.

In an environment of increased storage capacity, ageing assets, and increasing safety and environmental regulations, tank farm operators are confronted with several challenges. Adequate emissions measurements are essential for managing storage tanks. Tank farm owners want to benefit from excellent incident figures, high asset availability, and low insurance fees.

Storage tanks hold hydrocarbon product for brief periods of time in order to stabilise flow between production and pipeline, trucking or shipping distribution. During storage, loading and unloading, and daily or seasonal temperature changes, light hydrocarbons vaporise. These light hydrocarbons include methane and other volatile organic compounds (VOCs) and hazardous air pollutants (HAPs), such as benzene, toluene and xylene. These gas vapours collect in the space between the liquid and the fixed roof of the tank. When loading storage tanks, these gases are often vented to the atmosphere or flared.

Similar to the challenges detected at refineries or other production installations, all gaskets, connections, valves, pumps, etc., that are found around and on a tank are also susceptible to fugitive emissions.



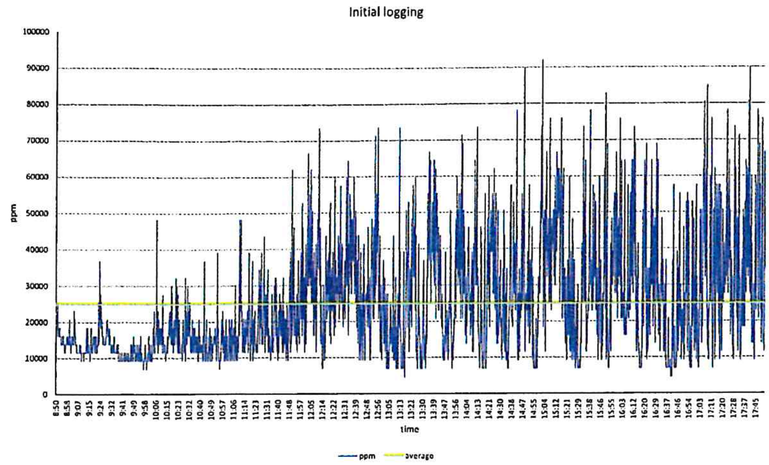


Figure 1. Initial logging of the breather valve – 2870 kg/yr emissions.

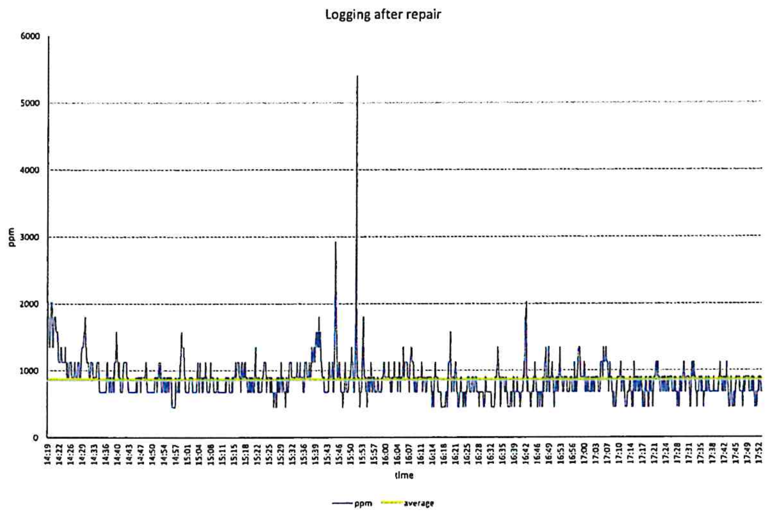


Figure 2. Logging after repair of the breather valve – 267 kg/yr emissions.

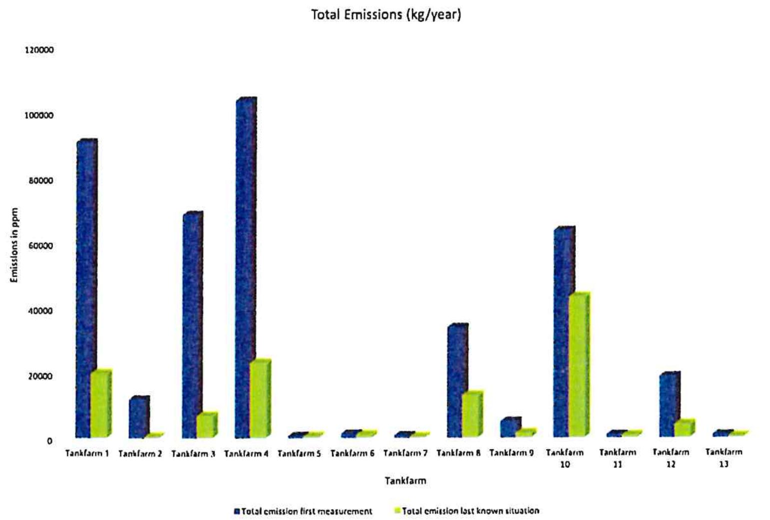


Figure 3. Benchmark of emissions on tank farms worldwide.

Seals and gaskets age and are subject to both external and internal circumstances, such as temperature or pressure variations and mechanical movements. Typical storage tank components that have to be included in a thorough survey are floating roof seals, rim seals, overflow drains, vacuum breakers, access/inspection hatches, guide poles, gauge floats, pontoons and vents.

VOCs emitted to the atmosphere react with the NO_X, forming an O_3 ozone and particulate matter. Due to the negative impact on air quality, VOC emissions have to be prevented.

HAPs are often regulated by local or national authorities. In several cases, companies set the emission levels from their storage tanks lower than legal requirements in order to be consistent with their ambition to be a reliable, sustainable company that minimises emissions using the best available technology.

A proper leak detection survey combines different measuring techniques in order to identify and quantify the leaks. Techniques include:

- Photo ionisation detectors (PIDs) or flame ionisation detectors (FIDs): these are well-known measurement instruments for leak detection and repair (LDAR) surveys in oil and gas, chemical, and petrochemical companies. They conduct measurements according to the EPA Method 21 protocol – the global standard in emission legislation for managing or reducing fugitive VOC emissions from industrial installations.
- Optical gas imaging (OGI) with an infrared camera: this camera technique allows companies to visualise the emission of VOCs from a source.
- High flow sampling (HFS): this technique is used to quantify a detected leak based on a flow rate and concentration measurement.

An OGI camera inspection involves a quick scan of the storage tank. This immediately shows the leaks, allowing a maintenance department to start planning repair activities. The advantages of an OGI screening can be important for the customer. The survey is fast and, therefore, more economical than an LDAR survey with PID/FID. In addition, OGI can tackle large leaks – the highest emitters and the highest risks – in an installation. However, one should be aware of the constraints of camera detection.

Measurements with PID/FID according to EPA M21 are often superior in quality and accuracy than the OGI camera. The influence of weather conditions (such as wind, rain and temperature), the relative position of the inspector (impacted by the sun's reflection and background contrast, etc.), and the qualification of the inspector, make a large difference in the quality of the detections. Even with experienced and certified technical operators, the detection limits of OGI vs PID/FID measurements are not on par.

Balancing techniques

A recent study involving a shadow measurement of 11 000 sources (both PID/FID and OGI measured), demonstrated the lower detection level for OGI. Where PID/FID detected 7.7% of the sources leaking above 9 ppm (the lowest detection limit), only 1.2% of the sources were leaking according to OGI. Only one out of seven leaks was found using the OGI camera. Similarly, where the PID/FID measurement detected 4.5% of the 11 000 sources leaking above repair definition (500 ppm, 1000 ppm or 5000 ppm, depending on the nature of the source), only 1.2% of the sources were detected with OGI. The OGI camera was unable to identify 225 leaks above repair definition. Of the 167 pegged leaks (above 100 000 ppm) detected with PID/FID, only 119 leaks (70%) were found with OGI. Thus, even larger leaks were not detected with OGI. On the other hand, 24 leaks (out of 869) were detected with OGI that were not with PID/FID because the sources were inaccessible, insulated and on iced equipment.

Hence, the best practice is to employ the PID/FID measurement whenever possible and engage OGI where PIF/FID cannot be used. This combination ensures a correct and complete leak detection survey.

Compliance

For tank inspection, the NTA 8399 guidelines for detection of diffused VOC emissions with OGI is a reference document for some legislation. Conforming to NTA 8399, tanks need to be checked by means of an infrared camera annually or biannually, depending on the stored product. Following an inspection, a detailed report with emissions findings, including images and video material, is presented. Repairing leaks must be completed directly after the inspection. If leaks cannot be repaired within a certain timeframe, the reason for this delay should be stated in a detailed repair plan.

Recent developments

A recent development is the explosion-safe camera. Screening for leaks with electronic equipment, like a

Figure 4. Datalogging on a fixed roof tank breather valve.

Figure 5. Infrared camera screening.

camera, in a hazardous environment requires a proper understanding of explosion risk. Explosion-safe cameras are designed to work fully in Zone 2 Class I, Division II areas and are, therefore, suitable for use where there is a risk of gas collection and ignition with a stray spark or hot surface.

Moreover, key measurement equipment suppliers are developing a device that can automatically quantify leaks based on the images taken with the camera – so-called quantified OGI (QOGI). The Sniffers is actively following this evolution and participates in different test setups and comparison scenarios. This is a promising development that requires a better understanding of the niche applications where it can add value.

A storage tank can be a dynamic installation with moving components. A floating roof, with or without rooftop coverage, has a different emission pattern in an empty tank compared to a filled tank or during the loading and unloading process. Therefore, emissions from the storage tank can vary with the dynamics of the process. An example is floating roof sealing as this can be 100% tight at one height but leaking at other heights. Continuous logging of some critical seal zones is the correct practice to measure the real exhaust from the roof seal.

A recent case study of a breather valve on a benzene storage tank has illustrated the sometimes unexpectedly high emissions. A logging of the breather valve demonstrated the faulty valve was causing emissions of 2.91 kg/yr of benzene. After fine-tuning the pressure settings, benzene emissions were reduced to 0.26 kg/yr.

What results can be expected?

On average, an emission reduction of 75% is within reach, and sometimes an even higher reduction of up to 90% is achievable. A dedicated benchmark study with 13 tank farms was conducted. These tank farms had between 3000 and 35 000 potential leaking sources. The number of leaks identified and quantified varied between 10 and 1200 for the bigger farms.

Of the 13 surveyed farms, 40% had unacceptable emissions. In fact, emissions as high as 100 000 kg/yr were detected. The tank emission measuring campaign was executed as a combination of PID/FID measurements and OGI infrared camera screening, followed by a quantification of every OGI visualised leak with the high flaw sampling technique. This approach made it possible to sort the identified leaks from high to low and, consequently, focus the maintenance efforts on the largest leaking sources first.

A thoroughly-developed software package, such as The Sniffers' SFEMP tool, makes it possible to manage all of this emission data and provide the customer with the data, analysis capabilities and report generation needed to significantly reduce these emissions. This technology helps to ensure proper condition-based maintenance and allows for easy selection of HAPs to analyse the leaking sources to create a safe operating condition. Official emission reports and meaningful maintenance repair orders for fast maintenance actions can be created. The tool also helps companies to prioritise capabilities to limit maintenance costs and efforts for maximum emission reduction effects. The tool can also help stimulate a culture of continuous improvement by reviewing historical performances per source or per source type to introduce best maintenance practices.

Conclusion

An effective tank emission reduction is a programme, not a project. All installations age, and a small leak almost never spontaneously stops leaking. Therefore, an annual, focused survey is required to continuously address leaks with immediate repairs and introduce enhanced practices in specifications, purchase tactics, installation methods and maintenance interventions. As inspections drive cost in a condition-based maintenance environment, a customer should rely on a certified or accredited service provider. This provides customers with peace of mind when receiving emission data, analyses, findings and recommendations.