**MEC3040 Module 11 Lab exercise: Design of an optimized AD diet - KEY**

*To complete this exercise, refer to the feedstock energy value tables and other feedstock testing information posted in MEC 3040 Module 11 richmond-hall.weebly.com.
You may find it worthwhile to create Excel spreadsheet(s) to answer these questions and understand feedstock formulation. In any case, please show all work for credit!*

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.

(a) What is the material’s C:N ratio?

(b) Which is limiting (ie in short supply) carbon or nitrogen?

(c) 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?

*(a) 10:1*

*(c) 5,000 lb/1000 gallons*

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.

 *low = 910 m3 biogas/day [37.9 m3/hour]
 high = 1,359 m3 biogas/day [50.5 m3/hour]*

1. Using values presented in the Module 11 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
*Avg C:N = 15.7:1 Needs more carbon!*

1. What is the percentage of on-farm feedstock material in the recipe described in the previous problem?
 *% on-farm =82.4%*
2. Using feedstock mixture presented in the table below, and Stephane’s feedstock data table (posted in Module 11 on richmond-hall.weebly.com) 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 the feedstock data contained within the Module 11 presentation (compiled by the Sustainable Energy Authority of Ireland) to create a diet that would allow VTCAD to operate at full power. You may only use 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!