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Rheological study and valorization of waste sludge from wastewater treatment plants in the dredging operation of hydraulic dams

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Abstract

The wastewater resulting from various urban activities cannot be directly released back to natural environment because they contain various pollutants, including organics and minerals causing potential various types of diseases. Instead, wastewater must be purified prior to its release, which leads the production of waste sludge. A large quantity is produced from a wastewater in the purifications plants. An activated treatment of sewage wastewater also results in the generation of a considerable amount of excess sludge. This sludge must be disposed of safely. Commonly used disposal practices comprise of incineration, landfilling and application. The cost for sludge treatment is highly dependent on the volume and water content of the produced waste sludge. Treatment and disposal of an excess sludge in a biological wastewater treatment system requires a very high cost which accounts for approximately 35–60% of the whole operation cost of a wastewater treatment. In this study we propose a technique less expensive and more convenient. This technique is based on the use of sludge to reduce the loads losses during the dredging operation of hydraulic dams. The rheological study of mixtures of mud of dam and sludge from purifications plants showed a reduction of the yield stress of mud of dam up to 95%. Therefore the use of sludge from purifications plants during the dredging operation of dams facilitates the transport of sludge of dam.

Keywords: Dam, dredging operation, mixture, mud, sludge, rheological study, yield stress.

Nomenclature

Ea	Energy of activation for viscosity
SM	dry matter of waste sludge
T	temperature

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$\dot{\gamma}$	shear rate
τ	shear stress
τ_0	Yield stress
η_B	Bingham viscosity
η_{lim}	limiting viscosity

1. Introduction

The treatment of wastewater in the purifications plants generally leads to the formation of large quantity of sludge. These occur at the exit in a purification plant as a high concentrated viscous fluid. The sludge production has environmental risks. It is then necessary to find solutions to extract the sludge from purifications plants and to use it in different areas such as soil fertility, production of energy after calcinations and in the field of civil engineering (base coat for roads). These procedures are very expensive. For example the cost of disposing of excess sludge represents 60% of the cost of operating a purification plant in Europe [1]. The method of disposal of sludge by biological treatment is also high, about 35% to 60% of the cost of operating a purification plant [2].

A simpler technique is the use of sludge on agricultural land but this technique is very limited in Algeria**.**

In addition, conventional disposal methods of landfill or incineration cause pollution problems and an installation of incineration is quite expensive. However, this technique reduces the volume and mass of excess sludge. Several studies have focused on physical, chemical and biological processes in order to reduce sludge production, such as mechanical treatment using ultrasound [3,4], chemical treatment by ozone [5,6] acid or alkali [7] and biological hydrolysis without addition of enzymes. The ozone treatment is generally higher compared to physical treatment. Some researchers have combined treatment with ozone and biological treatment to minimize sludge production [8,9].

In this study we propose a less expensive and more convenient technique based on the use of sludge of purification plant as a means to reduce the load losses during the dredging operation of hydraulic dams to facilitate the transport of mud of dams to storage location.

2. Materials and methods

2.1. Sample preparation

2.1.1. The waste sludge from wastewater treatment plants

The waste sludge used in this study was recovered from the drying beds of sewage sludge from wastewater treatment plant of mascara Algeria as a powder. The sludge was dried in an oven during 24 hours at 40°C for dehydration, then crushed and pass away a sieve of 80 μm.

2.1.2 Preparation of sludge samples

The method of preparation has a great influence on the final state of suspension and then on the rheological behavior. An identical experimental procedure was therefore used for the preparation of all suspensions. First, sludge powder was dispersed in the required amount of distilled water in order to obtain two sludge suspensions (mass concentration equal to 23 and 28 wt %). Homogenization was obtained by continuous mechanical agitation during 24 h at ambient conditions.

2.1.3. The mud of dam

The mud used in this study was recovered in the discharge area of Dam Fergoug located in the region Perregaux (west Algeria). This dam is the first having been dredging in Algeria from 1986 to 1989 with over 10 million m^3 of dredged mud. This dredging was carried out with floating suction dredge extruders. Sediment (vases) are sucked into the dredge and discharged through a pipeline consisting of a floating and a fixed part of several hundred meters in length.

2.1.4. Preparation of mixtures

To study the effect of the addition of sludge on the rheological properties of mud suspension of dam two suspension of mud of dam were prepared (40% wt and 45 % wt). The mixtures of water-waste sludge-mud of dam