ENVIROQUIP, INC.

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AERATION EQUIPMENT *(512) 834-6000 • fax: (512) 834-6039*

PAD®-K AEROBIC DIGESTION

Introduction

The PAD®-K process (Pre-thickened Aerobic Digestion with Membrane Thickener) provides integrated operation of a Kubota flat-plate membrane thickener and two or more aerobic digesters. By operating these units as a combined system, improved treatment is achieved. Specifically, the PAD-K process provides the following benefits:

- ✓ Digested Sludge Product exceeds Class B requirements
- ✓ Improved pathogen destruction at shorter solids retention time
- ✓ Smaller volume of digested sludge
- ✓ Continuous and automatic thickening to 3% solids without use of chemicals
- ✓ Zero TSS and reduced phosphorus returned to main treatment process
- ✓ Enhanced pH and temperature control
- ✓ Operational reliability using Enviroquip's non-clogging medium-bubble aeration systems

The PAD-K process offers of a sludge handling system that produces a stabilized, homogeneous Class B sludge effectively, reliably, and with minimal operator involvement.

Process Description

The PAD-K process consists of two or more Aerobic Digesters operating in conjunction with an Anoxic (pre-mix) basin and Membrane Thickener (MBT). One aerobic digester forms a recycle loop with the MBT and Anoxic basin that causes the digested sludge to be continuously thickening while undergoing both nitrification and denitrification.

Raw sludge containing organic material is introduced into the Anoxic basin, where it is vigorously mixed with nitrified sludge recycled from the in-loop digester. The combined sludge mixture contains the necessary substrates (carbon and energy sources) for the sludge to be denitrified by microbial action under anoxic conditions.

The driving force for the circulating flow of sludge through the in-loop basins is a simple airlift pump operating at approximately 3Q flow. Sludge is airlifted from the Anoxic basin into the MBT where it is thickened by the action of pulling water (permeate) through the membrane plates using a small centrifugal pump. Thickened sludge overflows from the MBT into the Aerobic Digester where it is aerated and nitrification occurs, but using less aeration than normally required in a digester, due to the effect of alternating anoxic/aerobic phases. Digested sludge gravity flows from the Aerobic

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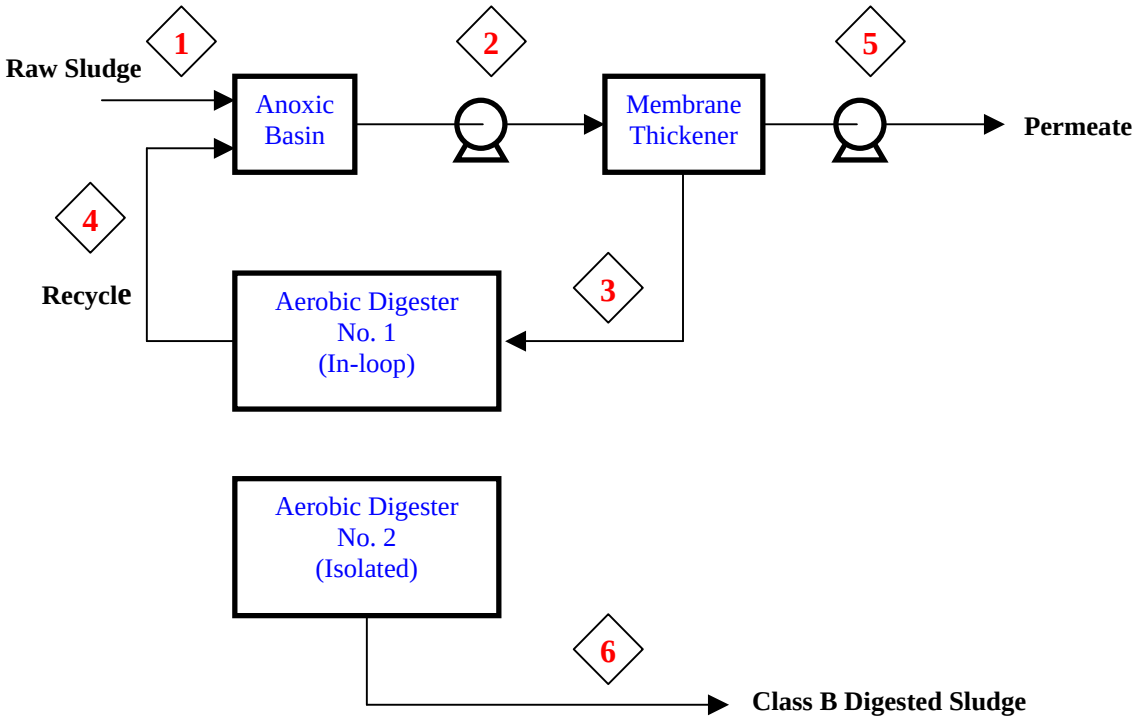
Digester to the Anoxic basin, where it is mixed with incoming raw sludge, completing the loop. In this manner the digested sludge is continually thickened and denitrified.

Figure 1. Process Flow Diagram



Stream ID	**Description**
1.	Raw sludge and scum from liquid treatment process
2.	Combined Membrane Thickener (MBT) Influent
3.	Thickened Sludge and Scum gravity flow from MBT
4.	Nitrified Sludge gravity flow from In-loop Aerobic Digester
5.	Membrane Thickener Permeate
6.	Class B Digested Sludge Product

While Digester No. 1 is “in-loop” with the Membrane Thickener and Anoxic Basin, Digester No. 2 continues to be aerated, but is isolated from incoming sludge. Sludge is drawn off of the isolated Digester for dewatering or disposal. Periodically, the Digester functions are “switched” so that Digester No. 2 is “in-loop” and Digester No. 1 is

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isolated. The batch operation of the isolated aerobic digester provides for improved volatile solids reduction and pathogen removal.

Process Control

In order to optimize volatile solids reduction and maintain a proper balance between nitrification and denitrification we recommend monitoring the aerobic digester pH, temperature, and DO on a daily basis or, if possible, continuously as part of the plant SCADA system. The TSS and VSS of the aerobic digesters and gravity thickener sludge should be measured weekly to track thickener performance and volatile solids reduction.

Other analyses, such as ammonia, nitrate, and alkalinity, are recommended for startup and troubleshooting. Fecal Coliform and SOUR measurements are required periodically to satisfy Class B treatment requirements.

The recommended monitoring parameters, analysis frequency, and operating ranges for the aerobic digester basins are shown in the table below. Analysis frequency should be increased during startup and during those times when large changes are made to operating conditions (sludge flow, sludge source, aeration rate, etc.).

The measurements of temperature, pH, DO, etc. should be recorded in a process control log to assist in operations and trouble-shooting. Sample log sheets are attached that may be used as is or modified to fit the needs of the facility.

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Table 1. PAD-K Monitoring Parameters and Analysis Frequency

Monitoring Parameter	Frequency	Operating Range		
		Minimum	Nominal	Maximum
Temperature, °C	Daily	15	20	34
pH	Daily	6.8	7.0	7.2
DO, mg./L	Daily	0.1	0.4-0.8	2.0
TSS / VSS, mg/L	Weekly	- [1]	- [1]	- [1]
Alkalinity, mg/L as $CaCO_3$	Monthly [2]	100	> 500	-
Ammonia-N, mg/L	Monthly [2]	-	< 20	40
Nitrate, mg/L	Monthly [2]	-	< 20	-
Nitrite, mg/L	as required	-	< 10	-
SOUR [3], mg O_2/g TS/hr	as required	-	-	< 1.5
Fecal Coliform [3], CFU	as required	-	-	< 2 Million

Notes:
1. Operating range will vary
2. Or as required
3. Recommended for satisfying Class B requirements of Digested Product

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Producing Class B Sludge using Aerobic Digestion

The following discussion is based on EPA requirements detailed in 40 CFR Part 503 and in EPA Guidance Document 625 R-92/013 Control of Pathogens and Vector Attraction in Sewage Sludge. The information presented is for training only and readers are referred to the above referenced documents for a complete treatment of Class B sludge regulations.

Aerobic Digestion is one of five Processes to Significantly Reduce Pathogens (PSRP's) listed in Appendix B of 40 CFR Part 503. Under Part 503.32, in order for treated sewage sludge to be considered Class B with respect to pathogens, fecal coliform densities must be reduced to less than 2 million Colony Forming Units (CFU) per gram of dry total solids and Salmonella sp and enteric virus densities must be reduced by a factor of 10.

By definition, aerobic digestion qualifies as a PSRP if aerobic conditions are maintained for a sludge retention time (SRT) between 40 days at 20°C and 60 days at 15°C. The definition does not distinguish between batch, intermittently fed, and single-stage systems. It is known that batch or staged digesters reduce pathogens more effectively than a single-stage digester with the same overall residence time. SRT required for batch or staged digesters to meet pathogen reduction requirements may be 30% lower than the PSRP definition. Thus, the SRT required for batch or staged systems can be reduced to between 28 days at 20°C and 42 days at 15°C with approval of the permitting authority.

Class B sludge applied to agricultural land, forest, or reclamation sites must also meet vector attraction reduction requirements. For aerobically digested sludge, there are two options: 1) at least 38% reduction in volatile solids or 2) SOUR (20°C) ≤ 1.5 mg Oxygen/hr/g total solids.

PAD-K treatment systems are designed to produce a stabilized sludge meeting Class B requirements with respect to pathogens and to meet EPA vector attraction reduction requirements for the land application of Class B sludge