

Appendix 18 – Low-range Estimate of Enteric VFA Emissions

The low-range VFA emissions (accounting for approximate inlet VFAs) can be calculated using data from Dr. Mitloehner's April 13 presentation (Appendix 4), as follows:

Given:

- Methanol inlet concentration = 24 ppb
- Methanol outlet concentration = 94 ppb
- Outlet VFA Range = 185 ppb to 515 ppb
- Outlet VFA Average = 350 ppb
- Molar Weight of Methanol = 32 lb/lb-mol
- Molar weight of Acetic Acid = 60 lb/lb-mol

Correction for inlet estimated from methanol measurements:

$$24 \text{ ppb}/94 \text{ ppb} \times 100\% = 26\%$$

$$\text{Inlet VFA (26\% of outlet Ave VFA)} = 91 \text{ ppb}$$

Emissions Factor = EF = (Concentration difference) x (Chamber Flow Factor) x (Molar Weight ratio)

$$EF = (\text{Outlet}_{\text{con}} - \text{Inlet}_{\text{con}}) \times (CF) \times (MW_2/MW_1)$$

$$EF_{\text{methanol}} = (\text{Outlet}_{\text{con}} - \text{Inlet}_{\text{con}}) \times CF$$
$$1.35 \text{ lbs/hd-yr} = (94 \text{ ppb} - 24 \text{ ppb}) \times CF$$

Solving for Chamber Flow Factor results in:

$$CF_{\text{methanol}} = 0.019 \text{ lb-ppb/hd-yr}$$

$$EF_{\text{acetic acid}} = (350 \text{ ppb} - 91 \text{ ppb}) \times (0.019 \text{ lb-ppb/hd-yr}) \times (60 \text{ lb/lb-mol} \div 32 \text{ lb/lb-mol})$$
$$= 9.2 \text{ lbs-VFA/hd-yr}$$

As shown in the calculation above, the VFA emissions from Dr. Mitloehner's study results in 9.2 lbs/hd-yr. This VFA emission factor includes emissions from the fresh excreta. Since other VOC measurements by Dr. Mitloehner using EPA Method TO-15 had shown that emissions from fresh excreta in the test chamber represented approximately 10% of emissions, the 9.2 lbs/hd-yr can be adjusted downward by 10% to 8.3 lbs/hd-yr, to obtain a value for the enteric emissions without the excreta.