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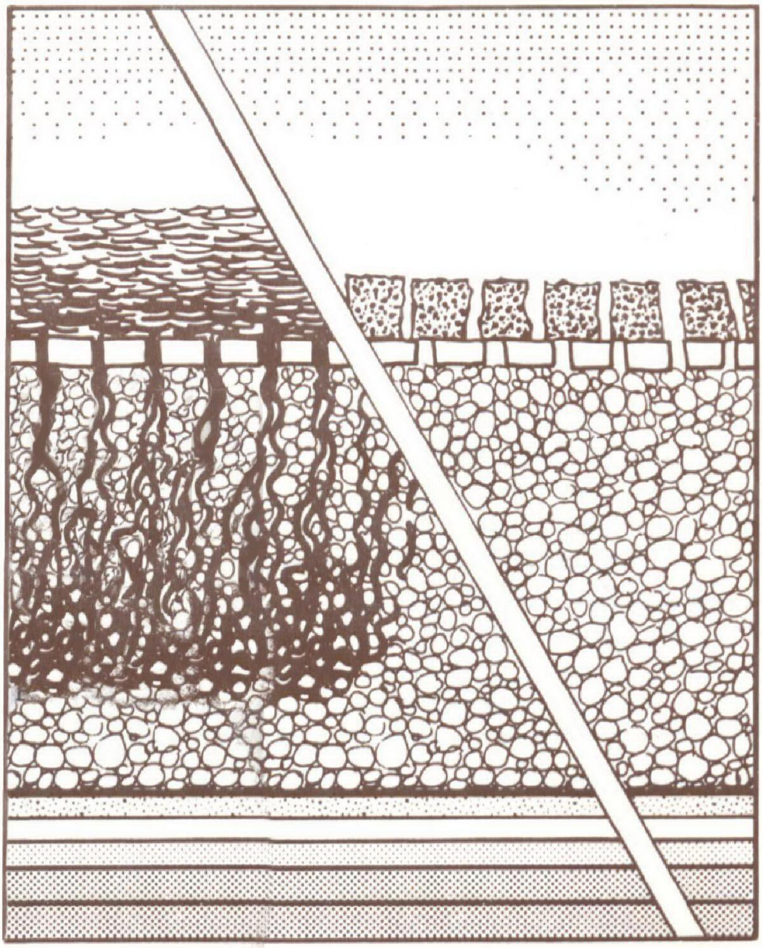
Vacuum Assisted Sludge Dewatering Beds (VASDB)

An Update



Vacuum Assisted Sludge Dewatering Beds (VASDB) - An Update

Introduction

A study was undertaken to evaluate twelve operational municipal treatment plants utilizing vacuum assisted sludge dewatering bed (VASDB) processes. The purpose of the study was to collect information on the design, operation, performance, cost, and improvements made to the VASDB process. The purpose of this brochure is to update an earlier brochure on VASDB with the improvements found during the study. The twelve facilities represented VASDB processes marketed by three manufacturers: Infilco Degremont, Inc., SDS Company, and U.S. Environmental Products, Inc.

While many smaller-sized conventional treatment plants use sand drying beds for sludge dewatering, VASDB has two advantages: (1) less land area is required, and (2) greater operational control can be maintained. VASDB has further advantages over other mechanical dewatering processes by lowering costs and easing operation.

Process Description

The basic component of the VASDB (Figure 1) consists of a support structure upon which media plates are laid. The media plates are underlaid with a filtrate collection/drainage system which is connected to an adjacent air tight filtrate sump. The media plates are sealed to one another and to containment walls to prevent solids seepage to the filtrate system.

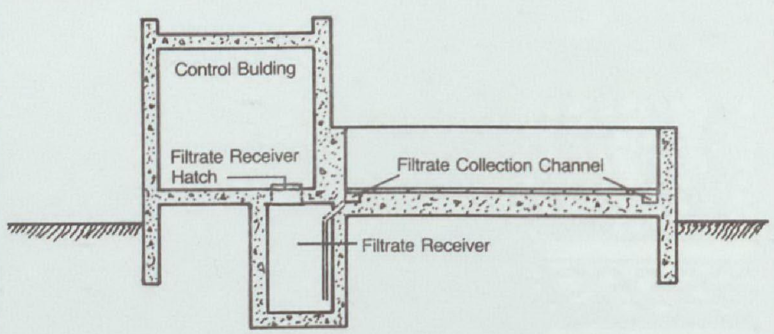


Figure 1. Cross-Section of VASDB System

The sludge is mixed with polymer prior to being distributed on the media plates. Once the plates are covered with sludge, filtrate valves are opened to allow gravity dewatering of the sludge. Gravity dewatering continues until the filtrate collection rate slows. The vacuum cycle is then initiated. The vacuum sequence generally proceeds in steps; the highest vacuum level continuing until the sludge cake cracks and vacuum is lost. Table 1 presents a typical vacuum sequence.

Stage	Vacuum (in. Hg)	Duration (hours)
Gravity dewatering	0	1 to 5
Low vacuum	1 to 4	1 to 2
Intermediate vacuum	5 to 8	1 to 2
High vacuum	10 to 15	1 to 2
Air drying	0	variable

Table 1. Typical Vacuum System Scheduling

The sludge cake is then air dried until the solids level is high enough for the sludge cake to be considered "liftable", meaning able to be removed mechanically leaving only a small amount of residue behind. A small tractor is most often used for cake removal operations. The plates are then cleaned and prepared to receive the next sludge application.

Design Considerations

One of the goals in studying operating VASDB systems was to identify any design modifications made to improve performance. In general, however, the basic design features (Table 2) have remained unchanged.

Bed Geometry and Size	Standard sizes are 20′ × 20′ or 20′ × 40′; media plates are generally 2′ ×2′ or 2′ × 4′. The number of VASDBs per facility range from one to four depending on operation flexibility and schedule desired.
Bed Loading Factors	Manufacturers suggest 1-2 lb dry solids/ft^2 per cycle for digester sludge; less for waste activated sludge, and higher for Imhoff tank sludge or lime stabilized sludge. Facilities have been able to increase loading by decanting clear supernatant from sludge bed, then adding more sludge.
Feed Sludge Tank	Since optimum polymer dosage is a critical parameter to sludge dewatering, it is suggested that a feed sludge tank be included in designs where polymer mixing and addition are provided.
Polymer Make Up & Feed System	A polymer feed pump which can be adjusted during operation is necessary since sludge characteristics may change during bed loading.
Polymer-Sludge Mixing	Mixing is provided in some systems by air injection, residence time, or a series of 90 degree or 180 degree elbows.
Sludge Pumping & Distribution	A uniform sludge loading on the plates must be maintained, otherwise premature loss of vacuum may result. It was suggested that bed flooding at the start or use of dual discharge headers may improve uniformity.

Table 2. Design Considerations for VASDB

The typical bed size of the VASDB is 20′ × 20′ or 20′ × 40′ since media plates are generally 2′ × 2′ or 2′ × 4′. The typical number of VASDBs per facility ranges from one to four. A minimum of two beds, and preferably three, is recommended. This will enable a facility to operate two beds per 24-hour cycle (one idle), five days a week, on a 21-day rotation.

The depth of sludge which can be applied varies and is dependent on the solids concentration of the feed sludge. At some of the facilities evaluated, the beds were loaded with sludge to depths below the recommended levels which underutilized the VASDB. Other facilities have been able to increase loading by decanting the clear supernatant from above the sludge bed then applying additional sludge. This enables solids loadings above those suggested by the manufacturers to be achieved.

Chemical conditioning of the sludge is accomplished by polymer addition to improve sludge dewaterability. Polymer dosage is a critical parameter for sludge dewatering. Operators typically judge proper dosage visually during application. Since sludge characteristics can change during bed application, an adjustable polymer feed pump is necessary. Another way to control this variability is to include a sludge feed tank in the design in which polymer addition and mixing would occur prior to application.

Another important design consideration is the uniformity of sludge loading for prevention of a premature loss of vacuum. Flooding the bed with one inch of clear water is suggested by one manufacturer as a way to enhance the uniformity of sludge application.

Operational Considerations

The most critical aspect of VASDB system operation is the selection and control of the polymer dosage. This is important from a cost standpoint as well as for the potential effect that improper dosage has on the VASDB system. Underdosage results in a wet, sloppy cake which is difficult to remove; overdosing results in unreacted polymer clogging the media plates. Jar tests and filtration tests therefore are recommended for selecting a polymer and proper feed rates.

Decanting of the supernatant is an operational consideration especially recommended for dewatering dilute, aerobically digested sludge. In addition, gravity drainage is recommended to continue for an extended period of time, at least until 50 percent of the liquid volume is removed.

Several installations have experienced plugging of the media plates with oil and grease. Special maintenance procedures may be needed to restore the plates to their original high permeability. These procedures include cleaning with a variety of agents such as high pressure hot water, acids, alkalis, hypochlorite, enzymes and lime, or repairing the plate surface.

Cost Comparisons: VASDB vs. Sludge Drying Beds
Costs were developed to compare covered and uncovered VASDB systems to uncovered, roofed, and totally enclosed sand drying beds for a wastewater treatment plant generating 2000 lb/day of aerobically digested sludge solids. It is important to note that a VASDB system is normally designed to yield only a liftable dewatered sludge cake in contrast to the sand drying bed which yields a much drier sludge cake.

Figure 2 presents sand drying bed estimated total system costs as a function of sludge solids loading rates. Also entered on the figure are the estimated total system costs for equivalent capacity uncovered and covered VASDB systems. The intersections in Figure 2 indicate the following:

- An uncovered VASDB system would be more cost effective than an uncovered sand drying bed at loading rates of less than 16-17 lb/ft^2/yr.
- A covered VASDB system would be more cost effective than a covered sand drying bed at loading rates of less than 38-39 lb/ft^2/yr.
- A covered VASDB system would be more cost effective than a totally enclosed sand drying bed at loading rates of less than 62-63 lb/ft^2/yr.

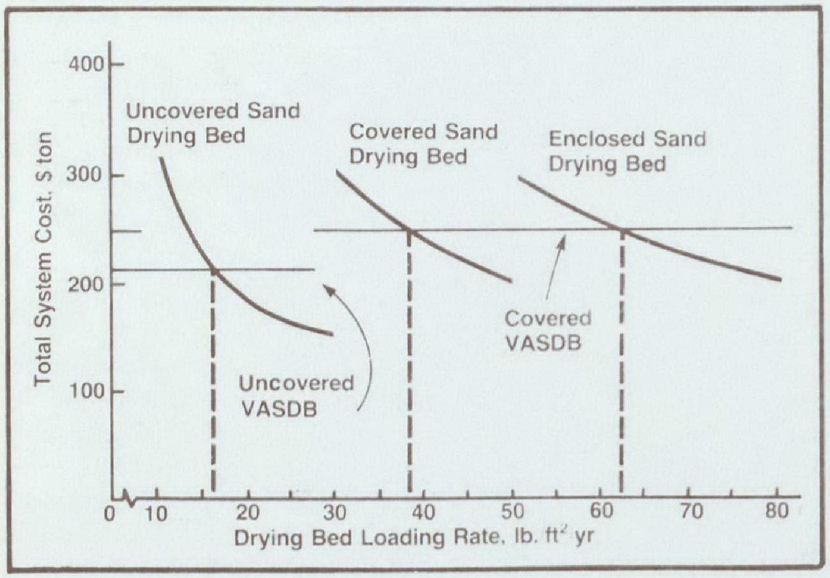


Figure 2. Estimated Sand Drying Bed and VASDB System Total Costs as a Function of Solids Loading Rate for Systems Processing 365 Tons of Sludge Solids/Year

New Developments
Both the manufacturers and system users have developed conceptual improvements for application to the VASDB technology. New media plate designs are being field tested and experimented with at various locations. It has been reported that one of the new designs can yield a drier cake when subjected to higher than normal solids loading rates. Another development is a device which is attached to the beds to measure permeability. This provides a mechanism to monitor media plate clogging or assess the effectiveness of the cleaning operations. Various bed geometries are also being investigated. One manufacturer has suggested flooding the bed with several inches of clear water to flood the oil and grease and keep it away from the media plate while the bed is being filled.

Recommendation
In summary, the VASDB process, under certain conditions, can be more cost effectively constructed than sand drying beds. The VASDB system is designed to operate with substantially shorter cycle times than sand drying beds and is not as severely impacted by adverse climate conditions.

In the design of a totally new municipal wastewater treatment plant, there is the potential for additional cost savings if a VASDB system is incorporated into the initial design. These savings might arise because minimal waste sludge solids storage facilities are required for a VASDB system which is designed to dewater sludge five days per week. Typical sand drying bed systems cannot be operated at such a frequency and thus must have an associated waste sludge solids storage facility. Cost savings associated with this aspect of a VASDB system should be thoroughly evaluated by design engineers comparing the total costs of VASDB and sludge drying bed systems.

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