**Assessment for Module 5: Start-up, operations & process monitoring**

***Instructions:***

1. *Watch the video for each topic.*
2. *Answer the questions for that topic. You are welcome to type your answers to this Word document.*
3. *Some questions will refer to links provided with this module’s web page.*
4. *Email the completed document to jrichmond@vtc.edu.*

**5.1: Four steps of AD**

1. List current feedstock materials used at VTCAD and classify each as either complex or simple organic matter.
2. What are the three most abundant or critical components of biogas? What are their typical concentrations?

**5.2: AD start-up**

1. Following start up, how long does it take to reach steady state gas production in anaerobic digestion?
2. List three actions that can be taken to increase the speed of start-up and explain how they do so.
3. During start-up, how should each of these operational parameters change:
   1. pH
   2. VFA levels
   3. biogas composition
   4. temperature
4. What is the worst season in which to fill and start-up an anaerobic digestion system?

**5.3: Operation & control**

1. For mixed digesters, continuous feeding is recommended and preferred to daily feeding. Why does that make sense?
2. What is the Ripley ratio and what does it tell you? Why is a great indicator of AD process stability?
3. Hydrosulfuric acid (H2S) is an undesirable component of biogas; it doesn’t contribute to biogas energy content. Why are H2S levels monitored by operators?
4. What is the major advantage of on-site testing? Why not send samples off to outside labs?

**5.4: Reasons for AD failure**

1. Name four common reasons for failure of anaerobic digesters.
2. The Foster Brothers Farm’s anaerobic digester was built in 1981 and was one of the first AD systems in Vermont. However, the AD system is now ‘dormant’. Use the profile of the Foster Brothers Farm system linked at Module 5 to answer these questions:
   1. How long did the digester operate?
   2. What caused operations to stop?
   3. What is the cost of putting the system back into operation?
   4. What does Robert Foster see as the major challenges to on-farm AD?
   5. What major maintenance did the Foster Brothers Farm AD system require while it was in operation?
3. If you were considering building an anaerobic digester, what might you hope to learn from an engineering review? What is meant by the term ‘third-party’, and why is third-party review wise?
4. Given your work experience at VTCAD, how many hours per day do you estimate are required to run the plant? How many of those hours are devoted only to operations and maintenance and not to feedstock reception or management of effluent?
5. Does the Vermont Tech farm treat hooves? If so, what chemical is used and how frequently is it used?

**5.5: Safety concerns**

1. While we focus, understandably, on threats to human health, failed or improperly operated AD plants also pose threats to the environment. Describe how AD could adversely impact the environment.
2. Hydrosulfuric acid is a particular safety concern at AD facilities. Use the links provided with this module to learn more about the hazards of this minor component of biogas.
   1. Is H2S more or less dense than room air?
   2. What level of exposure do you feel comfortable with?
   3. What treatment can be used to treat exposure to H2S?
3. Is anyone at VTCAD trained to enter confined spaces? And what areas of VTCAD could be described as confined spaces?
4. Les Gornall’s summary of the ZEBEC report an accidents at AD plants presents some data on the most hazardous aspects of AD plants. According to this summary:
   1. What is the most hazardous aspect of anaerobic digestion?
   2. How many deaths were reported worldwide from 2003 to 2011?

**5.6: Understanding & managing H2S**

1. What types of equipment could be used to generate electricity from unscrubbed biogas without damage?
2. Why does reducing the availability of sulfur to microbes increase methane production?
3. Levels of hydrogen sulfide in biogas can be lowered by preventative means or by post-digestion treatment. Which of the strategies mentioned in Module 5 are preventative and which are used for post-production treatment of biogas?
4. How is effective dosing of FeCl3 determined?
5. What are the common hazards of these H2S strategies: oxygen infusion and regenerated iron sponge?
6. What H2S management strategies are eligible for funding via NYSERDA? Use the link posted on the Module 5 web page!