**Take-home quiz for Module 5: Start up, operational monitoring & H2S**

Start-up

1. If a digester is started by filling with fresh manure or feedstock, which of the four steps of AD occurs first?
2. How can you jump start the AD process at start-up and achieve methane production more rapidly?

Operational parameters

1. During start-up, operators monitor four key parameters. What are they, and how should they change during a good start-up?
2. What are Zickefoose and Hayes seven keys to successful AD operation? List them, and rank them in terms of ease of monitoring and control, in your opinion.
3. Why is the Ripley ratio a more valuable operational parameter than pH?
4. Efficiency of AD can be monitored using either destruction of volatile solids (VS) or destruction of volatile fatty acids (VFA).
   1. Which parameter is easier to monitor?
   2. Which gives you more information about the AD value of your feedstock?

AD failure / underperformance

1. While the rates of AD failure have decreased since the late 1990s, short-term failure and underperformance are still too common.
   1. Name four causes of underperformance.
   2. Name at least two actions that could reduce underperformance.

Safety

1. Like any process combining mechanical, electrical, chemical and biochemical operations, anaerobic digestion poses a wide variety of safety challenges for its operators. Most components of biogas can endanger human health. What are the hazards posed by:
   1. Methane
   2. Carbon dioxide
   3. Hydrogen sulfide
   4. Ammonia
2. While a number of gases are human health hazards, digester operators often focus on H2S.
   1. How much H2S is usually produced by AD of dairy manure?
   2. What levels of H2S can harm internal combustion engines, the most common technology of converting biogas to electricity?
   3. What effect does H2S have on methanogenesis?

Lowering levels of H2S in biogas

1. What preventative or prophylactic steps can operators take to lower the levels of H2S produced in biogas?
2. Oxygen can be added to the biogas in a digester’s headspace to decreased H2S levels via a biological process.
   1. What organisms use the oxygen to lower H2S levels?
   2. What’s the most significant hazard of this method?
3. What is the difference between biogas and biomethane?
4. H2S can be removed or scrubbed from biogas by a number of chemical methods. Name and describe four methods of chemical scrubbing.
5. Based on economic comparisons of technologies for decreasing or scrubbing H2S and their operational complexities, identify the method you think would be most effective. Explain your decision.