Comparative Study of Dewatering Technologies for Sewage Sludge

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Abstract---Today, the treatment of water is a well-known process and is executed by state of the art techniques. The sludge resulting from this process represents the next challenge for the water treatment industry, in particular the minimizing of its volume. Now a days land is a premium and the use of open air drying might be offensive, are prime reason for the use of dewatering. The quantity of treated sewage as well as the level of their treatment results in the increasing amount of sewage sludge. Sewage sludge from water purification stations is difficult to handle. Sludge dewatering is a physical unit operation used to reduce the moisture content of the sludge and biosolids. Sludge dewatering reduce the transportation cost by reducing the volume of dewatering, easy to handle, increase the calorific value so that sludge dewatering is required. There are different types of sludge dewatering techniques but main aim of the paper is techno-economical comparison of belt filter press and centrifuge.

Keywords: Sludge, dewatering, unit operation, biosolids, belt filter press, centrifuge

I. INTRODUCTION

Sewage water is a well-known problem in any human agglomeration worldwide. The purification is achieved through a natural process by bacteria and microorganism growing in the basins of Waste Water Treatment Plants (WWTP). This biomass has to be evacuated from the basins in form of liquid sludge which is, generally speaking difficult to handle and difficult to dispose of! Different methods of treatment and disposal are possible:

The solids and biosolids resulting from wastewater treatment operations and the processes are usually in the form of a liquid or semi-solid, which typically contains from 0.25 to 12% solids by weight depending on the operation and processes used. Below table showing various types of sludge and biosolids from sewage treatment plant.

Sr No	Types of wastewater sludge	Total feed solids %
1	Raw primary	3 to 10
2	Raw WAS	0.5 to 4
3	Raw primary + WAS	3 to 6
4	Anaerobically digested primary	3 to 10
5	Anaerobically digested WAS	3 to 4
6	Anaerobically digested primary + WAS	3 to 9
7	Aerobically digested primary + WAS	1 to 3
8	Oxygen activated WAS	1 to 3

Table. 1: Types of Sludge and Biosolids from STP

II. DEWATERING TECHNIQUES

A. *Sludge Dewatering*

Sludge dewatering is a physical unit operation used to reduce the moisture content of the sludge and biosolids

B. *Sludge dewatering technologies*

There are 2 types of sludge dewatering technologies.

1. Natural dewatering techniques
   - Natural evaporation
   - Percolation
2. Mechanical dewatering techniques
   - Centrifuge
   - Filter press
   - Belt filter press

There are many dewatering technology but our main focus is belt filter press, centrifuge and sludge drying bed

1. Belt filter press: belt filter press is an industrial machine used for solid/ liquid separation process particularly the dewatering of sludges in the chemical industry, mining and wastewater treatment. Belt filter presses are designed for solids capacity, by weight or volume, rather than wastewater flow. Solid concentration must be determined based on the concentration of primary solids in th feed and further solids that may be precipitate during treatment. For most sludge type the feed dry solids concentration is typically the range of 1-10 %. The resulting dewatered sludge dry solid concentration typically falls in the range of 12-50%. The input to a belt filter is generally measured as the rate of dry solid loadings .[9]

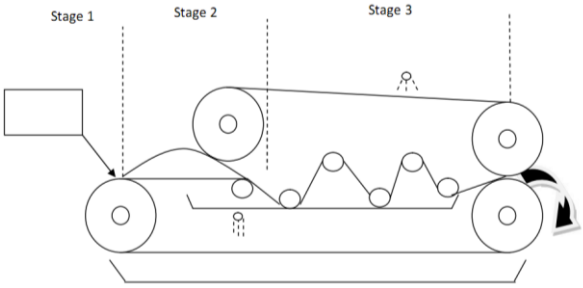

Fig. 1: schematic diagram of belt filter press

2. Centrifuge

The essential component of all centrifuges is rotating bowl in which the solids or heavier fractions in a liquid are separated by centrifugal settlement. The sludge is fed through a pipe entering the end of the vertical rotating bowl and the solids are collected and compacted at the bowl under the influence of centrifugal force. The batch operation makes these machine less suitable for handling large volume of sludge than a solid bowl centrifuge.

Centrifuge achieves water-solid separation by settlement and consolidation of solid under the influence of strong centrifugal forces generated in high speed rotating machine. It produce a sludge cake with 20- 25 % solids.

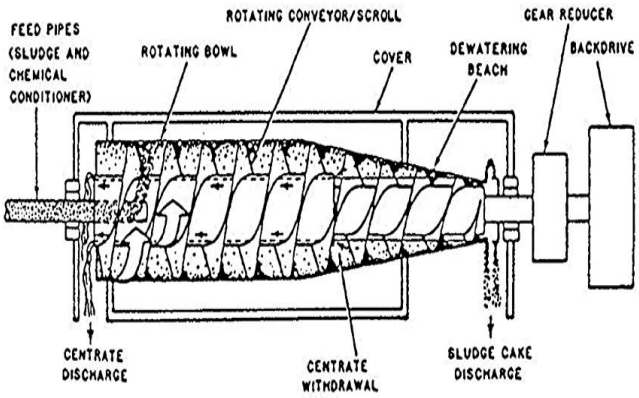

Fig. 2: Schematic diagram of centrifuge

C. Sludge drying bed

Sludge drying beds are used to dewater sludge by draining through the sludge mass and by evaporation from the surface exposed to the air. Usually collected filtrate is recycled in the treatment plant. Drying bed consist of 4-9 inch of sand which is paced over graduated gravel. Sludge can be removed from the drying bed after it has drained and dried sufficiently to be separable.

Sludge removal is accomplished by manual or mechanical by scrapper. Provision should be made for driving a truck along the bed to facilitate loading. mechanical device can remove sludge of 20 to 30% solids while cake of 30 to 40% concentration generally require manual removal.

Fig. 3: Schematic diagram of sludge drying bed

III. Results And Discussion

A. Belt filter press

Below tables showing capital and operation cost of belt filter press and technical data.

Descriptions	Capital cost
Primary sludge pumps (6) & valves (2)	1995988
Sludge thickner	2994012
Thickner mechanism	11976048
Digester	15000000
Digested mixing pump	600000
Belt press	39000000
Polyelctrolyte dosing tank	216000

Table. 2: Capital cost of belt filter press

Descriptions	operational cost
Primary sludge pumps & valves	444
Excess sludge pumps	67
Feed pump	148
TSPH	330
Wash pump	38
Digested sludge mixing pump	1350
Belt filter pump	296
Polyelectrolyte agitator	180
Polyelectrolyte dosing pump	180
Total	3033
Manpower	1500

Table. 3: operational cost of belt filter press

Parameter	Inlet	Outlet
Sludge consistency	3-5 %	25 %
Cost/ton	12	377

Table. 4: summary of technical n economical parameter of belt filter press

B. Centrifuge

Below table showing techno-economic parameter of centrifuge

Description	Cost of each	Total cost (vat/ contact/ profit etc)
Air grid pipe works for sludge sump	60000	159580
Air blowers	60000	172063
Motor	13983	40099
Centrifuge feed pump	64400	171282
Centrifuge with motor	1515000	4344605
Electric trolley	157680	209688
Polyelectrolyte dosing tank	54000	154857
With motor	58320	155111
Total		5407285

Table. 5: Capital cost of centrifuge

Description	Operating time	Energy cost	Chemical cost	Other
Air grid pipe works for sludge sump	-	-	-	
Air blowers	8-10 hr	-	-	
Motor	8-10 hr	185	-	
Centrifuge feed pump	16hr	296	-	
Centrifuge with motor	16hr	296	-	
Electric trolley	-	-	-	
Polyelectrolyte dosing tank	-	-	11	300 manpower
With motor	16hr	60	-	

Table. 6: operational cost of centrifuge

Parameter	Inlet	Outlet
Sludge consistency	0.8-2%	20%
Operation Cost/day	1148	
Cost/ ton		651

Table. 7: summary of technical n economical parameter of centrifuge

C. Sludge drying bed

Below table showing techno-economic parameter of sludge drying bed.

Description	Area	Cost
Land	38(400m^2)/ 18169 yard^2	181690000
Mechanism		500000
Total		182190000
Sludge generation	10ton/day	
Parameter	**Inlet**	**outlet**
sludge consistency	3-4%	50-70%
Manpower cost	Maintenance cost	Total cost
9000	3000	12000
	Per ton	Per day
Cost	40	400

Table. 8: summary of technical n economical parameter of sludge drying bed.

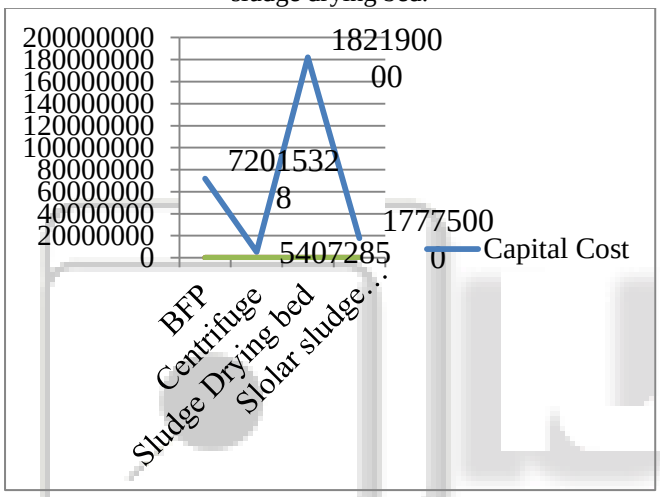

Fig. 4: capital cost comparison

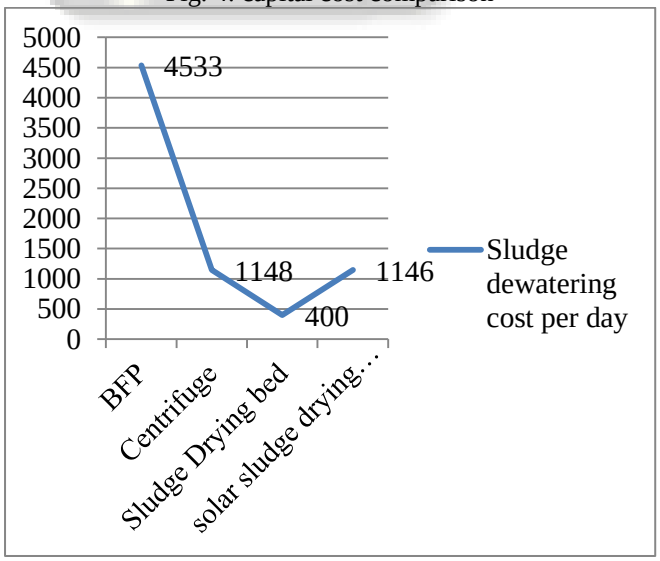

Fig. 5: sludge dewatering cost tons/ day

D. Discussion

Sludge characterization is important for any sludge dewatering technique. Sludge consistency, specific gravity and density are main factors. Comparative study of belt filter, sludge drying bed and centrifuge it is clear that belt filter press have high solid removal efficiency and large volume handling capacity compared to both and cost is also lower.

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