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Baker Hughes

October 2, 2023

Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
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Re: Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems (EPA–HQ–OAR–2023–0234; FRL–10246–01–OAR)

Introduction

Baker Hughes (NASDAQ: BKR) is pleased to offer our response to the United States Environmental Protection Agency (EPA) solicitation on August 1, 2023, regarding the proposed Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems Rule.[1]

Baker Hughes' Interest in these Proceedings

Baker Hughes is a leading energy technology company with a 100-year presence solving challenges in the oil and gas sector at a global scale. As a service company we do not have reporting obligations under 40 CFR Part 98 Subpart W. Rather, we offer a range of products and services to help our customers identify, monitor, and reduce methane and other emissions occurring during oil and gas exploration, production, and transmission. Solutions include monitoring of methane emissions, flare optimization and flare gas processing, zero and low-bleed valves to control fugitive emissions, and modular gas processing turbomachinery that can capture flare gas for use as a highly efficient power source. Our goal is to ensure that natural gas continues to play a valuable role in the clean energy transition by helping customers keep more natural gas in the pipeline and put less methane into the atmosphere.

[1] 88 Federal Register at 50282

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Introduction to flare.IQ

Baker Hughes flare.IQ technology helps to monitor, control, and reduce emissions associated with flaring. It can reduce methane slip, minimize costs, and improve transparency. flare.IQ is a full-stream flare solution based on a well-proven ultrasonic flare flow measurement technology. It covers everything from assisted flares associated with downstream petrochemical and refinery flare operations to unassisted flares associated with upstream operations.

The EPA is proposing to amend requirements that apply to the petroleum and natural gas systems source category of the Greenhouse Gas (GHG) Reporting Rule to ensure that reporting is based on empirical data, accurately reflects total methane emissions and waste emissions from applicable facilities and allows owners and operators of applicable facilities to submit empirical emissions data that appropriately demonstrate the extent to which a charge is owed. In these proceedings, <u>EPA can accelerate these goals by incentivizing operators to measure emissions data in real time. Further modifications to the rule are needed to account for the benefits of existing ultrasonic flow measurement technologies such as flare.IQ</u>.

Comments and Recommendations

The proposed rule discourages use of continuous monitoring of combustion efficiency. At proposed regulatory text 40 CFR 98.233(n)(4) EPA would establish three tiers of default flare combustion efficiency values based on the reporting entity's compliance with either §63.670 and §63.671 (Tier 1), or §60.5417b(d)(1)(viii) or §60.5417b(d)(1)(viii) (Tier 2). A default flare combustion efficiency (CE) value of 92% is proposed for cases where operators do not monitor the flare as specified in either of the previously referenced regulations (Tier 3).

The proposed rule does not consider circumstances where flare operators have installed flare combustion measurement or monitoring systems (CMMS) that provide accurate, continuous measurement of flare CE. Baker Hughes recommends that operators that have installed CMMS have the option to report flare efficiency measured by such systems in lieu of using default values to estimate CE. Further, EPA should clarify in the rule how continuous measurement of flare performance data should be reported (e.g., on a five-day moving average) and used.

An example of one such CMMS is Baker Hughes' flare.IQ solution which uses a parametric modeling method based on available CE measurement data and computational fluid dynamic data, analyzed by an artificial intelligence technique to generalize all the factors affecting CE of a flare system. These factors include crosswind speed and process conditions, such as flare flow rate, vent gas exit velocity (flare tip diameter), vent gas molecular weight, vent gas net heating

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value (NHV) or NHV in the combustion zone for assisted flares, gas composition (N2, H2 content) if available and assisted gas (steam or air) flow rate. These effects are generalized into a numerical model to calculate the CE. Destruction and removal efficiency (DRE) can then be derived from the calculated CE as they have shown to be in an approximate linear relationship.

Depending on the specific flare design of assisted media, three different CE models were developed for steam-assisted, air-assisted, and non-assisted (including pressure-assisted) flares. On a system level, one of the key features of this flare CE monitoring system is that it can be built around an ultrasonic flare flowmeter. Specifically, ultrasonic flare flowmeters are designed to measure flowrate based on ultrasound transit "time of flight" across the flow, where the flow and ultrasonic beam intercept at a fixed angle. Because sound wave travels faster along the flow and slower against the flow, the time difference between ultrasonic beam travel along the flow and against the flow is the transit time. Flare gas flowrate can be measured from the transit time.

In addition, from vent gas speed of sound, the average molecular weight (MW) can be derived using the virial equation of state. From the average MW, flare gas net heating value (NHV) can be determined providing concentrations of inert gases (noncombustible gases such as N2, CO2 etc.). With the measurement of flare gas flowrate, NHV and MW from ultrasound flowmeter, flare process key parameters affecting flare CE are available. With the addition of wind speed measurement, a complete flare CE monitoring system-including the flowmeter and an industrial computer loaded with the model can provide real-time measurement and continuous monitoring of flare CE and DRE.

The equations used to calculate CE and DRE should be clarified.

At proposed regulatory text 40 CFR 98.233(n)(5), the EPA calculation of annual CH_4 emissions from a flare stack in cubic feet at standard conditions (Es,CH4) is based on equation W-19:

$$E_{s,CH_4} = V_s * X_{CH_4} * \left[(1-\eta) * Z_L + Z_U \right] \qquad \text{(Eq. W-19)}$$

In the equation η designates flare CE, expressed as fraction of gas combusted by a burning flare.

However, in the scientific literature from the U.S. and internationally, CE and DRE have clear yet different definitions. η in the equation W-19, is equivalent to the DRE in the literature, see for example the Texas Commission on Environmental Quality publication "TCEQ 2010 Flare Study Final Report"[2] and "Detailed Expressions and Methodologies for Measuring Flare Combustion Efficiency,

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[2] "TCEQ 2010 Flare Study". Texas Commission on Environmental Quality PGA No. 582-8-862-45-FY09-04. August 1, 2011. Available at: https://downloads.regulations.gov/EPA-HQ-OAR-2012-0133-0047/attachment_32.pdf

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Species Emission Rates, and Associated Uncertainties".[3] This inconsistency will lead to confusion as those familiar with flares calculate emissions from DRE, not from CE. Essentially, what the EPA defines as CE in the rule is DRE in the literature. The definitions of CE and DRE in TCEQ 2010 report are more common and widely accepted.

Baker Hughes recommends that EPA clarify the definitions of these terms to avoid confusion and promote consistency. We recommend adopt the TCEQ definitions of CE and DRE:

Combustion Efficiency (CE) = $\left(\frac{CO_2(exhaust)}{CO_2(exhaust)+CO(exhaust)+\sum \text{hydrocarbons}(exhaust)}\right)\times 100$

Destruction and Removal Efficiency (DRE) = $\left(1-\frac{\text{propene}_{out}}{\text{propene}_{in}}\right)\times 100$

The regulations should allow the use of measured HHV when calculating N2O emissions. At proposed regulatory text 40 CFR 98.233(n)(8), EPA requires operators to calculate N_2O emissions from flare stacks using Equation W-40.[4] The text also provides operators three options for calculating higher heating values (HHV) to use in Equation W-40 calculations.[5]

We believe that operators should have the opportunity to measure flare gas HHV directly using, for example, continuous gas analyzers or by using a sound speed methodology from an ultrasonic flowmeter (see above). This latter method can provide reliable real-time measurement, is highly accurate (3 to 5 percent), can be implemented with minimum cost, and is easy to maintain.

As above, from vent gas SOS, the average MW can be derived using virial equation of state for an ideal gas. From the average MW, flare gas net/higher heating value can be determined providing concentrations of inert gases (noncombustible gases such as N_2, CO_2), see U.S. patent publication "Online Analyzers for Flare Gas Processing".[6] The method has very fast response time, typically with 6 seconds, and has been deployed in the field for flare gas MW and NHV/HHV measurement and for flare control.

[3] "Detailed Expressions and Methodologies for Measuring Flare Combustion Efficiency, Species Emission Rates, and Associated Uncertainties". Ind. Eng. Chem. Res. 2014, 53, 49, 19359–19369. 2014. Available at: https://pubs.acs.org/doi/10.1021/ie502914k
[4] 40 CFR 98.233(z)(3)(ii)(F)
[5] 40 CFR 98.233(n)(8)(i)-(iii)
[6] US Patent Pub . No .: US 2022/0107289 A1. April 7, 2022. Available at: https://patentimages.storage.googleapis.com/6b/46/97/d1524f32c62da7/US20220107289A1.pdf

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We recommend EPA include in the regulatory text the option for operators to use the above-mentioned measured HHV in Equation W-40 as an alternative to calculated values.

Conclusion

Baker Hughes appreciates the opportunity to add our comments on the proposed rule. We support the Administration's goal to move the industry towards emission reporting based on measured data rather than calculations using emission factors and estimates. We believe there is a wide range of technology commercially available today that operators can use to improve the accuracy of their reported emissions. The proposed rule should encourage uptake of this technology by ensuring operators can use measured data when it is available in lieu of calculated data. We look forward to the opportunity to meet with EPA to discuss the proposed rule and the state of technologies we believe can contribute value to emissions reporting.

Yours sincerely,

Matt Armstrong
VP, Global Government & Regulatory Affairs