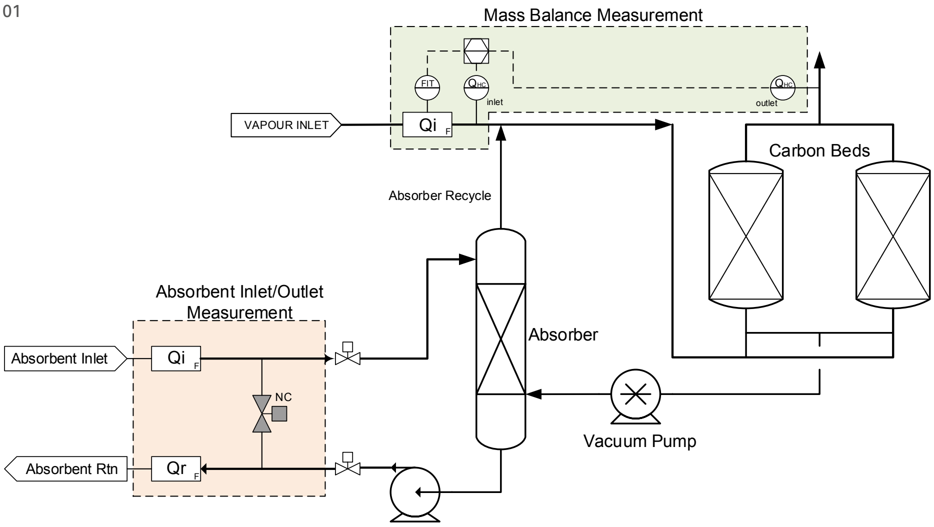
VAPOUR RECOVERY: REALISING YOUR RECOVERED PRODUCT

Vapour recovery systems are commonly used throughout the storage industry for products ranging from petroleum and aromatics to increasingly, crude oil. Common applications include the loading of road tankers, ships and tank breathing, with vapour flow capacities from 100m^3/hr – or lower – with rates of up to 1000m^3/hr to 5000m^3/hr becoming increasingly more common. Currently, the largest system is handling flows exceeding 30,000m^3/hr.

Activated carbon vapour recovery units largely remain the preferred technology and are often referred to as the best available technology (BAT) for many applications. These systems provide operators with maximum operational flexibility due to their ability to handle a variety of products with a wide turn down ratio capability, from 0% to 100% of the design flow and inlet concentrations.

Vapour combustion systems were commonly utilised and remain so in a number of applications, due to their low capital cost. However, there remains a push by legislators to require vapour recovery, the primary drive being the recovery and re-use of VOC's and a reduction in CO_2 emissions (a by-product of any combustion process). Naturally there is no recovery of the product with a vapour combustion system.

01



01 VRU Schematic showing two considered schemes for recovered product measurement

02 Recovered product error, based on the use of turbine meters

03 Recovered product error, based on the use of Coriolis meters

VAPOUR RECOVERY BENEFITS

Realisation of the product recovered by the vapour recovery unit is an important factor in understanding the operation and benefits of the system, although measurement of the recovered product is rarely requested. This may be a factor of the difficulties in determining accurate measurements.

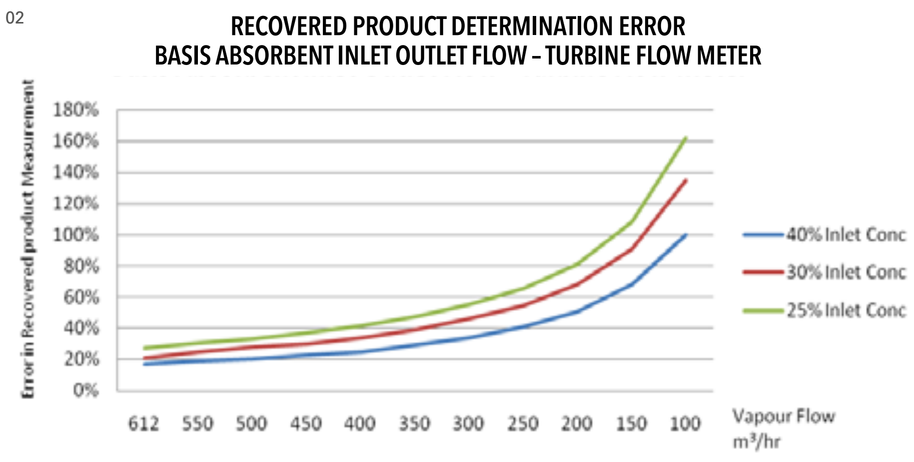
Two methods for determining the recovered product are generally considered, although with differing degrees of error in the determination.

i) Taking a mass balance approach across the carbon beds, and
ii) Measuring the difference between the absorbent inlet and outlet flows, considering the use of turbine meters, or alternatively, the more accurate Coriolis mass flow meters.

There are multiple parameters that can impact the accurate determination of the recovered product, including:

- The vapour flow rate,
- The hydrocarbon concentration,
- The molecular weight of the hydrocarbons in the inlet stream,
- The temperature of the vapour stream or the absorbent stream,
- The density of the absorbent,
- The repeatability of the meters being used,
- The accuracy of the meters being used.

02



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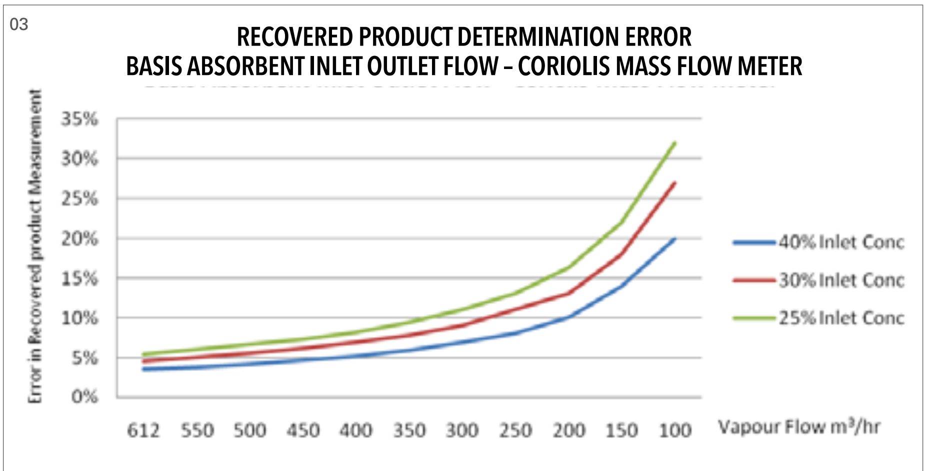

In the following examples, not every parameter has been considered, but those that would have the greatest impact have been taken into account such as the HC inlet concentration and vapour flow rate. The molecular weight, temperature variations, meter repeatability, and absorbent density are either constant or have a limited impact on the error in the calculation. This is a large step to assume and the actual error in the determination would most likely be a little wider than detailed here.

Considering varying vapour flow rates, 100m³/hr to 612m³/hr, for three different inlet hydrocarbon concentrations; 40%, 30% and 25% – the error in the measured recovered product values were determined.

- Using the mass balance approach across the carbon beds provided the most accurate measurement, as expected. The error was also quite constant across the varying parameters considered, at approximately 2.5%.
- Using the absorbent inlet/outlet flow measurement approach, two alternative measurement devices have been considered:

i) Turbine meters, fig 2
ii) Coriolis meters, fig 3

The resulting error in the measured volumes varied quite considerably with the vapour flow and hydrocarbon concentration.

As the inlet hydrocarbon concentration rises, the accuracy of the determination rises. The same effect is seen with flow. An increasing inlet vapour flow results in an increased accuracy. Both effects are explained by the increased hydrocarbon mass entering and recovered by the vapour recovery unit, resulting in a higher flow in the absorbent return line.

> "Reasonable accuracy in the determination of recovered product can be achieved"

For the turbine meter, where the accuracy of the meters is reported to be ±0.5%, the error in the determined recovered product ranged from ±17% to over ±100%.

For the Coriolis mass flow meters where the accuracies are reported to be ±0.1%, the error in the determined recovered product ranged from ±3.5% to ±32%.

The following charts provide the range of errors considering the vapour flow and inlet concentrations considered.

The mass balance approach taken across the vapour recovery unit is a considerably more accurate method of determining the product recovered. A means of measuring the vapour flow and inlet hydrocarbon concentration to the VRU is required. An ultrasonic flow meter can provide a high degree of accuracy and, in addition, a determination of the vapour molecular weight from which an estimate of the hydrocarbon concentration can be derived. However, ultrasonic flowmeters have the disadvantage of being a very costly type of instrument. The alternative would be to utilise a separate inlet hydrocarbon analyser.

Continuous Emissions Monitoring (CEMS) is common place for most vapour recovery unit systems. These analysers are used to determine the hydrocarbon concentration in the vent of the vapour recovery unit. Once the inlet vapour flow and the inlet and outlet concentrations are determined, the mass of the recovered hydrocarbon can be determined.

If measurement of the recovered product from the absorbent inlet/outlet flow remains a preferred method, the use of Coriolis meters offers better accuracy than turbine meters.

The cost of the two approaches and the equipment required for determining the mass balance across the VRU when compared with the cost of installing inlet and outlet Coriolis meters in the absorbent lines is similar, it makes sense to utilise the mass balance approach. Installing inlet vapour measurement also has the advantage that in addition to realisation of the recovered product it allows for ongoing continuous performance monitoring of the vapour recovery system. Emissions form the unit can be correlated against inlet flow and hydrocarbon concentration.

FOR MORE INFORMATION:

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