Experimental Research on the Properties of Sludge Thickening in Laboratory

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Received 6 July 2014, www.cmnt.lv

Abstract

Experimental research was performed to the properties of sludge thickening by increasing the pressure and shortening the path of water flowing in laboratory. And the relations between the diameters of sand columns and pressure on sludge water thickening were obtained. The results show that shortening the drainage path can enhance the compression effect, and the increasing of pressure can force water pass through filter layer quickly. The dosage of flocculants can be generally controlled; hereby can afford flocculants the variety and quantity in the process. The research results will be the guidance to the sewage treatment plants for tomorrow and to improve the current municipal wastewater treatment plants.

Keywords: Pressure; Sludge thickening; Flocculants

1 Introduction

With the economic development, the living standard of people is improved remarkably. However the resident polluted water is increasing year by year, the number of urban wastewater treatment plant has been developed rapidly nowadays.

The disposal of sludge has become an important problem that calls for immediate solution in the area of environmental science [1-4].For the moment, the construction and operation of municipal wastewater treatment plant affect directly its peripheral environment. The sludge must be well treated; thickening is the usual first step in sludge disposal processing. At present, the conventional gravity sludge thickening is main technology, but it is shown by application that this method possesses evident shortcoming. The efficiency level and the result of sludge thickening directly impact the cost of sludge thickening. Water contained in the sludge can be divided into four parts [3,5]: pore water, capillary water, adsorbed water and internal water. Removing some of the water under pressure can reduce the sludge volume, subsequent structures and processing unit pressure. So in order to obtain the desired results, the experiment was devised in this way.

2 Experimental methods

2.1 EXPERIMENTAL DEVICE

The schematic diagram of the experimental device is shown in Figure 1.

The experiment device is sketched in Figure1. Pressurized tank transform from portable carbon dioxide fire extinguishers. The inner diameter of pressurizing tank is 80mm and 400mm of height. In order to improve the efficiency of the sludge thickening and achieve smooth drainage, discharge using a porous scupper at the bottom of the pressure tank. The drainage holes discarded from the bottom and a valve controlled drainage conditions. There is a sand column, to some extent, by changing the diameter of sand column to control drainage path. When there is no sand column, the mud discharge downstream; when there is sand column in the middle, the drainage path greatly shortened. The sand contains water above filter have more aquifers radial emissions. This experiment used the sand after grit chamber treatment as filter sand. It can be deployed grading.

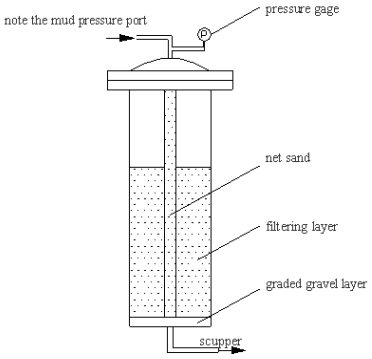

FIGURE 1 Schematic diagram

2.2 EXPERIMENTAL PROCEDURE

Recording the experimental data and comparing different successive experiment with different applied pressure and drainage pathways [6-8].

(1)Preparing for pressurized tank, throwing the flocculants and filling with prepared sludge samples.

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(2) Pressing and maintaining a certain pressure, recording time.
(3) Stopping pressure and recording time when the water-drop is less than 30 per minute.
(4) Opening the lid when pressure is decreased to zero and taking samples, and putting them into the evaporation pan (place it in an evaporating dish in the oven and heated at 125° C - 130° C for an hour. Take it out to a dryer to cool for half an hour. Weigh it with a one ten thousandth analytical balance. The weight recorded is w_1).
(5)Samples weight: Weighing evaporation pan and samples with a one ten thousandth analytical balance. The weight recorded is w_3. Then putting them into the Electro Thermostatic Water Bath, and heated at 125° C - 130° C for an hour until constant weight. Take it out to a cooler after for half an hour. The weight recorded is w_2.

Substitute the results into the following equation and calculate the sludge moisture:

$$p_i = \frac{(w_3 - w_1) - (w_2 - w_1)}{w_3 - w_1} \times 100\% = \frac{w_3 - w_2}{w_3 - w_1} \times 100\% \quad (1)$$

Where,

pi ---- Sludge moisture (%);

w1 ---- Evaporation pan weight, (g);

w2 ---- Weight after drying (evaporation pan weight and sludge weight), (g);

w3---- Weight before drying (evaporation pan weight and sludge weight), (g);

i ---- Number of trials.

And then calculating the difference of sludge moisture, the equation can be written as follows:

$$\Delta p = p - p_i \quad (2)$$

Where,

p ---- The sludge moisture which comes from Secondary sludge is fixed;

Δp ---- The difference of sludge moisture;

p_i ---- Significance and above the same.

In the case of pressure, the experiment shorted water flowing path. Repeat the above steps and computation; the results were listed in Table.1.At the same time, in the case of diameter of sand column, by changing the pressure obtained the results which were listed in Figure 2, by changing the dosage of the flocculants obtained the results which were listed in Figure 3.

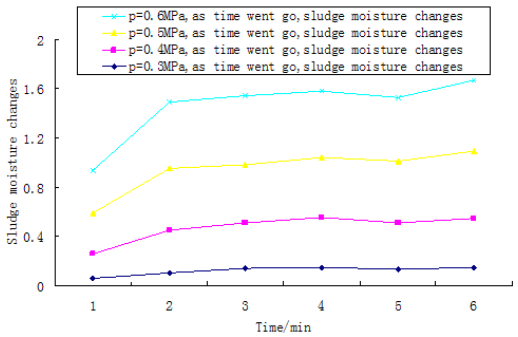

FIGURE 2 Effect of pressure on the experimen

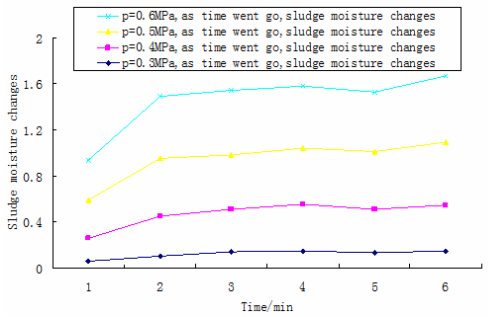

FIGURE 3 Effect of Flocculants dosages on the experiment

3 Experimental results

3.1 DIAMETER OF SAND COLUMN

It can be seen from Table.1, the data showed moisture content difference of mud samples without sand column is 0.06% -0.12 % before and after treatment. The time is 25-31 minutes. The drain path is large and unique, so concentrated efficiency is not obvious. When added a sand column with 20mm of diameter, the moisture content difference of mud sample before and after treatment becomes 0.43% -0.60%.The time change to 18-26 minutes. The time has been shortened, and the treatment efficiency is better than no sand column. When add a sand with the diameter of 30mm, the moisture content difference of soil samples becomes 0.58% -0.67% before and after treatment. The time was significantly reduced to 14-19 minutes. Therefore, reducing the drainage path can enhance the compression effect which is better for sludge thickening.

TABLE 1 Influence of sand column on the experiment

Test Conditions (Drainage path mm)	No sand Column (80mm)			Diameter of Sand Column 20mm(60mm)			Diameter of Sand Column 30mm(50mm)		
Sludge moisture changes Δp (%)	0.10	0.12	0.06	0.43	0.56	0.60	0.67	0.63	0.58
Test Time (min)	25	26	31	18	24	26	14	19	16

3.2 PRESSURE

The pressure can force water pass through filter layer quickly, accelerate the filtration rate and reduce filtration time [4-5]. However, if the pressure is too high, the treated water will damage the filter layer, the percolated phenomenon occurred and the treated water can not reach the treatment effect of the filter layer. Therefore, after combination experiment conditions, the choice of 0.3MPa, 0.4 MPa, 0.5 MPa, 0.6 MPa, pressure values were made without changing other experiment conditions Data shows in the following Figure 2.

It can be seen from Figure 2, when the pressure is 0.3 MPa, the maximum difference of sludge moisture is

0.15%. When the pressure is 0.4 MPa, the maximum difference of sludge moisture is 0.40%. When the pressure is 0.5 MPa, the maximum difference of sludge moisture is 0.55%. When the pressure is 0.6 MPa, the maximum difference of sludge moisture is 0.57%. However, when pressure is 0.7 MPa in the same condition, because of rapid and a large number of water discharge, percolated phenomenon occurred. Filtering effect did not meet the requirement. Basically without pressure, it is unable to reach a predetermined pressure.

3.3 DOSAGE OF THE FLOCCULANTS

The purpose of adding flocculants is accelerating accumulation of solid particles. From the Figure 3, it can be seen that without flocculants the moisture content of sludge sample before and after treatment difference is 0.25% -0.62 %; when added 0.3% of the flocculants, the sludge moisture content difference between the sample before and after treatment becomes 0.56% -0.76%. The treatment effect was significantly changed to be better. When adding 0.6 %, flocculants, the moisture content difference is similar with the one when added 0.3% of flocculants (0.58% -0.75%). But it formatted large particles prone to clogging or can not flocculants and the reached actual, the dosage is generally controlled at 0.3% -0.6%.

4 Conclusions

The experimental facilities of the sludge thickening are built. The methods of increasing pressure and shortening the path of water flowing are performed to study the sludge thickening and achieve the following conclusions:

(1) Shortening the distance and increasing the pressure, the volume of treated sludge greatly reduced to increase the sludge dewatering efficiency.

(2) The experiment uses the sand after grit chamber treatment as filter sand. It can be deployed grading. Taking the treatment of filter sand and mud cake into consideration solve the problem of gritting in grit chamber.

(3) The flocculants in the experiment is polyacrylamide. The purpose of adding flocculants is accelerates accumulation of solid particles [9-10]. However, the more the flocculants, the larger the granulation of sludge will be. It formatted large particles prone to clogging or can not reach a predetermined pressure.

Acknowledgments

This research was financially supported by Hebei University of Architecture Foundation Project (Project number: Q-201306).

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