

Toxic Release Inventory (TRI) Reporting Guidance for Poultry Processing for Hydrogen Sulfide (H₂S), Revision 1

March 15, 2017

Prepared by:



US Poultry & Egg Association



Woodruff & Howe Environmental Engineering, Inc.

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I. Regulatory Background

Hydrogen sulfide was added to the TRI list of toxic chemicals in a final rule published on December 1, 1993. However, on August 22, 1994, EPA suspended the TRI reporting requirements for hydrogen sulfide to address issues that were raised by members of the regulated community regarding the information used to support the original listing decision. On February 26, 2010, EPA published a Federal Register document that provided the public with the opportunity to comment on EPA's review of the currently available data on the human health and environmental effects of hydrogen sulfide. After consideration of public comments, EPA concluded that the reporting requirements for hydrogen sulfide should be reinstated. The U.S. Environmental Protection Agency (EPA) reinstated Toxic Release Inventory (TRI) reporting requirements for hydrogen sulfide (H₂S) beginning for the 2012 reporting year. Annual reporting for each calendar year is required by July 1 of the following year.

II. Hydrogen Sulfide and the Poultry and Meat Industry

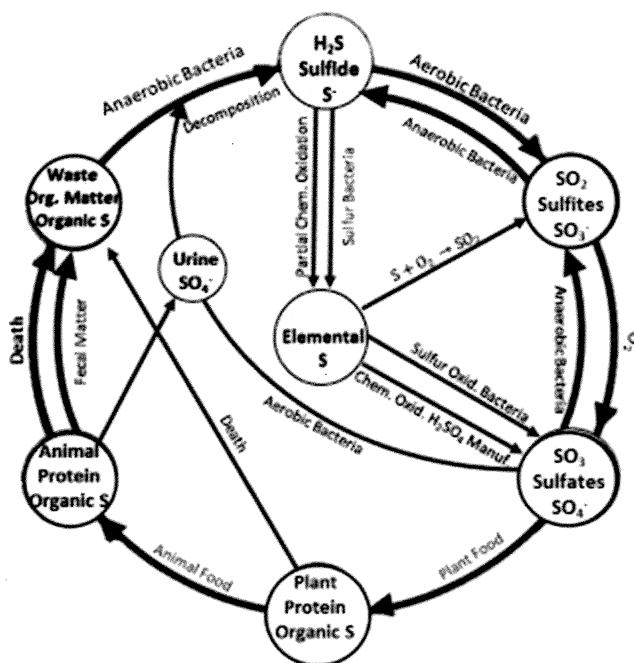
Hydrogen sulfide is not a chemical typically used in poultry and meat processing operations. However, hydrogen sulfide can be generated at these facilities as a byproduct in certain wastewater treatment units and in rendering operations. The TRI reporting threshold for hydrogen sulfide generated as a byproduct is 25,000 pounds. There is no de minimis reporting level for chemicals manufactured as a byproduct.

Oxidized sulfur compounds, such as sulfate, sulfite and thiosulfate, sulfur compounds in proteins and amino acids and other organic sulfur compounds (e.g., mercaptans, dimethyl sulfide, etc.) are commonly present in wastewater from poultry and meat processing, egg processing and rendering operations. Various bacteria can reduce sulfate and other sulfur containing compounds to sulfide under anaerobic conditions, including:⁽¹⁾

- 1) *Assimilatory microbes* which assimilate inorganic sulfur and reduce it to sulfide within their protoplasm;
- 2) *Proteolytic bacteria* which can hydrolyze proteins and amino acids under anaerobic conditions resulting in the release of sulfides; and
- 3) *Sulfate-reducing bacteria* which are specialized bacteria that use inorganic sulfate as the hydrogen acceptor in their energy cycle.

The figure below provides information on the sulfur cycle, which is an important cycle in nature.

The Sulfur Cycle

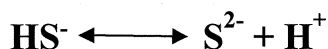
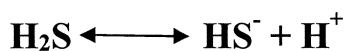


From USEPA: EPA/625/1-85/018

The overall sulfate reduction reaction can be shown as:⁽¹⁾

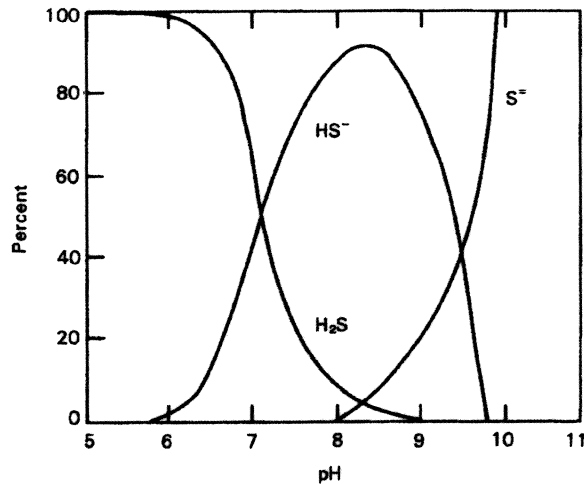


Hydrogen sulfide exists in an aqueous solution as either dissolved hydrogen sulfide gas (H₂S), hydrogen sulfide ion (HS⁻) or the sulfide ion (S²⁻), depending on the pH, temperature and specific conductivity of the solution in accordance with the following ionization reactions:^{(1),(2)}



Equilibrium reactions and dissociation constants can be used to determine the specific forms in solution. The concentration of the sulfide ion (S²⁻) species is insignificant in the typical range of poultry and meat processing wastewaters (pH 6 to 8). The figure below shows the distribution of the above species as a function of pH only.

Effect of pH on hydrogen sulfide equilibrium (mole %)⁽¹⁾



Anaerobic wastewater treatment systems and rendering operations are the most common sources of hydrogen sulfide that could potentially trigger TRI reporting at poultry and meat and rendering operations. However, other potential sources also need to be considered. Common sources of sulfur containing compounds that may result in hydrogen sulfide being generated as a byproduct at poultry and meat processing facilities; rendering operations; egg processing operations; manure handling operations and other byproducts handling operations include:

- Sulfates are commonly present in drinking water and ground water supply.
- Sulfur can be present in certain chemicals used in processing operations and/or wastewater treatment operations (e.g., sulfuric acid, alum, ferric sulfate, sodium metabisulfite used for peracetic acid neutralization, sulfite compounds used as oxygen scavengers in boiler water treatment programs, sodium acid sulfate-SAS used in chillers, gypsum, and other sulfur containing compounds).
- Sulfur is present in various organic compounds in animal and human excreta, in proteins and in amino acids (1% to 2%).^{(3),(1)}
- Hydrogen sulfide and other organic sulfur containing compounds (e.g., mercaptans, disulfides) can be present in exhaust gases from rendering operations/equipment and in condensate from rendering condensers; blow down from venturi and packed tower air scrubbers; in off-gases from blood, DAF skimmings, offal trucks and raw bins. Hydrogen sulfide can also be present in decant water and gases vented from DAF skimmings tank trucks.
- Hydrogen sulfide can be present in the wastewater associated with anaerobic treatment units and in the biogas from these systems.

Other sources of hydrogen sulfide can include septic conditions in sewer lines, waste sludge storage tanks, lagoons, hydrogen sulfide removal systems for ground/drinking water treatment systems (hydrogen sulfide strippers), etc. For TRI reporting purposes, companies are responsible for

identifying sources where hydrogen sulfide is generated as a byproduct and quantifying generation, treatment and releases from these sources.

EPCRA Section 313 states that covered facilities need not conduct monitoring or other activities for TRI reporting purposes beyond that required by other statutory or regulatory requirements (EPCRA Section 313(g)(2)). Specifically, EPCRA Section 313(g)(2) indicates:

“In order to provide the information required under this section, the owner or operator of a facility may use readily available data (including monitoring data) collected pursuant to other provisions of law, or, where such data are not readily available, reasonable estimates of the amounts involved. Nothing in this section requires the monitoring or measurement of the quantities, concentration, or frequency of any toxic chemical released into the environment beyond that monitoring and measurement required under other provisions of law or regulation. In order to assure consistency, the Administrator shall require that data be expressed in common units.”

Without measurement or monitoring data, the facility is required to make reasonable estimates using its best, readily available data.

As there can be significant differences in the amount of sulfur containing compounds in water supply and wastewater from poultry and meat processing, egg materials processing and rendering operations, the potential quantities of hydrogen sulfide generated in an anaerobic lagoon or rendering operation as a byproduct, treated and released can vary greatly. Also, there is not any significant published USEPA, etc. data or methods to base reasonable site specific hydrogen sulfide generation, treatment and/or release estimates for food and agricultural product processing plants for TRI reporting purposes. Because of these factors, performance of limited sampling of water supply, wastewater, biogas and/or rendering plant vapors and condensate is recommended to derive estimates on hydrogen sulfide generation, treatment and release rates for a specific facility.

Following are potential approaches and methods for poultry, meat and egg processing facilities to estimate hydrogen sulfide generation, treatment and releases for TRI reporting applicability determinations and to derive the information needed to complete a Form R report for this chemical. Adequate documentation must be maintained on data used, information sources used, calculation methods, assumptions, etc. for a minimum of three (3) years.

III. Potential Methods, Inputs and Assumptions for Hydrogen Sulfide TRI Reporting and Associated Calculations for Wastewater Treatment Systems with an Anaerobic Treatment Unit

One possible approach for estimating H₂S generation, treatment and release from wastewater treatment systems which include an anaerobic treatment unit is to perform a mass balance around a system for sulfur compounds. This approach would include collecting information on:

- Sulfate, sulfide, TKN and ammonia-nitrogen concentrations in wastewater entering an anaerobic system and annual wastewater flow.
- Sulfate, sulfide, TKN and ammonia-nitrogen exiting an anaerobic treatment system.
- Annual biogas generated.
- Hydrogen sulfide (H₂S) content in biogas (Dräger tube measurements can be used for this purpose. Third party laboratories can also analyze biogas samples) and before and after biogas treatment systems (e.g., condensation/refrigeration system, “iron sponge” biogas treatment systems, biofilters, wet scrubbers, etc.). For condensation/refrigeration treatment systems, analyzing the resulting condensate for hydrogen sulfide may also be applicable.

Potential assumptions for hydrogen sulfide generation, treatment and release estimates:

- 97.5% capture efficiency for covered anaerobic lagoons and 99% capture for enclosed vessel anaerobic reactor (based on USEPA GHG Reporting Rule).⁽⁴⁾
- Use manufacturer guarantees or assume 99% destruction efficiency for hydrogen sulfide (conversion to SO₂) in flare or boiler (assumes hydrogen sulfide destruction efficiency equal to that for methane per USEPA GHG Reporting Rule).⁽⁴⁾
- Assume 99% destruction efficiency of dissolved hydrogen sulfide gas and other sulfide ions in downstream aerobic treatment units (via oxidation).^{(5),(8)} Literature indicates conventional aerobic treatment systems (activated sludge biological treatment system) should provide 90% to 100% removal of sulfides. This includes systems with biological denitrification. It is assumed the operating pH of biological treatment systems is ≥ 7.0 . *Note: the removal efficiency should be reduced if hydrogen sulfide is being detected (rotten egg smell, significant corrosion in downstream sewer/treatment systems, etc.) in downstream anoxic cells, aerobic treatment units, wet wells, etc. The removal efficiency may also be reduced for less advanced biological wastewater treatment systems (i.e., aerobic lagoon system), systems with limited aeration, and/or for systems which operate at a pH ≤ 7.0 .*
- Assume Ideal Gas Law applicable for estimating hydrogen sulfide in biogas using a measured or estimated concentration in the biogas. ($PV=nRT$)
- Assume organic nitrogen conversion to ammonia nitrogen across lagoon is associated with anaerobic decomposition of protein/amino acids.
- Assume 16% of protein/amino acids is nitrogen.⁽³⁾
- Assume 1.5% of protein/amino acids is sulfur.⁽³⁾
- Molecular weights – Sulfate (SO₄): 96 lbs./lb. mole, Hydrogen Sulfide (H₂S): 34 lbs./lb. mole, Sulfur (S): 32 lbs./lb. mole.

The following assumptions or methods could be used if not all the data listed above is available.

- If anaerobic lagoon effluent data for sulfate is not available, assume all sulfate in the influent is converted to hydrogen sulfide.

- If anaerobic influent data for sulfate is not available, estimate using sulfate levels in the incoming water plus the additional sulfate and other sulfur containing compounds added to the wastewater across the plant (e.g., based on chemical usage rates and weight percent of sulfate or sulfur in other sulfur containing chemicals used at plant). There is a secondary drinking water standard of 250 mg/l for sulfate, and municipal water providers and other public water supply systems are generally required to perform testing for sulfate. Associated water quality data should be available in annual Consumer Confidence Reports (CCRs) required under safe drinking water programs.
- If site specific TKN and/or ammonia data is not available, use typical raw wastewater and anaerobic wastewater effluent values provided in USPOULTRY *Poultry Wastewater Operators Training Manual* or other reliable resource.
- If annual wastewater flow volume is not available, use water purchase data and adjust for evaporative and product moisture pickup water losses across plant and/or addition of water through the collection of storm water.
- Biogas flow:
 - Use influent wastewater BOD or COD level for anaerobic treatment systems and methods indicated in USEPA GHG Reporting Rule 40 CFR Part 98, Subpart II – Industrial Wastewater Treatment to estimate biogas generation volume.⁽⁴⁾
 - Use biogas blower/compressor flow rating and estimated time blower/compressor and/or flare was operated in reporting year to estimate annual biogas flow volume. If this approach is used, flow volumes should be adjusted to address moisture content in biogas. Assuming a moisture removal system is not provided, it can generally be assumed the biogas is saturated with moisture at the actual conditions.
- If hydrogen sulfide content data for biogas is not available, use data from similar plant. *Caution – hydrogen sulfide levels in biogas can vary significantly based on influent sulfate levels, COD loading, CO₂ generation, operating pH and other factors.* Section 11.5 in the book *Anaerobic Biotechnology for Industrial Wastewaters* by Richard E. Speece provides information on estimating the H₂S content in the off-gas (biogas) from anaerobic treatment systems based on various system operating parameters (feed COD, CO₂ production, system pH, and sulfide precursors in influent).⁽⁷⁾
- If any other data is unavailable, use data point(s) from similar plant, reliable reference or reasonable estimate.
- Maintenance of a good scum cover (grease cap) on an uncovered anaerobic lagoon has been shown to significantly reduce hydrogen sulfide emissions (i.e., provides treatment). A study of an anaerobic lagoon at a meat packing plant in Moerwa, New Zealand included sampling and analysis of air samples (samples collected four inches above *open water* and scum cover on lagoon) for hydrogen sulfide. This study indicated an average hydrogen sulfide level of 0.35 mg/l above the scum cover and concentrations ranging from 2.0 to 15.0 mg/l above the open water areas, which indicates the scum cover provided a reduction in hydrogen sulfide emissions ranging between 82.5% to 97.7% (assume average of 90%).⁽⁶⁾ This information

along with adjustments for annual scum cover coverage could be used in estimating hydrogen sulfide emissions (and treatment in scum cover) from uncovered anaerobic lagoons.

Other factors that must be considered:

- Dräger tube readings are calibrated to 20°F and 1 atmosphere. A correction factor must be used to correct Dräger tube readings taken at a different pressure (see Dräger Tube & CMS-Handbook).
- Hydrogen sulfide measurements and biogas flow volume measurements need to both be as wet gas or as dry gas. A correction must be made if one measurement is as dry gas and the other is as wet gas.
- Standard conditions should be the same for hydrogen sulfide measurements and biogas flow volume measurements. If standard conditions are different, applicable adjustments to the flow volume can be made using the Ideal Gas Law.
- Various other sulfur sinks can occur across anaerobic treatment systems which result in sulfide/sulfur disappearance. These other possible sulfur sinks include microbial synthesis of sulfur, sulfide precipitation (e.g., metal sulfides, etc.) and production of other sulfur compounds (e.g., polysulfides which reportedly do not enter the gas/liquid phase partitioning, etc.).⁽⁷⁾ These potential sulfur sinks can result in significant differences between the sulfur entering and exiting an anaerobic system. Assuming an anaerobic system has reached “steady state,” the proposed hydrogen sulfide estimation method assumes these other modes of sulfide loss represent treatment of hydrogen sulfide in the system. If sludge, scum or other solids are removed from an anaerobic treatment system, the dissolved free sulfides (dissolved hydrogen sulfide gas and other dissolved sulfide ions) in these residuals should be included in TRI reporting and associated release calculations.
- Sulfate can be reported by laboratories and onsite testing methods as SO₄ or as SO₄-S. Adjustment to the proposed TRI reporting calculations may be required to address the actual sulfate form being reported.

IV. Example Calculations

A. Covered Anaerobic Lagoon Scenario

Inputs and Assumptions

- Covered anaerobic lagoon with biogas collection system and flare. Effective biogas collection, and the lagoon cover is in good condition with no significant tears, rips, etc.
- Total wastewater volume for year: 425 million gallons.
- Total biogas volume for year: 75,650,000 cubic feet (standard conditions: 20°F, 1 atm., wet basis).

- Average hydrogen sulfide content in biogas: 2,800 ppmv (standard conditions: 20 °F, 1 atm., wet basis), ppmv = parts per million by volume
- Average sulfate and sulfide data for anaerobic lagoon:
 - Influent sulfate – 130 mg/l (as SO₄)
 - Influent sulfide – <0.1 mg/l (as S)
 - Effluent sulfate – 1.5 mg/l (as SO₄)
 - Effluent sulfide – 46 mg/l (as S)
- Average TKN and ammonia data for anaerobic lagoon:
 - Influent TKN: 150 mg/l
 - Influent NH₃-N: 15 mg/l
 - Effluent TKN: 130 mg/l
 - Effluent NH₃-N: 120 mg/l
- Sulfide in treated effluent discharged to stream is below detection limits
- Assume 99% of sulfides treated in downstream activated sludge biological treatment system with denitrification.
- Assume untreated sulfides associated with downstream biological treatment system released to atmosphere as hydrogen sulfide (fugitive release).

Example Calculations

Estimate Hydrogen Sulfide generation:

From Sulfate

(Annual Flow) x (Sulfate converted to H₂S in anaerobic system) x (8.34) x (molecular weight conversion to H₂S) = lbs. H₂S generated

$$425 \text{ MGD} \times (130 \text{ mg/l} - 1.5 \text{ mg/l}) \times 8.34 \times (34/96) = 161,312 \text{ lbs. H}_2\text{S}$$

From Protein Breakdown

(Annual Flow) x ((TKN, influent – NH₃-N, influent) – (TKN, effluent – NH₃-N, effluent)) x (8.34) x (1/nitrogen content in protein) x (Sulfur content in protein as S) x (molecular weight conversion to H₂S) = lbs. H₂S generated

$$425 \text{ MGD} \times [(150-15) - (130-120)] \times 8.34 \times (1/0.16) \times 0.015 \times (34/32) = 44,133 \text{ lbs. H}_2\text{S}$$

Total Estimated H₂S Generated:

$$161,312 \text{ lbs. H}_2\text{S} + 44,133 \text{ lbs. H}_2\text{S} = \underline{205,445 \text{ lbs. H}_2\text{S}}$$

H₂S in Biogas

Ideal Gas Law to calculate lbs. H₂S in Biogas (PV=nRT)

R – Universal Gas Constant = 0.7302. Ft³ • atm/lb-mole • °R

Pressure x (Annual Gas Flow x ppm (volume) H₂S) = n x R x Temperature (°F+460)

$$(1 \text{ atm}) \times 75,650,000 \times (2,800/10^6) = (n) \times 0.7302 \times (68+460)$$

$$n = 549.4 \text{ lb mole H}_2\text{S} \times 34 \text{ lb/lb mole}$$

$$= \underline{18,680 \text{ lbs. H}_2\text{S}} \text{ in Biogas}$$

Fugitive emissions from anaerobic lagoon and biogas handling systems

$$[\text{Lbs. H}_2\text{S in Biogas} / \text{Capture Efficiency}] - \text{Lbs. H}_2\text{S in Biogas}$$

$$(18,680 / 0.975) - 18,680 = \underline{479 \text{ lbs. H}_2\text{S}} \text{ (Fugitive Air Emission)}$$

Emission from Flare

$$\text{Lbs. H}_2\text{S in Biogas} \times (1 - \text{Destruction Efficiency})$$

$$18,680 \times (1 - 0.99) = \underline{187 \text{ lbs. H}_2\text{S}} \text{ from Flare (Point Source Air Emission)}$$

H₂S oxidized to SO₂ (treated) in Flare

$$18,680 - 187 = \underline{18,493 \text{ lbs. H}_2\text{S}}$$

Estimate of sulfide treated in downstream biological treatment system

$$(\text{Annual Flow}) \times (\text{Anaerobic Effluent Sulfide concentration, as S}) \times (8.34) \times (\text{molecular weight conversion to H}_2\text{S}) = \text{lbs. H}_2\text{S}$$

$$425 \text{ MGD} \times (46 \text{ mg/l}) \times 8.34 \times (34/32) = \underline{173,237 \text{ lbs. H}_2\text{S}} \text{ to downstream biological treatment system}$$

H₂S Treated/Converted in Biological Treatment System

$$(\text{lbs. H}_2\text{S to downstream biological treatment system}) \times \text{Treatment efficiency}$$

$$173,237 \text{ lbs. H}_2\text{S} \times 0.99 = \underline{171,505 \text{ lbs. H}_2\text{S}}$$

$$\text{H}_2\text{S Fugitive Release} = 173,237 \text{ lbs. H}_2\text{S} - 171,505 \text{ lbs. H}_2\text{S} = \underline{1,732 \text{ lbs. H}_2\text{S}}$$

Summary of Covered Anaerobic Lagoon Calculations

$$\text{Total Generated} = \underline{205,445 \text{ lbs. H}_2\text{S}}$$

$$\text{Total Fugitive Releases (to air)} = 1,732 \text{ lbs. H}_2\text{S} + 479 \text{ lbs. H}_2\text{S} = \underline{2,211 \text{ lbs. H}_2\text{S}}$$

$$\text{Total Point Source Releases (to air)} = \underline{187 \text{ lbs. H}_2\text{S}}$$

$$\text{Total H}_2\text{S Treated} = 205,445 \text{ lbs. H}_2\text{S (generated)} - 2,211 \text{ lbs. H}_2\text{S} - 187 \text{ lbs. H}_2\text{S}$$

$$= \underline{203,047 \text{ lbs. H}_2\text{S}}$$

Note: The management of biogas in combustion systems will generally result in the conversion of hydrogen sulfide in the gas to SO₂ (sulfur dioxide), which may impact air permitting requirements.

B. Uncovered Anaerobic Lagoon Scenario

Inputs and Assumptions

- Uncovered anaerobic lagoon with partial to complete grease cap. In this example, an annual average estimated grease cap coverage of 90% is used. The yearly average estimate of grease cap coverage should adequately account for seasonal variations and changes in lagoon operating conditions (pH, etc.), sanitation and other chemical usage, etc. that impact grease cap coverage, etc.
- Total wastewater volume for year: 425 million gallons.
- Average sulfate and sulfide data for anaerobic lagoon:
 - Influent sulfate – 130 mg/l (as SO₄)
 - Influent sulfide – <0.1 mg/l (as S)
 - Effluent sulfate – 1.5 mg/l (as SO₄)
 - Effluent sulfide – 38 mg/l (as S)
- Average TKN and ammonia data for anaerobic lagoon:
 - Influent TKN: 150 mg/l
 - Influent NH₃-N: 15 mg/l
 - Effluent TKN: 130 mg/l
 - Effluent NH₃-N: 120 mg/l
- Sulfide in treated effluent discharged to stream is below detection limits
- Assume 99% of sulfides treated in downstream activated sludge treatment system (system does not include denitrification).
- Assume untreated sulfides associated with downstream biological treatment system released to atmosphere as hydrogen sulfide (fugitive release).
- Estimated hydrogen sulfide treatment within the anaerobic lagoon grease cap of 90%.⁽⁶⁾

Example Calculations

Estimate Hydrogen Sulfide generation:

From Sulfate

(Annual Flow) x (Sulfate converted to H₂S in anaerobic system) x (8.34) x (molecular weight conversion to H₂S) = lbs. H₂S generated

425 MGD x (130 mg/l – 1.5 mg/l) x 8.34 x (34/96) = 161,312 lbs. H₂S

From Protein Breakdown

(Annual Flow) x ((TKN, influent – NH₃-N, influent) – (TKN, effluent – NH₃-N, effluent)) x (8.34) x (1/nitrogen content in protein) x (sulfur content in protein as S) x (molecular weight conversion to H₂S) = lbs. H₂S generated

$$425 \text{ MGD} \times [(150-15) - (130-120)] \times 8.34 \times (1/0.16) \times 0.015 \times (34/32) = 44,133 \text{ lbs. H}_2\text{S}$$

$$\text{Total Estimated H}_2\text{S Generated: } 161,312 \text{ lbs. H}_2\text{S} + 44,133 \text{ lbs. H}_2\text{S} = \underline{205,445 \text{ lbs. H}_2\text{S}}$$

Estimate of sulfide treated in downstream biological treatment system

(Annual Flow) x (Anaerobic Effluent Sulfide concentration, as S) x (8.34) x (molecular weight conversion to H₂S) = lbs. H₂S

$$425 \text{ MGD} \times (38 \text{ mg/l}) \times 8.34 \times (34/32) = \underline{143,109 \text{ lbs. H}_2\text{S}} \text{ to downstream biological treatment system}$$

H₂S Treated/ Converted in Aerobic Systems

$$(\text{lbs. H}_2\text{S to downstream aerobic treatment system}) \times \text{Treatment efficiency } 143,109 \text{ lbs. H}_2\text{S} \times 0.99 = \underline{141,678 \text{ lbs. H}_2\text{S}}$$

$$\text{H}_2\text{S Fugitive Release (downstream aerobic systems)} = 143,109 \text{ lbs. H}_2\text{S} - 141,678 \text{ lbs. H}_2\text{S} = \underline{1,431 \text{ lbs. H}_2\text{S}}$$

H₂S in Biogas

H₂S Generated - H₂S in Anaerobic Effluent

$$205,445 \text{ lbs. H}_2\text{S} - 143,109 \text{ lbs. H}_2\text{S} = 62,336 \text{ lbs. H}_2\text{S in Biogas}$$

Note this method does not consider other potential sulfur sinks in the anaerobic lagoon, and therefore the estimated hydrogen sulfide in biogas may be overestimated.

H₂S Treated in Anaerobic Grease Cap

(lbs. H₂S in Biogas) x Treatment efficiency x % Grease Cap Coverage, Annualized

$$62,336 \text{ lbs. H}_2\text{S} \times 0.90 \times 0.95 = \underline{53,297 \text{ lbs. H}_2\text{S}}$$

H₂S Fugitive Release (from anaerobic lagoon)

H₂S in Biogas - H₂S Treated in Anaerobic Grease Cap

$$62,336 \text{ lbs. H}_2\text{S} - 53,297 \text{ lbs. H}_2\text{S} = \underline{9,039 \text{ lbs. H}_2\text{S Released}}$$

Summary of Uncovered Anaerobic Lagoon Calculations

Total Generated = 205,445 lbs. H₂S

Total Fugitive Releases (to air) = 1,431 lbs. H₂S + 9,039 lbs. H₂S = 10,470 lbs. H₂S

Total Point Source Releases (to air) = 0 lbs. H₂S

Total H₂S Treated = 205,445 lbs. H₂S (generated) – 10,470 lbs. H₂S (fugitive to air)
= 194,975 lbs. H₂S

V. Closing Comments

These calculations are provided as an example of how the quantities of hydrogen sulfide manufactured, treated and released associated with anaerobic treatment systems could be estimated based on the given information. Other methods are available and may be more applicable. The actual TRI calculation requirements for a specific Facility must be based on reasonable estimates utilizing the best readily available data and information, including best professional judgment. Each Facility must assess the best readily available information for that Facility. Monitoring anaerobic influent and effluent for sulfate and sulfide and monitoring the biogas for hydrogen sulfide, although not necessarily required by the law/regulation, is suggested due to the significant variability that can be observed between different facilities. This document is not applicable for estimating hydrogen sulfide generation, treatment and releases for rendering plant processing operations or other operations not specifically indicated.

This document was produced by US Poultry & Egg Association with assistance from Woodruff & Howe Environmental Engineering, Inc. (WHEE, Inc.) for use by its members as a guidance document for the estimation of hydrogen sulfide generated as a byproduct from wastewater treatment operations associated with poultry processing facilities as well as treatment and releases for the purpose of reporting under EPA's Toxic Release Inventory (TRI) program. The use of this document requires significant knowledge of the applicable rules, regulations and associated engineering calculations. In addition, the user must have an understanding of the specifications and limitations of the sampling, metering and analytical instruments utilized in collecting the applicable information for TRI reporting.

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VI. References

- 1) *Design Manual: Odor and Corrosion Control in Secondary Sewerage Systems and Treatment Plants*, NTIS No. PB88184031, US Environmental Protection Agency Center for Environmental Research Information, Cincinnati, OH, October 1985.
- 2) *Wastewater Engineering, Treatment, and Reuse*, Metcalf & Eddy, Inc., 4th Edition, McGraw Hill, New York, 2003.
- 3) *Chemistry, The Central Science*, 2nd Edition, Theodore L. Brown, H Eugene LeMay, Jr., Prentice Hall, Inc., 1981, pg. 773.
- 4) 40 CFR Part 98, Subpart II, Industrial Wastewater Treatment (USEPA GHG Reporting Rule).
- 5) *Codes of Practice for Developing an Emissions Inventory for Refineries and Terminals, 2015, REV. 15, Table 7-1*, Canadian Fuels Association
{http://www.canadianfuels.ca/website/media/PDF/Environmental%20Stewardship/Guidance%20Material/Canadian-Fuels_CoP_Rev15_Final_Report.pdf}.
- 6) *Control of Odors From an Anaerobic Lagoon Treating Meat Packing Wastes*, J. A. Chittenden, L. E. Orsi, J. L. Withero, and W. J. Wells, Jr. From EPA-600/2-78-151, July 1978.
- 7) *Anaerobic Biotechnology for Industrial Wastewaters*, R.E. Speece, Vanderbilt University, 1996. Some of the information presented herein is also based on correspondence with Dr. Speece in 2016 and 2017.
- 8) *National Pollutant Release Inventory, Guidance Manual for the Wastewater Sector*, Environment Canada, Minister of Public Works and Government Services Canada, Catalogue # En40-495/1-2003E, Table F-1.

Notes

- References #5 (previous version referenced) and #8 are referenced by the USEPA as resources available for estimating hydrogen sulfide generation, treatment and releases for TRI reporting {<https://tri-epa.zendesk.com/hc/en-us/articles/211670548-What-resources-are-available-for-estimating-hydrogen-sulfide-release-and-waste-management-quantities>- as of 3/9/2017}.
- The USEPA WATER9, Version 3 model available at https://www3.epa.gov/ttnchie1/software/water/water9_3/index.html has the capability to estimate hydrogen sulfide releases from certain wastewater treatment systems. However, the USEPA indicates: “*The WATER9 model was developed using a software that is now outdated. Because of this, the model is not reliably functional on computers using certain operating systems such as Windows Vista or Windows 7. We are anticipating that additional problems will arise as PCs switch to the other operating systems. Therefore, we can no longer provide assistance to users of WATER9. The model will remain on the website to be used at your discretion and at your own risk.*”