Anaerobic Digester Gas (ADG)-to–Electricity PON 2828 - Processes Eligible for Hydrogen Sulfide (H_2S) Reduction Incentives

Purpose: H_2S is a component generally present in biogas from anaerobic digestion processes that is highly corrosive to engines and other equipment for power generation. Consequently, high H_2S levels in biogas may significantly reduce the performance of those systems and may increase operations and maintenance (O&M) costs. The purpose of this document is to identify certain H_2S reduction processes that NYSERDA has determined to be eligible for H_2S reduction incentives through PON 2828.

In an effort to increase performance and reduce O&M, NYSERDA has made available particular performance and capacity incentives in PON 2828 to help off-set the costs associated with different types of H_2S reduction processes, including: Iron Chloride, Ferric Hydroxide, Biological Scrubber, Carbon Filter, Iron Sponge, and Other processes. Performance of these processes is dependent on the amounts of H_2S present in the biogas, the H_2S reduction requirements, the process design effectiveness and the operational performance of the process. Some have little or no upfront costs but can have significant on-going costs, like iron chloride and ferric hydroxide. These processes may be a good option for relatively small digester projects (less than approximately 250 kW) that have relatively low H_2S levels in the raw biogas (less than approximately 2000 ppm) and have a goal to reduce H_2S levels to under 800 ppm. Others may have significant up-front costs but lower on-going costs such as some biological scrubbers which currently may be more cost effective for relatively large projects (greater than 250 kW) that have high H_2S levels (greater than 2000 ppm) in the raw biogas and have a goal to reduce H_2S to less than 400 ppm. Still others may have moderate upfront costs but also have ongoing costs, like carbon filter processes and iron sponge processes which are both known to also be effective in reducing H_2S when properly designed and sized based on the biogas flow rate and H_2S concentration. Combinations of processes may also be effective in reducing H_2S. Air injection into the digester gas space and/or gas chilling/drying may also be effective in reducing H_2S when used in combination with other processes.

In developing the list of eligible H_2S reduction processes, the performance and capacity incentives suitable for each process, and the associated requirements for PON 2828, NYSERDA, with the assistance of independent technical reviewers, has conducted an investigation of various H_2S reduction processes, including a survey of projects within NYSERDA's ADG-to-Electricity project portfolio.

Biological Scrubber, Carbon Filter, Iron Sponge processes have been demonstrated to be effective in consistently reducing H_2S levels in biogas from 2000 ppm or greater to less than 400 ppm, when properly designed and operated. But these processes also can have greater upfront installation costs than other options. Applicants installing new Biological Scrubber, Carbon Filter, Iron Sponge processes are therefore able to request Capacity Incentives and relatively greater overall incentives (as compared to other processes) but must meet stringent requirements of H_2S reduction to 400 ppm in order to receive payment (as described in Appendix C of PON 2828.

The following is a listing and description of H_2S reduction processes currently eligible for H2S reduction incentives through PON 2828:

Iron Chloride – Iron (ferric or ferrous) chloride is a liquid compound that is injected into and mixed with the influent of an anaerobic digester. It is used commonly as a coagulant in wastewater treatment but also can be used to oxidize sulfur compounds in the digester influent thereby reducing the sulfur compounds available to produce H_2S. Iron chloride has been shown to reduce H_2S levels in biogas when properly administered to the digester influent. Generally, daily dosing of iron chloride may be required to effectively reduce H_2S in biogas. Applicants proposing to use the Iron Chloride process must submit design details in order for NYSERDA to determine if the system is appropriately sized and that adequate quantities of iron chloride are planned for the expected gas flow and H_2S levels.

Ferric Hydroxide – Ferric hydroxide is a solid compound that is added to and mixed with the influent of an anaerobic digester. It is used to oxidize sulfur compounds in the digester influent thereby reducing the sulfur compounds available to produce H_2S. Ferric hydroxide has been shown to reduce H_2S levels in biogas when properly administered to the digester influent. Generally, daily dosing of ferric hydroxide may be required to effectively reduce H_2S in biogas. Applicants proposing to use the Ferric Hydroxide process must submit design details in order for NYSERDA to determine if the system is appropriately sized and that adequate quantities of ferric hydroxide are planned for the expected gas flow and H_2S levels.

Biological Scrubber – A biological scrubber (or biological desulfurization process) is a microbial fixation process in which biogas is streamed through a vessel containing a media on which microorganisms, such as *Thiobacillus*, are encouraged to grow. A small amount of air is injected into the process and H_2S in the biogas is oxidized (via chemical and biological action) and may produce sulfuric acid and elemental sulfur. Properly designed biological scrubbers can be effective in reducing H_2S levels in biogas for systems with high or variable H_2S in the biogas. Applicants proposing to use a biological scrubber process must submit design details in order for NYSERDA to determine if the system is appropriately sized given the expected gas flow and H_2S levels.

Due to the fact that biological scrubbers in particular require significant Capacity Incentives to offset higher capital costs, compared to other processes, and that Capacity Incentives are paid before the system can operate and demonstrate performance, NYSERDA has developed an Approved Vendors list for biological scrubbers that have demonstrated an ability to meet stringent performance criteria. For purposes of PON 2828, only biological scrubbing systems that are external to the digester and that have been shown to meet the following criteria are included among the eligible H_2S reduction processes:

- At least hourly H_2S level monitoring of the output from the biological scrubber over a six month period, with no more than a total 3 week gap in data;
- Demonstrated effectiveness in reducing H_2S levels from at least 2000 ppm to less than 400 ppm on average over the 6 month period at a full scale ADG-to-electricity project;
- Automated control of air injection processes to optimize H_2S reduction and react to increases or decreases in H_2S in the raw biogas;

- Incorporation of appropriate explosion prevention measures.

Currently only two Vendors are known to have systems which meet these criteria. Applicants to PON 2828 may only use the following Approved Vendors if applying for biological scrubber incentives:

American Biogas Conditioning – Syracuse, NY

Energy Cube – Versailles, MO

Additional vendors may be added to this listing if determined by NYSERDA to have provided adequate documentation that their biological scrubber processes meet the criteria described above. Vendors interested in being added to the list should contact Steve Hoyt, (518) 862-1090 ext. 3587, sah@nyserda.ny.gov or Tom Fiesinger, ext. 3218, twf@nyserda.ny.gov. A Vendor a of biological scrubber processes may be removed from the Approved Vendors list if NYSERDA determines that the vendor's system has failed to perform to the above criteria for a six month period at a project that receives H_2S reduction incentives.

Carbon Filter – Carbon filters (or activated carbon) is a process in which biogas is streamed through a vessel containing activated carbon impregnated with a chemical such as potassium iodine or sulfuric acid. Air is injected into the biogas to promote carbon absorption of the H_2S and conversion of the sulfur into elemental sulfur. Properly designed and operated carbon filter systems are known to be an effective means of reducing H_2S levels in biogas. Applicants proposing to use a carbon filter process must submit design details in order for NYSERDA to determine if the system is appropriately sized and that adequate quantities of chemical reagent are planned for the expected gas flow and H_2S levels.

Iron Sponge – Iron sponge is a process in which biogas is streamed through a vessel iron particles typically wood chips impregnated with iron). Air is injected into the biogas to promote chemical conversion of the H_2S into elemental sulfur. Properly designed and operated iron sponge systems are known to be an effective means of reducing H_2S levels in biogas. Applicants proposing to use an iron sponge process must submit design details in order for NYSERDA to determine if the system is appropriately sized and that adequate quantities of iron particles are planned for the expected gas flow and H_2S levels.

Other - Other H_2S reduction processes not specified herein, for example processes consisting of combinations of the processes listed above, may also be eligible if determined by NYSERDA to have demonstrated H_2S reduction effectiveness comparable to currently available H_2S reduction processes. Appropriate incentives for such processes will be determined by NYSERDA based on the effectiveness compared to currently eligible processes.

H_2S reduction technologies are currently in a stage of significant development and improvement. The incentive structure created for H_2S reduction in PON 2828 is based on current information about these processes and may not be comprehensive. However, NYSERDA may periodically review and amend the incentive structure in PON 2828 created for H_2S reduction processes and the eligible technologies shown above to accommodate new developments in H_2S reduction technology and to provide more appropriate incentives.