

Processing System of Rapid Dehydration, Solidification/Stabilization and Resource Reuse for Silt of River and Lake

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Abstract: This paper discusses the processing of desilting for silt of river and lake in order to improve the water quality. The technology system of multi-dimensional combination of trash sorting separation, separation of sand, silt amendment, silt concentration, silt flocculation, dehydration, solidification/stabilization and resource reuse are proposed. The average water content of the dehydrated silt is less than 45 percent in the practical project when the system was used. The dehydrated silt can be used for backfilling. The effect meets the expected demand. The given results provide valuable reference for the process and equipment of environmental desilting project.

1. Introduction

The water environment comprehensive treatment projects with the main target of eliminating black-odor water were developed intensely[1-5], since the rule of Action Plan for Prevention and Control of Water Pollution (hereinafter referred to as "water ten") in April 2015 was proclaimed. However, the numerous projects met many tough realistic questions, which produced the bad treatment effect even dying on the vine, due to the improper disposal for the silt in the internal pollution sources and the insufficient knowledge about the affection on water quality by silt. This brings about a vicious circle of annual treatment, annual odor, annual black odor and annual treatment[6].

Among the management of river and lake water body, desilting is an important and effective means of eliminating endogenous pollution. But the polluted silt, such as the silt polluted by industrial sewage, could cause the serious secondary pollution after the unappropriated desilting way and the treatment disposal. The silt is buried in sanitary landfill as hazardous waste, which is the disposition of silt for long term. However, the resource reuse of silt becomes an imminent realistic demand goal because the available storage capacity of landfill site becomes less and the cost of landfill greatly improves. With the analysis of the composition of the silt of the polluted city river and lake, this paper presents a set of effective processing system of rapid dehydration, solidification/ stabilization and resource reuse for silt of river and lake, which is based on the practical experience from our practical project.

2. Characteristics of polluted river and lake silt

The sediment of polluted river and lake has obvious sequence structure and mainly includes three layers, i.e. pollution layer, transition layer and normal sediment layer[7]. The river and lake silt is assigned to



the pollution layer and transition layer. The silt is constituted with flocculent and honeycomb sediments that are formed by the clay minerals content in the slowly flowing water environment. The silt has the characteristics of high moisture content, large compressibility, low strength, low permeability and slow consolidation of drainage, etc.[4]. It has obvious odor. The proportion of organic matter in it is between 2% and 20%, whose content decreases with its depth[7]. Its component mainly includes six parts: trash, inorganic substances, nutrient elements, persistent toxic substances (PTS), persistent organic pollutants (POP) and heavy metal elements.

3. Problems in general environmental desilting project

There are two main ways of desilting in rivers and lakes[8-9]. The first is digging or scratching head and the silt is buried in landfill after natural drying. The second is that desilting by the washing pump group without water or by the cutter suction dredger with water, and the silt is buried in landfill after it is sent to the cofferdam for drying naturally. These two ways show a few major problems as follows along with the implement for the rule of Action Plan for the Prevention and Control of Soil Pollution (hereinafter referred to as "soil ten") proclaimed by the State Council in 2016.

Firstly, the way of digging or scratching head with water either cannot completely dig out the silt layer, especially for the floating mud with high water content, or easily causes the hard sediment layer in the bottom mud to be excavated. In either case, some polluted silt still keeps at the bottom of the water, even if the depth of the dredging is adequate. The agitation and leakage will also cause the pollutant deposit in the silt to be released into the water quickly and seriously pollute the water. Therefore, this way only reaches the requirement of water dredging, but not the requirement of improving water quality.

Secondly, if the separation of trash and s from the silt is not taken well, the pollutants in silt without effective stabilization processing, have many impurities after natural drying and are only landfilled, which causes secondary pollution without effective utilization of resources. The implementation of the "soil ten" has intensified the shortage of land for landfill sites. Therefore, it is very imperative to carry out the effective and resource-based utilization for the silt.

Thirdly, the silt meets the requirements of being buried in landfill only after the long period of natural drying. The period is usually longer than half a year, which occupies a large number of land resources. Therefore, the secondary pollution happens easily for the dry ground and water environment.

Fourthly, the microbial anaerobic action of polluted silt will release a large amount of odorous gases. During the desilting, the digging and scratching head, the washing pump group also will release harmful gases. The natural drying field in drying cycle also will release harmful gases. All the gases are sure to give bad influence on the surrounding atmosphere.

4. Processing System of Rapid Dehydration, Solidification/Stabilization and Resource Reuse for Silt of River and Lake

4.1. Overall treatment process

In consideration of the above mentioned practical problems, this paper suggests that the desilting technology of using a cutter suction dredger or a rake boat with water is combined with the concentration dehydration treatment of silt. The silt is transmitted by pipeline, which avoids environment pollution for the road. This paper develops a complete set of concentration dehydration processing and equipment for desilting. The overall process route is shown in figure 1, where the sorting of trash and sand from the silt is taken firstly, the second step is rapid dehydration and solidification/stabilization treatment of silt that is in the circle marked with dotted lines. This processing method less occupies land and maximizes the reduction of secondary pollution. The processed silt will be reused according to the status of pollutants and the silt removal method of the construction site. Only the seriously polluted silt of hazardous waste will be buried in landfill. The separated trash is sent to a trash treatment company. The separated sand will be used as construction materials. The resource utilization of s and silt will create certain economic benefit.

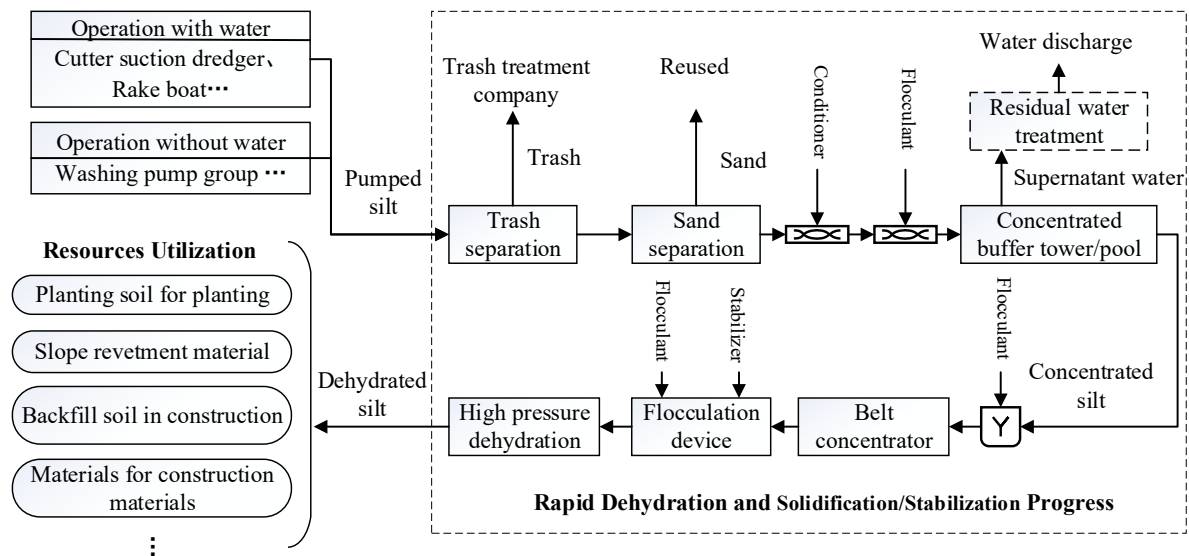


Fig. 1 Overall process diagram

4.2. Design of pre-sorting equipment

The pre-sorting equipment includes the trash sorting device and sand separation device. For the automatic sorting equipment this paper does not select simple grille, rotary grille and vibrating screen, etc. because it is easy to be noisy and blocked. The polyester strainer is banded encircling in the sorting device. Such device has the advantages of fully automatic operation, resistance to shock loading, trash cleaning, trash filtering, unmanned operation, low noise, etc.. Based on a lot of experiments, in the case of the mesh dimension less than 3 millimeters the separated silt from the trash does not contain trash impurities, such as leaves, branches, and plastic and grass, but contains impurities in the form of sand. The sand separation device scrapes the sand by chain plate shaving based on the principle of advection and sediment precipitation, which can greatly reduce the energy consumption. The selection of the staying time of 30~60 seconds in the s separation device is ideal. It has been concluded by practice that the pre-sorting technology and equipment selected in this paper fully meet the resource utilization requirements of subsequent silt.

4.3. Silt concentration dehydration equipment

After separating from the trash and s the silt usually contains a large number of pollutants such as humus, which form a colloidal structure that is difficult to dehydrate under natural conditions. So the sludge conditioner is added in the silt before concentration dehydration. The conditioner is also required to deodorize silt. The silt concentration dehydration equipment includes two parts. The first one is for concentration. The second part is for dehydration. The first device is called as concentrated buffer tower (pool), which gets rid of most of the slurry water and provides homogeneous slurry buffer effect. The water content from the concentrated buffer tower (pool) is required not too high or too low because too low water content will lead to difficulty release bottom flow and pipe blockage, and high water content will increase the hydraulic load of the subsequent equipment and decrease the operating efficiency. It is appropriate that the water constant is between 85-90 percent. These selections provide guarantee for the follow-up equipment's operation. The second device is called as belt concentrating device, which makes the silt own less water constant. Before it works, the silt is mixed with the flocculating agent. The silt from this device has the water constant of 70~80 percent. The third device is called as flocculation device, where the flocculating agent, stabilizing agent or consolidation agent and the silt are uniformly mixed. It will greatly improve the efficiency of silt mechanical dehydration. Also the unconfined compressive strength and shear strength of the silt becomes better after dehydration, which reaches the strength requirements for backfill or subgrade soil and slope soil. The fourth device is called as high-pressure ciliated filter press dehydration machine. This machine will make the water constant of silt

lower than 45 percent by using a three dimensional structure of homemade ciliated filter cloth. It is found by the practical projects' experience that there is no penetrating fluid through transportation and stacking when the water constant is lower than 50%. The silt after dehydration is easy to further lose water in natural condition and not easy to be muddled while meeting water again. The silt has lest impurities, which is convenient to design the means of subsequent resource utilization.

The key of the high effective dehydration lies on the selection of filter cloth. Generally, the belt concentrator and dehydrator use the plain weaver filter cloth or spiral mesh filter cloth. These two types of filter cloth exist the contradiction between the rejection coefficient and the dehydration efficiency. When the mesh hole increases, the dehydration efficiency is improved but the leakage is large and the rejection coefficient decreases. The homemade ciliated filter cloth with three-dimensional structure is selected in this paper. Such cloth has high rejection coefficient and high water permeability. In the case of the same value of rejection coefficient, the water permeability of the ciliated filter cloth is 10 times more than that of general filter cloth, and the tensile strength is greater than that of the general filter cloth. The ciliated filter cloth can endure greater tension and can run stably for a long term.

4.4. Resources utilization of silt

The means of resource utilization is determined according to the status of silt pollutants and the standard requirements of available disposal methods. At present, domestic treatment of silt is to discard in wrong way. Governments everywhere are expecting that someone thoroughly could solve the silt discharge by resources utilization. Although there are a lot of technical solution ways but there are no sure standard for the resources utilization. According to our engineering practice over years, this paper puts forward some feasible ways of resource utilization. They are complied with the principle of short transportation distance and large digestible amount. The silt from our processing system can be used for planting soil, backfill soil in construction, slope revetment material and materials for construction materials, etc..

4.5. Operation effect of the system

Table 1 shows the result data of the practical project. The engineering data were obtained by two different desilting ways. One is to use a cutter suction dredger for desilting. Another is to use washing pump group for desilting.

Table 1. Engineering Data of Two Desilting Ways

Items name	cutter suction dredger for desilting		washing pump group for desilting	
	1	2	3	4
Total amount of silt pumped (m ³)	754	950	185	236
Total trash (T)	14.63	7.92	16.67	9.48
S amount (T)	8.21	11.56	6.76	9.32
Average water content before concentration tower (%)	96.27	97.64	85.35	91.25
Total residual water discharge (m ³)	532	734	50	115
Average water content from bottom discharge of concentration tower (%)	86.31	88.79	79.28	81.43
Total silt amount from bottom discharge of concentration tower (m ³)	199	195	111	102
Average water content of silt from the second concentrator device (%)	71.50	70.32	70.67	69.62
Total silt amount from the second concentrator device (m ³)	94.7	70.8	78.4	60.9
Average water content of the dehydrated silt (%)	43.26	42.78	38.45	37.56

Total amount of the dehydrated silt (T)	45.82	35.83	35.74	28.82
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The solid content of silt from the cutter suction dredger is lower than 5 percent, and that from washing pump group is lower than 20 percent. High water constant of the silt produces large amount of water discharge during the process. The silt is transmitted to the system of the rapid dehydration, solidification/ stabilization that can be operated in boat or on the bank of river. In both cases, the average water content of the dehydrated silt is less than 45 percent, which achieves the expected results. All the dehydrated silt can be used for backfilling.

5. Summarization

The process system of rapid dehydration, solidification/ stabilization and resource reuse for silt of river and lake has reached the requirement of water dredging and the requirement of improving water quality by both method and practice. This system achieves the ideal treatment effect with the aim of low water constant of the dehydrated silt.

The design elements of the management equipment should be considered as follows. The first one is to use suction pump way for desilting. The second one is to use the combined technology including sorting separation, concentration device, flocculation device and the dehydration device with ciliated filter cloth. The third one is to make the dehydrated silt be reused. The fourth one is to prepare the generator power supply. The result is that the system of this paper provides an effective means of desilting, which solves the tough problem of hard reducing and reusing. It realizes the purpose of resources utilization in low cost and high efficiency.

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