Utilization of COD for L1.1.3 in GREET LOP

Synopsis:

In farms that utilize washdown manure and solids screening as their manure collection practices, utilizing VS as a methane marker can produce an artificially reduced baseline. However, the other recognized methane marker COD, is unaffected by the screening process. This marker would provide a more accurate assessment of baseline methane emissions and project results.

The COD methane metric is utilized in the IPCC and EPA frameworks for estimating methane emissions in establishing baseline for waste water treatment systems. Specifically, we are requesting the utilization of COD equivalent for B_{oL} in GREET L1.1.3, Maximum CH_4 Potential. This approach would better reflect the manure management processes utilized for sites that collect diluted washdown low solids (2% TS) effluent, and mechanically separate out solids prior to dispensing to the lagoon. Sample requirements for COD testing are very similar to Biomethane Potential (BMP) testing, where both testing procedures recommend diluted effluent for quantification, due to the interference created by high %TS samples[1]. The dilution used in these washdown sites fits these recommendations.

Discussion:

VS as a methane marker is heavily dependent on the animal type and feed composition, and it is demonstrated in the variance of L1.1.3, Maximum CH_4 Potential values in the LOP L1.1.1 pull down menu. A major contributor to this variability is particle size, and is seen in the methane generation differences between hog, poultry and cow, even with similar VS readings[2]. However, many dairies pre-screen their effluent, which changes the average particle size residing in the lagoon, therefore underreporting the emissions in baseline, when using VS as the metric. To test the effect of VS on screened lagoon influent, two studies were performed and found that VS dropped between 21.5% to 34%. During the same testing, COD levels were performed resulting in a change of +16% (increase) and a -5% (decrease) in COD, respectively[3]. However, in spite of dilutions or mechanical separation, COD remains intact, and therefore provides a better tracking metric for GREET for diluted low solids effluent.

Approach

Due to the high percent composition of recalcitrant VS In dairy studies, VS was found to not be an accurate indicator for methane generation[4]. Conversely, COD does not provide accurate results in high solids effluent work due to the high turbidity interferes with the oxidation step in the test. Chemical Oxygen Demand, or COD, is the metric utilized in IPCC and EPA procedures to estimate Methane emissions. COD testing can be performed through Standard Methods procedures in a testing lab, or in the field, through simple analytic test kits.
There is a well-documented chemical relationship between COD and VS (COD:VS ratio), so performing the conversion from VS to COD can be easily calculated. This relationship between VS and COD, has been

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[1] Esposito G et al (2012) Bio-Methane Potential Test to Measure the Biogas Production from the Digestion and Co-Digestion of Complex Organic Substrates. The Open Environmental Engineering Journal 2012, 5, 1-8, p 3.

[2] Hill DT (1991) Steady-state mesophilic design equations for ethane production from livestock wastes. Transactions of the ASAE, 34(5), 2157-2163. Hog and poultry waste contains nearly three times more digestible VS.

[3] T&W Farms, Eatonton GA, 2018, Davalar Farms, Rock Creek, IA, 2016 respectively

[4] A.C. Wilkie et al (2004). Fixed-film Anaerobic Digestion of Flushed Dairy Manure after Primary Treatment: Wastewater Production ad Characterization. University of Florida. Elsevier. p 470

quantified through published works and Trane on-site testing. We have found ratios ranging from 1.42[5], 1.46[6], 1.30[7], and 1.66[8]. The average of these ranges is 1.46.

To utilize a COD equivalent in L1.1.3 will require calculating a conversion factor. This is derived by multiplying the VS/COD ratio by the Emission Factor, which is 0.24 $gCH_4/gCOD$[9]. The Emission Factor is converted from density to volume per kg of COD as shown in the table below.

EF gCH4/g COD*	CH4 Density- grams/liter	Conversion to Ft3
0.25	0.64	0.035314667
CH4 Density- grams/liter	M3 CH4/KG COD	MT CH4/KG COD
0.64	0.390625	0.00025

The converted Emission Factor (m^3CH_4/kgCOD) is 0.390625.
This factor is then multiplied by the VS/COD ratio, which results in 0.57, which is the conversion factor that is used in place of the VS in L1.1.3. As a validation check, the emission factor is converted to English Units which equals 6.257 ft^3/lbCOD. This number is in agreement with numerous published reports[10 11 12] in regards to dairy manure to methane utilizing COD.

Conclusion

The allowance of utilizing COD as an equivalent metric addresses two key issues:

1- Equivalency- IPCC and EPA have both adopted the COD metric for determining CH4 emissions. There is an established process to convert VS to COD
2- More Opportunities- Manure Management programs that utilize washdown with mechanical solids separation reduces the amount of VS that goes to the lagoon, which reduces their baseline emissions. This allowance to use COD would provide more access to BCS technology to these farms.

Respectfully Submitted,

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[5] Irvine and Bryers, 1985, Stoichiometry and kinetics of waste treatment. In: CW Robinson and JA Howell (eds.) Comprehensive Biotechnology. Vol. 4. Pergamon, New York. Cap. 41 757-772
[6] Dry Creek Farms Rock Valley IA , 5 samples, taken 90 days apart, 2016-2017. Source- Fresh dairy cow washdown slurry
[7] T&W Farms, Eatonton, GA 3 samples, taken same time 2018. Source- Fresh dairy cow washdown slurry
[8] Sunrise Farms, Eatonton, GA 5 samples, taken same time. 2018. Source- Fresh dairy cow washdown slurry
[9] https://www3.epa.gov/ttn/chief/conference/ei12/green/present/scheele.pdf
[10] Pozo R, Diez V and Beltran S (2000) Anaerobic pre-treatment of slaughterhouse wastewater using fixed-film reactors, Bioresource Technology, 71, 143-149.
[11] NRCS Publication Technical Note 1 An Analysis of Energy Production Costs from Anaerobic Digestion Systems on US Livestock Production Facilities, October 2007 Page 11 and Speece, R.E. 1996. Anaerobic Biotechnology for Industrial Wastewaters. Archae Press. TN.
[12] Khanal, SK, 2008. Anaerobic Biotechnology for Bioenergy Production. Wiley-Blackwell. IA.