

GETTING THE MEASURE

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The Sniffers, Belgium, highlight the
importance of flaring and vapour recovery
measurements for tank farm operators.

In an environment of increased storage capacity, ageing assets and increasing safety and environmental regulations, tank farm operators are confronted with several challenges. Adequate emission measurement and vapour recovery unit (VRU) effectivity measurements are essential to the management of storage tanks, and allow a tank farm to benefit from good brand reputation, excellent incident figures, high asset availability and low insurance fees.

The Sniffers, headquartered in Belgium, was founded in 1991 and operates its core business within oil and gas plants, and the chemical and petrochemical industry. The company assists operators with measuring emissions to the atmosphere, detecting and quantifying energy leaks, and maintaining the integrity of pipeline networks. This support and advice helps operators to reduce emissions, save energy and prolong the lifetime of critical assets

Storage tanks are used to hold product for brief periods of time in order to stabilise flow between production and pipeline, and distribution through trucking or shipping. During storage loading and unloading, and during daily or seasonal temperature changes, light hydrocarbons vapourise, including methane and other

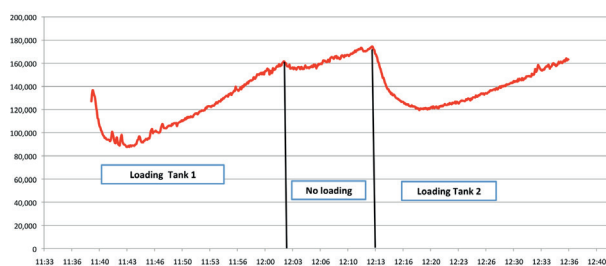


Figure 1. PPM value from exhaust VRU during loading of tank.

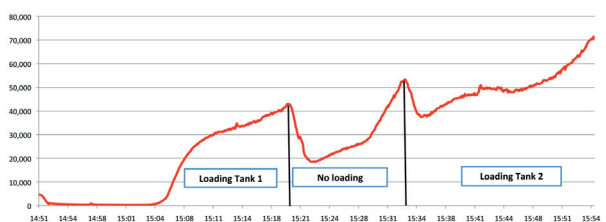


Figure 2. PPM value from exhaust VRU during loading of tank with new carbon filters.

Table 1. Example one of payback flare loss reduction programme

Source	Number of sources	Number of leaks		Loss (kg/y)	
		Before SD	After SD	Before SD	After SD
Safety valve	7	2	2	16 488	9686
Gate valve	10	2	2	3379	3524
Control valve	2	4	3	231 951	56 863
Brake plate	1	0	0	0	0
Total	20	8	7	251 818	70 073

Table 2. Example two of payback flare loss reduction programme

Valve type	Number of sources	Number of leakers	Leak rate (%)	Emission loss (kg/y)
Control valve	14	1	7.14	1.982
Hand valve	41	0	0	0
Relief valve	34	8	23.53	17.182
Total	89	9	10.11	19.164

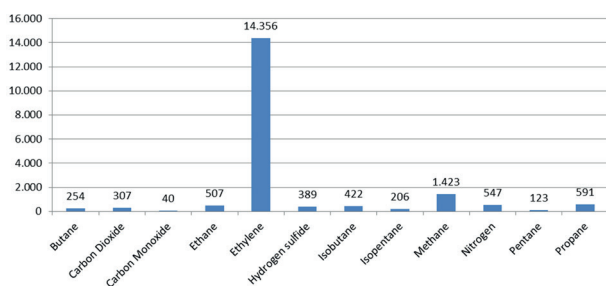


Figure 3. Emissions per chemical product (kg/y).

volatile organic compounds (VOCs), hazardous air pollutants (HAPs), such as benzene, toluene and xylene (BTX), and many others. These gas vapours collect in the space between the liquid and the fixed roof of the tank. During loading of the storage tank, these gases are often vented to the atmosphere or flared. One way to prevent the emission of these light hydrocarbon vapours, and yield significant economic savings, is to install VRUs on storage tanks. VRUs are relatively simple systems that can capture approximately 95% of the vapours for return of the valuable gases to the production process, or to remove environmentally hazardous gases.

The installation of VRUs has generated significant savings through recovering and marketing the valuable vapours, while at the same time substantially reducing VOC and HAP emissions. When the volume of vapours is sufficient, installing a VRU on one or multiple storage tanks can result in a payback of around three months.

Environmentally unfriendly gases can be captured using VRUs. Methane is a greenhouse gas with a much higher capacity to absorb heat compared to carbon dioxide, and hence an underestimated and significant global warming potential. VRU capture of methane prevents release into the atmosphere.

VOCs emitted to the atmosphere react with the NO_x present and form O_3 ozone and particulate matter (PM). Due to the negative impact on breathing air quality, VOC emissions must be prevented. HAPs, such as BTX and many others, are often regulated by local or regional authorities. Effective VRUs can capture these carcinogenic vapours.

Effectivity of a VRU

Given the important financial and environmental objectives of a sufficient working VRU, regular monitoring of its performance is inevitable. Sampling of emissions at the end exhaust reveals the performance of the total system.

The following case study concerns a storage tank containing a carcinogenic product. The end exhaust of the recovery was equipped with active carbon filters, and the residual vapours were vented to the atmosphere. Company employees and neighbours began to complain about an offensive smell, so a thorough investigation became necessary. Outstanding legislation requirements, permit thresholds and social responsibility objectives were in doubt.

Using continuous flame ionisation detector (FID) measurement, the concentration of the exhaust vapours was logged during different tank operating conditions. A specific test was prepared to visualise the effectiveness of the VRU unit.

The graph in Figure 1 shows the increasing concentration of the carcinogenic vapour during loading, reaching a level above 10%. This concentration remained high during 'no loading', therefore it was suspected that the carbon filters were saturated.

For this reason, a second test was executed with an improved carbon filter configuration (Figure 2). During the first 15 minutes, the parts per million (ppm) value of the

carcinogenic vapour was almost zero. However, following that initial 15 minutes, the ppm level increased again, and after 1 hour a value of 7% was reached.

Urgent action was required as the saturation level was reached very quickly. It became obvious that the design dimensions of the existing VRU were inadequate for the current gas vapour generating conditions in the storage tank. A new VRU with a larger capacity and larger active carbon filter was required to ensure the safety of the workers in the plant. The continuous logging of exhaust emissions during several different operating conditions of the storage tank can ensure the correct operation of the VRU.

Flaring on storage tanks

Pressure relief valves, ball and gate valves, control valves and other external equipment are part of a complete storage tank installation. These components are ideally closed in normal conditions, but in reality this is not the case. Internal leaks in this type of equipment occur, and this uncontrolled product loss is routed to the flare to be burned. Local legislation can mandate a VRU or a combustion unit to completely burn off these losses; however, in reality, due to safety reasons, flaring will still go on as a backup.

Factors such as the visible flame at the flare stack, the losses of raw materials, unreliable stream balances and the environmental consequences have created an important awareness. Companies should monitor and manage their flare losses; in the absence of a flare loss monitoring and reduction programme, these losses are the single most significant cause of raw material losses resulting from plant activities. The total number of flare-connected pieces of equipment, and thus possible leaking sources, is typically less than 1% of the total number of fugitive emission sources. Nevertheless, even when only a few leaks are found, this will result in a significant payback opportunity.

Within a storage tank at a European refinery producing light end products, such as liquefied petroleum gas (LPG), ethylene, propane, methane and hydrogen, around 20 components were found to be suspicious. All of the tank equipment should close completely in normal conditions. A monitoring programme using ultrasonic leak detection measuring equipment was executed to identify and quantify the product losses. The sound intensity (dB) measured on the suspected equipment, the density of the product and the pressure difference over the valve are parameters to calculate the product loss.

Of the 20 sources measured, eight were identified as leaking, with a total loss of 251 t of product every year. After shutdown (SD) a reduction of more than 70% was achieved by repairing only one control valve, and reducing the leakage of one of the safety valves (Table 1).

Measuring the storage tank equipment identifies the leaking components, quantifies the amount of lost product per component in both kilograms and value, and enables companies to prioritise maintenance activities. Adding the cost of repair to the total project cost, a



Figure 4. Active carbon filtration.



Figure 5. Exhaust to atmosphere.

company could expect a payback time of three to six months for a flare loss reduction programme. In this case – only repairing one piece of equipment and replacing another – a cost saving of more than US\$200 000 was achieved.

Another example of a flare loss reduction programme concerns a large petrochemical site with a tank farm (Table 2). Only 89 potential leaking components were identified after examining the equipment for a full tank farm, which is relatively simple to manage. After identifying nine leaks on the total of 89 using ultrasonic leak detection (a 10% leak rate), quantification revealed a loss of 20 tpy of product. Eight relief or safety valves were detected as leaking, and could be repaired through maintenance work. The measuring programme makes it possible to limit the maintenance efforts on safety valves, instead of testing all of the safety valves. In normal circumstances, all the valves had to be dismantled and installed on a test bench for a full functional test. The time and cost reduction realised due to condition-based information for these valves was extremely valuable for the maintenance team and accelerated turnaround activities.



Figure 6. Ultrasound measurement of internal leakage safety valve.

A proper flare loss reduction programme also reports on the individual chemical products routed to the flare and burned into the atmosphere. In the graph shown in Figure 3, the main contributor to the losses is ethylene. Even in situations with losses of mixtures, state-of-the-art software calculates the loss per chemical product. This enables easy environmental reporting and financial loss and benefit calculations.

Conclusion

Over the past few years, emission reduction programmes in refineries, crackers and chemical plants have been mandated by local authorities. This resulted in significant reductions from the industry, contributing to the 50% fall in non-methane VOCs over the past 13 years in the EU-28. A strong improvement in air ozone levels was a clear and direct effect of this legislative work.

More regulations have now been issued to manage emissions from tank farms, as their release to the atmosphere must be minimised. The Sniffers is able to measure direct emissions to the environment using PID/FID equipment or optical gas imaging devices, as well as internal leaks using ultrasonic or thermographic measuring equipment. Services such as this help operators to manage all possible leaks on tanks with both fixed or floating roofs. Eventually, the minimisation and prevention of leaks can allow tank managers to achieve a low environmental impact, low energy consumption figures, a good brand reputation, excellent incident figures and high asset availability. 