December 4, 2023

Clean Air Task Force appreciates the opportunity to comment on EPA's November 2023 Memo, "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2022: Updates Under Consideration for Underground Natural Gas Storage Well Emission Events".

These comments are focused on responding to Question 2: feedback on the preliminary combustion efficiency value of 60 percent. It is appropriate to introduce a combustion efficiency in cases where there is evidence of combustion rather than simple venting. However, EPA has proposed to use 60 percent based on a lower end of the range presented in Maasakkers et al. 2022,[1] which, as we discuss below, is too high for emergency events and well blowouts with combustion.

First, 60 percent is not the true low end of combustion efficiencies in the literature. Maasakkers et al. assesses emissions from well blowouts, but it presents combustion efficiencies based on the literature for the efficiency of natural gas flares. In that flare literature, very efficient flares achieve 98-99% efficiency, while flares that contain water or condensate vapor have poor efficiencies ranging from 60-80%. Maasakkers et al. also refers to Gvakharia et al., 2017, which observed a flare efficiency as low as 30%.[2] Neither EPA nor Maasakkers explain why this 30% is not considered.

Second, the literature cited is for flaring efficiency, and it is not clear that the combustion efficiency at emergency events and well blowouts would be comparable in any way to that of engineered flares. The studies cited for the 60-99% range are studies of sites with engineered flares, e.g. Strosher 2020 looked at oil-field battery sites[3] and Caulton et al., 2014 looked at flares at shale wells.[4] We believe that combustion in fires and explosions is likely far lower than that of engineered flares, which are designed to destroy methane. Flares are designed to pass *all* gas into and through a flame; there is no assurance that all gas in an emergency event is burned to any degree.

There are several variables that can lead to low combustion efficiencies at emergency events and well blowouts:

1. Improper Air-to-Fuel Ratio: Combustion requires a specific ratio of air (oxygen) to fuel (natural gas). If the mixture is not within the optimal range (with presence of contaminants or water), incomplete combustion can occur.
2. Limited Oxygen Availability: In certain scenarios, a large release of natural gas may create localized oxygen depletion, preventing complete combustion.
3. Ignition Source: If there is an ignition source present, even a spark or open flame, it can initiate combustion. However, the release velocity of natural gas may be too high for complete combustion to occur. Some volumes of gas may entirely escape combustion, for example in sufficiently turbulent conditions.
4. High Release Velocity: A rapid release of natural gas at high velocity can make it

[1] Maasakkers et al, 2022. https://doi.org/10.1016/j.rse.2021.112755.
[2] Gvakharia et al, 2017. https://doi.org/10.1021/acs.est.6b05183.
[3] Strosher 2020. https://doi.org/10.1080/10473289.2000.10464218.
[4] Caulton, et al, 2014. https://doi.org/10.1021/es500511w.

challenging for sufficient air to mix with the gas, leading to incomplete combustion.

5. Temperature Conditions: Extremely high or low ambient temperatures can affect combustion efficiency. Cold temperatures, for example, might impede the vaporization and mixing of natural gas with air.
6. Equipment Malfunctions: Malfunctions in equipment, such as burners or combustion systems, can contribute to incomplete combustion during a release.

We acknowledge that there has been very little effort being put into quantifying the combustion efficiencies of uncontrolled release events (because the priority is on health and damage control). With that, 60% is too high for EPA to assume as the average combustion efficiency for these uncontrolled emission events. We suggest that EPA assume the lower end of the estimate provided by Gvakharia et al. (30%) unless there is sufficient proof of favorable conditions and technologies present to achieve higher combustion efficiency.

Thank you for considering these comments.

Lesley Fleischman
David McCabe
Heny Patel
Clean Air Task Force
18 Tremont St.
Boston, MA 02108