



## STEP 4

### Steps in the Anaerobic Digester Series

1. Understanding and Technical Feasibility
2. Estimate Potential
3. Economics
- 4. Selection**
5. Maintenance

# E<sup>3</sup>A: Anaerobic Digester Applications for the Farm or Ranch

## Selecting the Appropriate Anaerobic Digestion Technology and a Technology Provider

Many companies specialize in installation of anaerobic digesters. Some of these companies are new, and others have been around for more than 30 years. Recent technological improvements in anaerobic digesters have made them more successful on-farm, however anaerobic digestion is still a buyer-beware market. Technology providers often offer one anaerobic digestion technology, and it is important for you to know if a given technology is a good fit for your site or not. Educating yourself about anaerobic digester technologies and their fit to your facility before contacting technology providers is a valuable exercise.

## Guidance for Anaerobic Digestion Technology Selection

Several different technologies are available for anaerobic digestion including; covered lagoons, plug flow, complete mix, upflow sludge blanket, and fixed film reactors. Technology selection is highly dependent on solids content (Table 1). Of note is that swine waste is generally in the form of a slurry (<15 percent solids) and thus amenable to conventional anaerobic digester technology while cattle waste collected from dry lots can be very high in solids content (>50 percent). Dairy manure collected on concrete (by scraping) generally has a total solids content between 10-16 percent, while flushed manure can have a solids content less than 3 percent, but can vary substantially depending on the amount of water used for flushing manure. You can use the online decision support tool for additional guidance on technology selection based on your current waste management method(s).

**Table 1. Recommended Waste Solids Content for Anaerobic Digestion Technologies.**

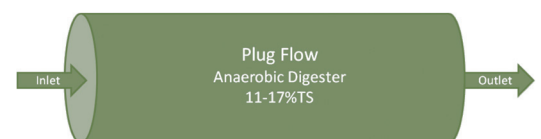
Technology	Recommended Waste Solids Content
Plug Flow	11-17 percent
Complete Mix	5-10 percent
Upflow Sludge Blanket	1-5 percent
Covered Lagoon	<3 percent
Fixed Film	<1 percent

### Covered Lagoons

Covered lagoons are one of the cheapest and simplest anaerobic digestion technologies available. Anaerobic digestion and subsequent production of methane takes place naturally in lagoons which contain animal wastewater. A synthetic cover, typically plastic or rubber is used to trap and store the biogas. Covered lagoons are difficult to heat and they are only recommended in warm climates where freezing temperatures are rarely observed. Too little methane is generated by covered lagoons during cold winter months to justify installation of biogas capture and use equipment.

### Plug Flow

Plug flow digesters are a low tech anaerobic digestion technology for treatment of high solids content waste (Table 1). The thick, high solids content waste travels down the digester in a “plug,” as a continuous mass.



*Plug Flow Anaerobic Digester (figure developed by Lucas Loetscher, Colorado State University)*

Plug flow digesters can be a good fit with the high solids content waste generated by animal feeding operations in the arid west.

### Complete Mix

Complete mix reactors are large, often cylindrical, tanks which have a mechanism to keep the reactor completely stirred.

The stirring mechanism can be injected biogas, or a motorized paddle. Mixing produces an ideal environment for anaerobic microorganisms by spreading the nutrients evenly throughout the reactor, while simultaneously helping to dampen shock loads of toxins which may enter the system since influent is instantaneously diluted through mixing. Complete mix reactors operate best when solids content is between 5-10 percent (Table 1). Because solids content of waste produced at most intermountain west cattle feeding operations is higher than 5-10 percent, complete mix reactors are often not a good fit unless an external source of water or wastewater is readily available.



Complete Mix Anaerobic Digester (figure developed by Lucas Loetscher, Colorado State University)

### Upflow Sludge Blanket

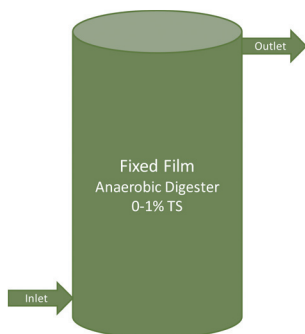
Upflow sludge blanket reactors are similar in design to a complete mix reactor, except that there is no integrated mechanism for homogenizing the waste. Instead, settling of solids is encouraged so that a sludge blanket is formed, maintaining biomass within the system, thus reducing the required holding time. These reactors are highly efficient and have been successfully up-scaled to the commercial scale. In general, waste generated at intermountain west animal feeding operations is too high in solids for application of an upflow sludge blanket reactor.



Upflow Sludge Blanket Anaerobic Digester (figure developed by Lucas Loetscher, Colorado State University)

### Fixed Film Digesters

In a fixed film digester, bacteria colonize a provided support structure within the reactor. This support structure is a high surface area material suitable for colonization, such as PVC pipe or shredded plastic. Fixed film reactors have successfully been implemented with low solids



Fixed Film Anaerobic Digester (figure developed by Lucas Loetscher, Colorado State University)

content (< 3 percent) dairy manure wastewaters in Florida, but are not likely to be a good fit with wastes produced in the arid west.

## Technology Provider Selection

After you have gained some knowledge on appropriate anaerobic digestion technologies for your operation, you are ready to contact technology providers. You may choose to hire a consultant who will guide you through the process of technology provider selection. However, make sure that the consultant is not tied to a specific technology provider. Some technology providers may assist you with project financing, although it is also important to consider all financing options. Below follows a list of questions that should be asked of a technology provider.

1. **How many on-farm anaerobic digesters does your company currently have in operation and where are they located?** The advantage of going with a company that has a large number of successfully operating projects is lower risk. Some of the newer companies offer novel systems that can be advantageous compared to conventional systems, however there is more risk in investing in a newer technology provider. Newer technology providers should be considered, but you need to make sure that technologies have been successfully demonstrated on-farm at a large scale. You should ask to speak with producers who have been involved in demonstrations. Many companies will also have published case studies which they can provide.
2. **Of the operating digesters, how many are applied for animal feeding operation manure management?** A company that specializes in anaerobic digestion of manure may be a good choice. Several companies have emerged who specialize in anaerobic digestion of food and yard wastes collected in urban areas. Manure is very different from these urban wastes, and technologies developed for food and yard waste may not work well for anaerobic digestion of manure.
3. **Where are successfully operating anaerobic digesters located? Are you willing to take on projects in the Mountain West region?** Many technology providers have regions where they have had a lot of success, and may not be willing to move outside of their current service area. Companies that have experience working in the Mountain West region and are familiar with the challenges associated with working in arid climates may be a more suitable choice.
4. **What types of anaerobic digestion technologies does your company provide?** Some companies may only offer one technology type (i.e. complete mix, plug flow, upflow sludge blanket, or fixed film). Make sure you work with a company that offers technologies

suitable to the waste generated at your farm (see above section “Guidance for Anaerobic Digestion Technology Selection” and the online decision support tool).

5. **What are the services your company provides?** You need to be sure of what services the company provides, and determine if you will need to find additional support for other services.
6. **Are there case studies of your technology that you can share?** Many technology providers have published case studies of their technology. If such publications are available, you should review them. This will help you compare performance of various technologies.
7. **Is pretreatment required?** Some technologies will require pretreatment of waste. This can add substantial capital and maintenance costs to operation of an anaerobic digester. One example is pretreatment of waste to remove inorganics (rocks, soil, and/or sand). Make sure you understand the entire process before investing.
8. **How long are your project design, construction, and system lifetime on average?** Make sure you understand how long it will take to install the system and what the expected lifetime for the system is.
9. **Does your company provide a performance guarantee and/or warrant and if so what are the details?** Different technology providers will provide different guarantees and/or warranties and you should understand the details of those so that you can make comparisons between different companies.
10. **Does your company provide support and guidance for handling of end products?** The end-product of anaerobic digestion is a slurry, which can either be land applied or must be disposed of (see Handling of End-Products in Step 1: Understanding Anaerobic Digestion and Consideration of Technical Feasibility). Some technology providers do not provide support for handling of end-products and you need to make sure you consider how you will handle the end product. The costs and maintenance of handling end products must be considered in the project feasibility study. You will need to determine how much support the technology provider or consultants you are working with can provide in this area.
11. **Will your company hire any subcontractors to complete portions of the project design/construction?** Make sure you understand who will be the project team and that you are comfortable with the design-build process.
12. **What kind of training is provided to the client by the technology provider?** Installation of an anaerobic digester will increase maintenance required for animal waste management compared to composting or lagoon management (see Step 5: Maintaining Your Anaerobic Digester). You need to make sure that the technology provider you work with is clear about maintenance activities which will be required after initiation of operation. Anaerobic digester operation will be more successful if the technology provider provides a clear plan for maintenance activities and training on these activities.
13. **Will the technology provider help coordinate project financing?** As with any large capital investment, it pays to research financing options. Numerous federal and state funding programs that provide grants, reduced interest loans, and/or tax credits for anaerobic digesters. A good place to start your research is the U.S. Environmental Protection Agency Ag Star website. This link will take you directly to the funding programs: <http://www.epa.gov/agstar/tools/funding/index.html>  
Several technology providers offer loans directly for anaerobic digestion projects. The technology provider may also help you to navigate through the numerous federal and state grant or loan programs that are available. The technology provider might be able to connect you with privately funded niche programs, including green house gas mitigation programs.  
Your local ag bank may be your best financial resource. While the technology provider might be able to help coordinate project financing, be sure that you fully understand the project financing package offered.



