**HW for Module 4: Types of AD Technology**

In addition the questions for each section of Module 4, fill out the following table to compare and contrast the variety of AD technologies described in Module 3. If you type your answers in the cells will expand to accommodate your response. Add any additional notes or qualifications below the table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **AD technology** | **Cost**  **(high or not)** | **Operation**  **(simple or complex)** | **Mixing**  **(yes / no)** | **Efficiency**  **(low to high)** | **HRT**  **(days)** | **Feedstock notes** |
| Passive |  |  |  |  |  |  |
| Complete mix |  |  |  |  |  |  |
| Plug flow |  |  |  |  |  |  |
| + solids recycling |  |  |  |  |  |  |
| Fixed-film |  |  |  |  |  |  |
| Suspended media |  |  |  |  |  |  |
| Sequencing batch |  |  |  |  |  |  |
| Dry AD |  |  |  |  |  |  |

**4.1: Introduction**

1. What thee essential functions do all AD designs have to perform?

**4.2: Passive AD systems**

1. What is “passive” about lagoon AD?
2. What factor most significantly limits the potential of lagoon AD in Vermont?

**4.3: Low-rate AD systems**

1. What does the term low-rate refer to?
2. What is the difference between one-phase and two-phase complete-mix AD? And which is more efficient?
3. What is meant by “wash out”?
4. Why are plug-flow tanks sometimes formed in a “C” or “U” shape rather than a straight trough?
5. Speculate about why plug-flow AD is used more frequently on farms than complete-mix AD.

**4.4 High-rate AD systems**

1. What does the term “high-rate” refer to?
2. What is meant by the term “biofilm”?
3. Why does removing solids from the feedstock of fixed-film digesters lower both HRT and biogas production?
4. What is the critical difference between fixed-film and suspended-media AD sytems?
5. If you were operating a sequencing batch AD system, how would you decide when to end the reaction phase? What data would you use to make the decision?
6. What do all three of the low-rate AD technologies described here have in common?

**4.5: Dry AD systems**

1. What are the specific feedstock requirements of feedstock materials for dry AD?
2. Why is the aerobic phase of dry AD longer than for most AD technologies?
3. Why is dry AD often combined with composting in Europe?

**4.6: Choosing an AD system**

1. Download the paper by Meyer and Power (2011) and use their simple formulas to calculate the cost of these AD systems for a herd of 500 head of cattle:
   1. Covered lagoon AD
   2. Complete-mix AD
   3. Plug-flow AD
2. List at least six types of data input required by the digester economics spreadsheet’s developed by Lazarus at the University of Minnesotta and by Glory at Cornell.

**4.7: ‘Extras’**

1. What type of feedstock do some state’s fear might be enriched for human pathogens?
2. Would you compress biogas before scrubbing?
3. Why is nutrient separation the holy grail of ‘AD’ technologies?