Pilot-scale Water Hyacinth Bed for Dewatering of Sewage Sludge

A.S. El-Gendy[1], A.G. Ahmed[2]

[1]Associate Professor, Department of Construction Engineering, The American University in Cairo, Egypt
[2]MSc Student, Environmental Engineering Program, The American University in Cairo, Egypt
Keywords: Sludge, Dewatering, Water Hyacinth, Phyto-technology.
Presenting author email: ahmed.elgendy@aucegypt.edu

Introduction

Currently, many technologies are available for sewage sludge dewatering. They include sophisticated technologies such as centrifugation and filtration using filter presses. They also include simple technologies such as drying beds and reed bed sludge drying systems (Nielsen & Larsen 2016). Each technology has its limitation in applications. In Egypt, drying beds is the most commonly used technology in dewatering of sewage sludge. This is mainly due to the simplicity of the technology as well as the warm climate of Egypt most of the year. The main disadvantage of using drying beds include the required huge land area, which may pose an obstacle in expanding many existing treatment plants for future needs. This is considered a problem in areas where the available land is limited. Therefore, there will be an imminent need for upgrading the dewatering capacities of the existing drying beds, to accommodate the higher quantities of sludge in future expansions of wastewater treatment plants without using additional land area. The use of plant-assisted drying beds (Nielsen & Larsen 2016) seems to be an ideal solution for increasing the capacity of the existing drying beds. Sewage sludge also carries different types of pollutants, since many wastewater treatment plants receive discharges from residential areas as well as industrial areas (Bright & Healey 2005; Dai et al. 2007). In addition, plant-assisted drying beds have been successfully used in some areas employing reed plants (sludge treatment reed beds) (Pandey & Jenssen 2015; Nielsen & Larsen 2016) and *Panicum repens L* (El-Gendy et al. 2017).

Some aquatic plants such as Water Hyacinth (*Eichhornia crassipes*) grow in Egypt and have a high evapotranspiration ability. Therefore, the main objective of the current study is to investigate the dewatering ability of Water Hyacinth compared with conventional drying beds, when applied for sewage sludge dewatering in a pilot scale system.

Methodology

The pilot scale experiment of the current research composed of two drying beds. The two beds were identical and were constructed using two plastic basins, each with dimension of 2.5m (L)* 1.5m (W)* 1m (H). Each basin had an underdrainage system that was made from two layers of crushed stones (size 5 mm) over gravel (size 32 mm) to allow drainage of water in sludge through the media layers and collection of solids on top of the crushed stones layer. Both basins were installed on a sloped layer of crushed stones to provide a slope of 1:10 in the bed bottom to ease the movement of water collected by the underdrainage system. Raw liquid sewage sludge was added to each basin in three successive batches. Each batch had a volume of 500 liters. Then, batches of sludge were added every day till a sludge depth of 30 cm (above the crushed stones layer) was created. Then, water hyacinth, plants were added to one of the basins to create the Water Hyacinth bed, while no plants were added to the other basin to create the control bed (conventional drying bed). Figure 1 shows the pilot-scale setup of both basins at the start of the experiments. The plants were kept in the Water Hyacinth bed till the end of experiments. During the experiments, raw sludge was added frequently (about 500 liters per basin) to each bed. These batches were added every 1 to 3 day to the Water Hyacinth bed; while they were added every week to the control bed (unplanted basin).

Raw sludge was analyzed at the beginning and throughout the experiments for pH, Total COD, Total BOD, Total Nitrogen, Total Ammonia (NH4), Nitrate (NO3), Total Potassium, Total Phosphorus, TS, TSS, VSS, total Coliform bacteria, Fecal Coliform bacteria, Salmonella and Shigella and Parasitism. Samples of dry sludge were also collected and analyzed for TN , NH_4, NO_3, TP ,TK, Organic Matter, Organic Carbon, Total Coliform bacteria, Fecal Coliform bacteria, Salmonella and Shigella, Parasitism. Dry sludge samples were collected during the experiments before the addition of the frequent batches of raw sludge. The samples were collected from the basin using a cylindrical core (Diameter = 10 cm) from three random locations in the basin then mixed before sending it for analysis.

Results

The current study demonstrated that phyto-dewatering or plant assisted drying system can be efficient in dewatering of sewage sludge. The current study showed that Water hyacinth (*Eichhornia crassipes*) can tolerate and grow in sewage sludge matrix. The study also demonstrated that these aquatic plants are able to speed up the dewatering of sewage sludge compared to control conditions without plant cover. The study also demonstrated that the Water Hyacinth assisted drying basin were able to dewater about 70% additional sludge volume in less than 50% of dewatering time by ordinary drying beds without plants. Also, it was noticed that after the sludge drying was completed and mortality of waste hyacinth (due to drying of the growth medium), seed germination of tomato plants was flourishing in the whole basin. The tomato seeds are present in the human feces which settled with solids and become part of the sewage sludge. These seeds germinated in the basin when conditions were suitable. This observation indicates the good quality of the dried sludge with the phytoremediation as compared with ordinary drying beds. This phyto-dried sludge can be further investigated for use as compost or soil amendment as it may have a high potential for such application based on that observation. The experiments in the current study showed that phyto-dewatering of sewage sludge utilizing certain species of aquatic plant can significantly reduce the time needed for dewatering.

a. Conventional Drying Bed (No Plant Cover) b. Water Hyacinth Bed

Figure 1. Pilot-scale system for sewage sludge dewatering at the start of the experiments

References

Bright, D. A. & Healey, N. 2003 Contaminant risks from biosolids land application: contemporary organic contaminant levels in digested sewage sludge from five treatment plants in Greater Vancouver, British Columbia. Environmental Pollution 126 (1), 39–49.

Dai, J. Y., Xu, M. Q., Chen, J. P., Yang, X. P. & Ke, Z. S. 2007 PCDD/f, PAH and heavy metals in the sewage sludge from six wastewater treatment plants in Beijing, China. Chemosphere 66 (2), 353–361.

El-Gendy, A.S., El-Kassas, H.I., Abdul-Razek, T.M., & Abdel-Latif, H. 2017 Phyto-dewatering of sewage sludge using *Panicum repens L*. Water Science and Technology 75 (7), 1667–1674.

Nielsen, S. & Larsen, J. D. 2016 Operational strategy, economic and environmental performance of sludge treatment reedbed systems-based on 28 years of experience. Water Science and Technology 74 (8), 1793–1799.

Pandey, M. K. & Jenssen, P. D. 2015 Reed beds for sludge dewatering and stabilization. Journal of Environmental Protection 6, 341–350.