**Exercises for Module 6: AD Feedstock**

To complete this exercise, refer to the feedstock energy value tables and other feedstock testing information posted in the appendices to the AD Apprentice Operators course at richmond-hall.weebly.com.  
You may find it worthwhile to create Excel spreadsheet(s) to answer these questions and understand feedstock formulation.

1. Forage tests often report concentrations in terms of pounds of element per 1,000 gallons of tested material. Testing of a feedstock material shows it to have 2,000 lb/1,000 gallons of carbon and 200 lb/1,000 gallons of nitrogen.
   1. What is the material’s C:N ratio?
   2. Which is limiting (ie in short supply) carbon or nitrogen?
   3. How many lb of carbon would you have to add to 1,000 gallons of this material to achieve a C:N ratio of 25:1?

Bonus: How many pounds of sucrose (table sugar) would give you that much carbon?

1. Your feedstock has is 5% TS with a VS content of 80% and you are feeding 666.6 gallons per hour. Your system destroys 50% of VS content. What is the estimated range of your biogas production with this feedstock, feeding rate and efficiency? Give both low and high estimates.
2. Distillation and titration tests of your feedstock and slurries show these concentrations of VFAs:  
   prep pit 5,000 mg/L  
   hydrolyzer 10,000 mg/L  
   AD tank 800 mg/L  
   effluent 700 mg/L  
   Calculate the efficiency of the AD process as percent VFA destruction at each step. And why is the VFA concentration highest in the hydrolyzer?
3. Using values presented in the Module 5 presentation, calculate the average C:N ratio of a feedstock mixture of:

5000 gallons of dairy manure   
1250 gallons of grass silage

250 gallons of garden waste   
500 gallons of grass clippings   
1,000 gallons of brewery waste   
500 gallons of food waste

1. What is the percentage of on-farm feedstock material in the recipe described in the previous problem?
2. Using feedstock mixture presented in the table below, and Bio-Methatech feedstock data (linked on the webpage for Module 6) calculate:  
   a. average %TS  
   b. average %VS (aka OM)  
   c. average C:N ratio

d. biogas yield  
e. average % methane  
f. electric yield

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **gallons** | **% TS** | **% VS** | **C:N** | **biogas**  **(m3/tonne VS)** | **% CH4** | **kWh** |
| Dairy manure | 5,800 | 8.5 | 76.5 | 19.5:1 | 400 | 55 |  |
| Heifer manure | 1,250 | 19 | 80 | 20:1 | 450 | 55 |  |
| Grass | 500 | 17 | 91 | 16:1 | 840 | 55 |  |
| Silage (grass) | 750 | 37 | 85 | 16:1 | 500 | 53 |  |
| Effluent | 1,500 | 2 | 5 | 10:1 | 100 | 50 |  |
| Beer | 2,000 | 10 | 91 | 10:1 | 660 | 61 |  |
| glycerol | 200 | 100 | 99 | 100:1 | 850 | 50 |  |
| **Total** | **12,000** |  |  |  |  |  |  |

1. Use data from one of the feedstock databases linked on the website for Module 6, create a diet that would allow VTCAD to operate at full power. You may only use off-farm feedstock materials that VTCAD ***DOES NOT*** use. Be sure to consider volume, %TS, C:N, power output, and the 51% on-farm requirement. I suggest creating an Excel spreadsheet like the one shown in 6.7.