EXTERNAL PEER REVIEW OF THE TEST PROCEDURE FOR DETERMINING ANNUAL FLASH EMISSION RATE FROM CRUDE OIL, CONDENSATE, AND PRODUCED WATER TANK AND SEPARATOR SYSTEMS

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Overview.

The California Air Resources Board (ARB) staff have developed a test procedure whose intended purpose is to quantify emissions from crude oil, condensate and produced water separator and tank systems that are open to the atmosphere. Fluid phase behavior (existence and stability of liquid and vapor phases at equilibrium) is governed by fluid composition, pressure and temperature. As produced fluids move downstream to tanks or separators used to separate or store liquid hydrocarbon or produced water, it is possible that gas previously dissolved in the liquid phase may be released. If vented to the atmosphere, the released gas may contribute to overall greenhouse gas emissions.

The procedure for determining the volume and composition of the released gas is as follows:

1. A liquid sample (oil, liquid condensate, produced water) is collected upstream of the separator or tank where flashing may occur. These samples will be collected under pressure to replicate conditions in the flowlines leading to the separator.
2. The sampling methods include a double valve cylinder for crude oil/produced water samples or a cylinder with a pressurized piston for collecting lighter oils/condensate/produced water samples.
3. The collection of at least one duplicate sample is recommended and necessary in order to ensure repeatability of the test results.
4. The collected samples are then sent to a laboratory where the samples are re-heated to the sample collection temperature for 30 minutes. After the temperature is stabilized, the cylinder is opened to atmospheric conditions and all the released gas is collected, its volume measured at 60F and 14.696 psi and its composition measured.
5. The volume of oil/liquid condensate/produced water is also recorded at 60F and 14.696 psia.
6. The gas-oil/gas-water volume ratios from the previous two steps are then used to calculate net emission rates in Mass/Year of gas and methane.

Review:

My review addresses the overall readability of the test procedure as well as the three conclusions listed in Attachment 2 *'Description of Scientific Bases of the Test Procedure to be addressed by the Peer Reviewer'*. The conclusions listed below are sourced from Attachment 2 and the review immediately follows each conclusion.

Conclusion 1: The test procedure provides a sound approach for taking samples of oil, condensate, produced water upstream from the oil and gas separator and tank systems.

In general, the procedure documented using a double valve cylinder or a piston cylinder to acquire liquid samples is reasonable. There are a few technical comments that need addressing:

1. In Section 7.2, the list of data to be recorded on the sample cylinder identification tag is provided. Item (e) specifies 'percent water cut' defined in Section 3.14 as 'volume percentage of produced water to crude oil or condensate'. In the oil industry, the water cut is defined as the volume percentage of produced water to the total liquid flow rate (water plus oil or condensate). The inconsistency in definitions may lead to inconsistencies in reported data.
2. The sampling procedure described does not explicitly document an approach for collecting liquid samples when both oil (or liquid condensate) and water is being produced. If both oil and water are to be tested for gas emissions, in what ratio should they be collected and how? Ignoring one or the other liquid phase can either underestimate or overestimate gas emissions.
3. In Figure 1 and in Section 8.10, the valve D is opened to allow for a slow displacement rate of the non-reactive displacement liquid at a rate of 3 drips/second to prevent the collected liquid from flashing. Likewise in Figure 3 and Section 9.7, the liquid sample is collected at 150-200 ml/second. This procedure needs to be more quantitative. What should the downstream pressure be in relation to the upstream pressure (Gauge N versus Gauge M in Figure 3)? Should there be a downstream gauge in Figure 2 and Section 8.10 and what is an acceptable pressure

differential. For relatively high pressure sampling points, it may require the tester to determine the extent that valve D opens by trial-and-error and may lead to erroneous sample collection. If an acceptable range for the pressure differential is provided, this may become less subjective. However, a recommended pressure range may also require higher precision pressure gauges than those provided in Section 5.1 and 5.2. As an example, the procedure outlined in GPA 2174-93 is a more suitable and precise approach for sample collection.

4. In Section 8.16 and Section 9.13, the test procedure calls for the sample to be transported to the laboratory after ensuring that the valves are closed. Unless the valves are tested periodically, this is likely to lead to inaccuracies in the data reported. I recommend that each sample collection cylinder come with its own pressure gauge(s). The pressure values in the sample collection cylinder should be recorded immediately after sample collection and again, prior to testing in the lab at the sample collection temperature to ensure that no fluid has leaked. This will also ensure that when the sample is heated as specified in Section 10.3(a), the pressure in the sample chamber returns to the same value it was collected at.

Conclusion 2: The test procedure provides a sound approach for preparing and analyzing samples of oil/condensate and produced water from oil and gas production separator and tank systems for constituents and properties needed to estimate emissions from flashed gases from such separator and tank systems.

I do not have anything to add to this conclusion and find that the recommended procedures are sound.

Conclusion 3: The test procedure provides a sound approach for calculating the emissions of methane and various other pollutants from flashed gases from oil and gas production separator and tank systems.

The calculations outlined as a part of the test procedure are sound. The test procedure needs to however provide a more explicit approach for computing cumulative gas and methane emissions when the produced liquid comprises both oil/condensate and water phases. For instance in Section 11, the test procedure indicates that 'The same calculations are used for crude oil, condensate and produced water' should be modified to read 'The same calculations are used for crude oil, condensate and produced water and the cumulative mass of methane emissions is calculated as the summation of annual mass of methane from each source' or something analogous.

Other Comments:

Big Picture. Reviewers are not limited to addressing only the specific assumptions, conclusions and findings presented above and are also asked to contemplate the following questions.

(a) ***In reading the staff report and supporting documentation, are there any additional substantive scientific issues that were part of the scientific basis or conclusion of the proposed oil and gas regulation but not described above?***

In reading the 'Initial Statement of Reasons' (ISOR) prepared by California ARB, I note that the net methane emissions from oil and gas extraction process losses (Figure 1 in the ISOR) constitute less than 4% of the overall methane emissions in the State of California. Agriculture and landfills constitute close to 80% of the net methane emissions. I strongly support regulation of greenhouse gas emissions; however I feel that unless corresponding regulation is being proposed to address emissions from other significantly larger sources, the test procedure as a part of the proposed regulation of the oil and gas industry will have a very limited impact on reaching a 40% reduction in methane emissions by 2030.

(b) ***Taken as a whole, are the conclusions and scientific portions of the proposed oil and gas regulation based upon sound scientific knowledge, methods and practices.***

In general, the proposed test procedure is largely free of any scientific issues or oversights except as outlined above.

Quality of the figures/text

The readability of the test procedure and the quality of the figures/tables provided is good.