MANAGING VAPOUR RECOVERY SYSTEMS WELL

Jeff Robson from Flotech, an Adler and Allan company, looks at the options

CONTROLLING volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution through vapour recovery systems, such as those employing carbon adsorption, was cemented into legislation in 1996. As most units are now 16–25 years old, owners are likely to be looking to upgrade or decommission them. However, with the need to diversify energy infrastructure in the race to net-zero, it can be difficult to justify the cost of managing ageing hydrocarbon infrastructure.

LEGISLATION

It was estimated that in 1988 the evaporation of hydrocarbon vapour during the transportation of petrol from refineries to service stations resulted in 128,000 tonnes of VOC emissions in the UK alone. As a result of this, EU Directive 94/63/EC, and under the BAT conclusions for the refining of mineral oil and gas under Directive 2010/75/EU, controls were placed on VOC emissions resulting from the storage of petrol and its distribution from terminals to filling stations. The guidelines have been revised to incorporate good practice learnt during the implementation of EU Directive 94/63/EC, both in the UK, and elsewhere in Europe.

HOW VAPOUR RECOVERY UNITS WORK

A basic carbon adsorption vapour recovery unit (VRU) system comprises a pressure swing adsorption process with two activated carbon bed vessels, alternating on a 15-minute time cycle.

Adsorption, is the process where the hydrocarbons in the air form a weak bond and form a liquid on the surface of the activated carbon, allowing the air to pass through the bed to atmosphere. The bond formed becomes stronger the larger the molecule, so high carbon number hydrocarbons are more strongly adsorbed. Because the carbon has a very high surface area (in the region of 1250 m^2/g before pre-conditioning) it has a very high working capacity for the vapours, and because the gasoline is forming a liquid the energy is released in the form of heat. Hence the carbon temperature increases.

Regeneration of the carbon reactors is accomplished primarily by vessel evacuation with a vacuum pump to a pressure level of around 80 mBar (a) (approximately -0.92 Bar(g)). As the pressure falls, the hydrocarbons will begin to boil, taking the heat from the carbon, and be removed in the vapour stream through the pump. Not all hydrocarbons, particularly the small amount of heavier molecules (high carbon numbers), will be removed with vacuum alone, so a small amount of ambient air purge is admitted into the bed during the last 25% of the regeneration cycle. The changes in partial pressures, help to break the stronger adsorption bonds to fully clean the carbon.

The desorbed hydrocarbons are recovered by absorption in a packed absorber tower using a counter flow of gasoline absorbent pumped from the supply tank. This gasoline is also used as a heat exchange fluid for removing compression heat from the vacuum pump(s).

All product recovered by the system is pumped back to the absorbent supply tank mentioned. The enriched recovered liquid product is allowed to disperse throughout the supply tank environment.

DIFFERENT TYPES OF VRUS

There were a number of VRUs in use in the UK before the legislation came into effect, however, the first units installed to comply with the new legislation began to be built in 1996 and 1997, with further requirements by 2000 and then finally by 2004 for smaller terminals. By far the majority of installations in the UK are carbon adsorption units. The technology required is quite simple, but to meet the legislation, they had to be reliable, while operating for many motor running hours and valve operations per day. For example, a typical unit with a 15-minute cycle which is required to operate for 10 hours per day will have valves operating nearly 15,000 times a year.

After around 25 years of controlling VOC emissions resulting from the storage of petrol and its distribution a lot has been learned about maintaining and improving efficiency.

WHAT ARE THE RISKS?

In most cases there is very little redundancy of equipment, meaning any defect can potentially result in a loss of recovered product and failure to meet legislation. For owners and operators, this means they can be susceptible to potentially dangerous faults if not operated correctly. Also, as units become older, equipment becomes obsolete, and replacement parts are not always compatible. This is a particular issue for units built before ATEX.

Current regulations for emissions at 35 g/Nm^3, non-methane VOCs are currently easily achievable, and the UK has been policed fairly rigorously to achieve them. Legislation will only get tougher, and it is important to be ready to do what is needed.

Legislation does not give freedom to continue to operate in the event of breakdowns, so it is essential the availability of spares is continually monitored. Where equipment begins to become obsolete, then preparations and

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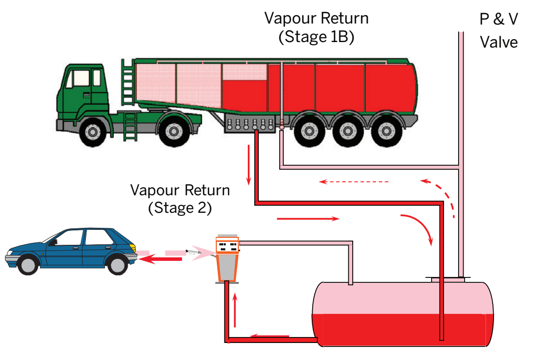

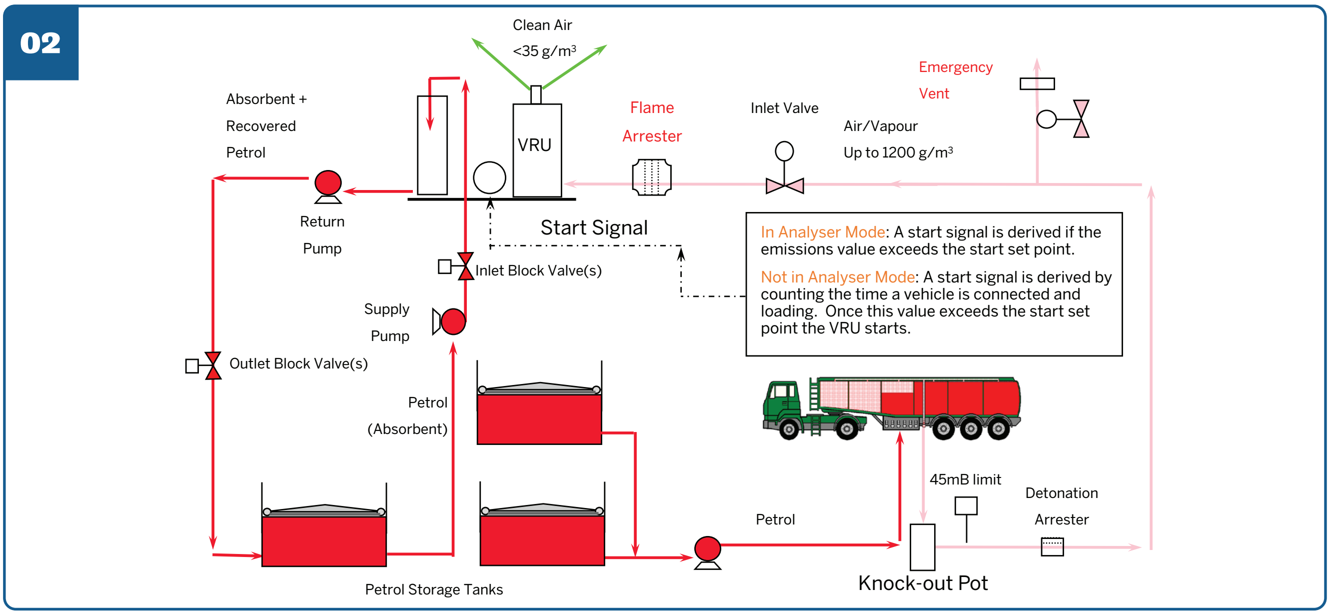

plans should be considered for methods of overcoming the changes.

WHAT THE GUIDELINES STATE

The Energy Institute (EI) Working Group for Vapour Recovery set out the 'Guidelines for the Design and Operation of Petrol Vapour Emission Controls at Distribution Terminals' and regularly update them. This document focusses on key points covering initial design of vapour containment systems and VRUs, as well as system maintenance techniques, safety considerations, and testing procedures.

The document is a good source of information, not just during initial design, but also when carrying out modifications or upgrading existing systems, to ensure all safety and legal aspects are reviewed and considered. It can also be a good reference when carrying out HazOp reviews.

MAINTAINING AN EFFICIENT VRU

VRUs are complex mechanical and electrical systems which operate in hazardous atmospheres and failure to service these units correctly can lead to financial inefficiencies, operational issues, safety complications and environmental emission problems.

The benefits of maintaining an efficient VRU are reduction in VOCs, improved safety through reduced risk of flammable atmosphere and reduced losses of valuable product vapour. They are also very economical to run. Testing in 2000 showed that the cost of recovering gasoline was in the region of £0.015/L (€0.017/L), and at current prices this is around £0.04 /L. Typical recovery rates over a year for an efficient VRU are in the region of 1.5 L per 1000 L of gasoline loaded (0.15% gasoline throughput).

Maintenance can take multiple forms from preventative maintenance, gas analyser and instrument calibration, system operation checks as per OEM data on site repairs and replacement and performance testing including compliance testing, UK customs tests and capacity testing, carbon replacement and programmable logic controller replacement and modifications.

UPGRADING THE CARBON

The working life of the carbon can expire after 10 years, although with good maintenance and operation, in excess of 20 years has been achieved. Replacement of carbon is an expensive operation, which also requires the VRU to be out of service for several days. The EI Working Group carried out some early research into suitable types of carbon and conditioning procedures, as well as looking at ways to test carbon for remaining operational life. Understanding the remaining lifespan of your carbon can help you to develop a strategy for migrating to new energy infrastructures, reinvesting the expense associated with carbon replacement with new technologies.

THE BIOFUEL CONUNDRUM

VRUs are associated with traditional hydrocarbon energy and will no longer be required when these fuels are no longer in use. However, there is consideration to be made with biofuel blends as we transition through greener fuel types, the process in the VRU will be required to be altered to account for varying biological elements in the fuel. Currently the existing VRUs are expected to be able to continue operations with up to E10 (10% ethanol) blends. E5 (5% ethanol) has been in use for some time with very little impact on the systems, and E10 is beginning to roll out. Older VRUs employing liquid ring vacuum pumps, with mono ethylene glycol seal systems, are expected to be the first concern when E15 (15% ethanol) comes in. Mainly this is to do with the ability of the seal fluid to separate from gasoline, but there are also more complex issues around vapour pressures above 10% ethanol as well.

Being prepared for these problems in advance will help make transitions much easier and smoother.

BALANCING THE RACE TO ZERO WITH MANAGING AN AGING INFRASTRUCTURE

There are a lot of uncertainties with the net-zero climate targets. But what we do know is the world won't change overnight. Businesses are trying to keep legacy infrastructure going to see them through to new technologies. VRUs for hydrocarbon fuel infrastructures are no exception. Flotech is a partner that can help maintain existing units safely and compliantly, while supporting the development of a strategy for transitioning to new technology with the least cost and operational impact for a company's unique decarbonisation journey.

For more information:

www.flotechps.com

01 Stage IB and Stage II recovery at service station

02 Stage IA at distribution terminal