

Assessment of Physical and Chemical Contents of Textile Sludge and Associated Risks on Public Health: In Case of Common Effluent Treatment Plant (CETP)

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ABSTRACT

Industry Parks Development Corporation (IPDC) is constructing Eco industrial parks in different regions of the country along with its infrastructure to build cleaner and resource-efficient production technologies and practices that reduces economic growth from unsustainable resource consumption and environmental degradation. To reduce pollution and reduce water resource depletion due to the existence of industry parks, Wastewaters must be treated to the level of acceptable standards to discharge or reused. Sludge from wastewater treatment plants is a serious issue because it can affect human and animals' health, and also environmental quality. In this study, sludge from a textile and garment wastewater treatment plant was analysed regarding its physicochemical characteristics and disposal options. For this study, dewatered sludge sample was send to laboratory to determine the contents of sludge. The results showed that generated sludge has contents of pH (9.09), alkalinity (473.3 mg/kg), moisture content (17.99%), cadmium (4.970 mg/kg), lead (22.70 mg/kg), total phosphorous (5.3 mg/kg) and sulfur was not detected. These results indicate that the sludge has physical and chemical pollutants which have also public health interests. With the apprehending facts, IPDC is in trouble due to lack of sludge standards, management, and transportation and disposal site. Therefore, handling sludge is one of the most important challenges in this wastewater treatment plant.

INTRODUCTION

Ethiopia has been transforming the backbone of its economy to green manufacturing powerhouse. To make this potential the most effective, the Ethiopian Industrial Parks Development Corporation (IPDC) is becoming an engine of rapid industrialization that nurture manufacturing industries. Accordingly, IPDC is constructing Eco industrial parks in different regions of the country along with its infrastructure to build cleaner and resource-efficient production technologies and practices that reduces economic growth from unsustainable resource consumption and environmental degradation^[1]. To have competitive eco-industrial parks in the country, among many infrastructures which attract anchor investors, IPDC shall build advanced domestic and industrial wastewater treatment facilities. To reduce pollution and reduce water resource depletion due to the existence of industry parks, Wastewaters must be treated to the level of acceptable standards to discharge or reused^[2]. One of the aims of wastewater treatment is to reduce concentrated pollutants from wastewater. But, still there are residues from the wastewater treatment called sludge which has no sludge standards to reduce pollution or reuse it for intended purpose. Industrial wastewater treatment covers the mechanism and processes used to treat wastewater that is produced as a by-product of industrial or commercial activity. In this process, the wastewater undergoes preliminary, primary, secondary and tertiary treatment to yield treated effluent and a concentrated stream of solids in liquid, called sludge. After treatment, the treated industrial wastewater (effluent) may be reused or released to surface water in the environment. Furthermore, sludge from the Common Effluent treatment needs to control of generation, storage, collection, transfer and transport, processing and recycling or disposal of sludge waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation to reduce waste material's effect on human health or local aesthetics or amenity. This study specifically assesses the physical and chemical contents of textile sludge and its associated risks on public health from the wastewater treatment plant called Common Effluent Treatment Plant (CETP) of Bole Lemi I industrial park. Bole Lemi I industrial park is the first Ethiopian industrial park which is located in the Addis Ababa City administration in Bole Sub-City. It has been operational since 2014 and there exist 12 different enterprises which occupy 20 sheds. The park is currently producing only export standard garment and textiles. An industry that consumes 50 m³ of water per hour can generate 1-10 ton of sludge per day in wet basis^[3]. Because the diversity of chemicals that may possibly be present in this waste; it is difficult to determine its toxicity based only on chemical analysis^[4,5]. Advanced conventional Effluent treatment plant can produce 1.5 kg of dried sludge from 1000 litre of treated textile wastewater^[6]. Physical and chemical laboratory tests

can provide additional information about the hazard of sludge complex mixtures^[4]. Sludge Waste is classified either as hazardous or non-hazardous. Hazardous sludge waste is a waste that due to its (intrinsic) chemical or other properties poses a risk to the environment and/or human health^[7]. Disposal of sludge from industrial Common Effluent Treatment Plant (CETP) is a serious issue because it can affect human and animals' health, and also environmental quality^[8]. Exposure to physical and chemical compounds can produce a variety of adverse effects including non-communicable diseases, chromosomal changes, mutations, sperm abnormalities, early or late fetal loss, still births, decrease birth weights, altered sex ratio, birth defects and childhood malignancies^[9]. The resulting textile sludge has usually been disposed in landfill or incinerated with high associated costs. Modern waste management practices suggest recycling when possible^[10]. The degradation of the environment due to discharge of polluting sludge from textile industries is a real problem in several countries, and this situation is even worse in developing nations where little or no treatment of sludge is carried out before final disposals. Here, all types of sludge are disposed in landfill sites haphazardly or openly, leading to soil, surface water and groundwater contamination, and can pose a threat to natural resources, the environment and residents living within the immediate vicinity of the sludge disposal locations^[11]. Many countries (for example Australia and the USA) have guidelines for use or disposal of sludge, these guidelines tend to focus on the health or environmental risk from physical, chemical, microbial pathogens and nutrients of textile effluent treatment plant. Very little is mentioned regarding the potential presence of trace contaminants. There is concern about the potential health and environmental impacts by the compounds if they accumulate in the environment and enter the food chain^[12].

Problem Statement

Most industries in Ethiopia dispose untreated sludge on unsecure open landfills which aggravate pollution. Untreated sludge coming from textile effluent treatment plant may accumulate unsafe levels of physical and heavy metals that are very active to circulate on environment. This poses a health concern to the public because of the known health problems that may arise from accumulation of physical and chemical pollutants toxicity and physical injuries in the body. In addition, unknown presence of inorganic and physical pollutants in textile sludge may lead to environmental pollution and public health risks. Unlike wastewater and air emission standards to air, land and water, sludge has not got attention as potential pollutant in Ethiopia until this study. Untreated sludge disposal in an open area has been a big issue in terms of human and animal health; however, In Ethiopia sludge from different industry, are discharged together. No report in Ethiopia is available about the presence and content of physical and chemical residues from wastewater treatment and associated risks on public health. And again there are no sludge standards to dispose or reuse the sludge for different purposes. Therefore, there is a need to carry out assessment of physical and chemical pollutants in textile sludge from Common Effluent Treatment (CETP) in order to determine whether the sludge is hazardous or not. Furthermore, this study will indicate whether there are associated public health risks or not.

Justification of the Study

There are many industries in Ethiopia and studies have shown that most of them have no advanced wastewater treatment or are not fully functional. Due to these, industries which have liquid waste are discharging their wastes above allowable standard limits of pollutant parameters containing higher concentration of physical and chemical pollutants. Infact, due to public, costumer, clients' pressure and stringent discharge limits; wastewater management practices are going to be broadening in Ethiopia. But, sludge pollutant content characterization, management practices and assessment of associated risks on public health were overlooked for last many years. There is need therefore to determine the levels of physical and chemical pollutant contents of textile sludge from CETP and signifying associated risks on public health from the nature of sludge. Therefore the study will provide a report that will enable the public health and environmental policy makers to draw a baseline on treatment, reuse and disposal standards establishment of textile sludge; therefore it is becoming eye opener on the public health concerns that could arise from textile sludge.

Research Questions

- I. What quantities are the physical and chemical pollutant contents of textile sludge from Effluent Treatment plant?
- II. Is the sludge reusable or disposable?
- III. Are there associated risks to public health from sludge management practice in Ethiopia?

Null Hypothesis

The pollutant levels in the sludge is insignificance, hence the Industry Park can sell or give away to the reuses or dispose the sludge on open land fill with other general municipal solid wastes.

Objectives of the Study

General objectives

The general objective of the study is to determine the contents of pollutants in the sludge from textile wastewater treatment plant and imply associated risks on public health which is generated from Bole Lemi Industry Park. Another major objective is to prepare base line data for sludge management and disposal or reuse standards preparation.

Specific objectives

Some of specific objectives are:-

- I. To determine the contents of chemicals in the sludge (lead, cadmium, total phosphorous and sulfur).
- II. To determine physical pollutants of the sludge (pH, alkalinity and moisture contents).

Significance of the Study

The output of this study is baseline information about the nature and content of physical and chemical pollutants in sludge which are among the soil, water and air pollutants and the consequent health risks from improper sludge management practices specially from lack of standards and its' enforcement. This information will be communicated to the policy makers in order to initiate standard preparation and enforcement to prevent or reduce health risks of untreated sludge reuse or disposal practices.

Scope of the Study

The study was conducted at Common Effluent Treatment Plant (CETP) sludge after primary chemical precipitation (primary clarifier), sludge thickening and dewatering of textile wastewater. At sludge thickening tank excess activated sludge from secondary clarifier was mixed with chemically precipitated sludge.

The study was purposive to the textile Common Effluent Treatment Plant (ETP). Even though the study is specific to this project, it is applicable to all textile sludge's due to chemical inputs and production process similarities of the company or companies. Most of textile industries in Ethiopia have conventional chemical based treatment plants ^[13]. Therefore, this study result is considered as baseline indicators for all types' of sludge which is generated from primary chemical precipitation based textile Effluent treatments plants.

Limitation of the Study

For this study the assessment was done only for end of pipe process and the investigation was to characterize few parameters and estimate contents of dried sludge in the specified advanced conventional wastewater treatment. There is no sludge management and treatment trends in the country, hence it was not possible to describe clearly the associated risks of the sludge pollutants on public health.

MATERIALS AND METHODS

The Study Site

The study site was Bole lemi Industry Park Common Effluent Treatment Plant. The sample collection points were at treatment plant drying bed, which is the place where dewatered sludge is stored for further drying. After further drying and packaging with polyethylene bags, the sludge is supposed to dispose on the land fill (**Figure 1**).



Figure 1. Sampling site after dewatering of moist sludge.

Methods

All materials, chemicals and equipments used for the sample collection, characterization and detection of pollutant contents in the sludge were according to standard laboratory testing procedures for each parameter.

RESULTS AND DISCUSSIONS

Types and Amounts of Physical Parameters Content Determination in the Sampled Sludge

In this study, some physical characteristics of textile wastewater sludge were studied and the results showed that alkalinity had the highest concentration (473.33 mg/kg); pH is 9.09 and after one day open natural drying period moisture content is 17.99% (Figure 2). According to this study, the studied sludge could be suitable for acidic soil treatment. It should be noted that there are other parameters in the dewatered textile sludge than those studied in this study including different organic and inorganic compounds, and it would be better for these parameters to be considered in future studies.

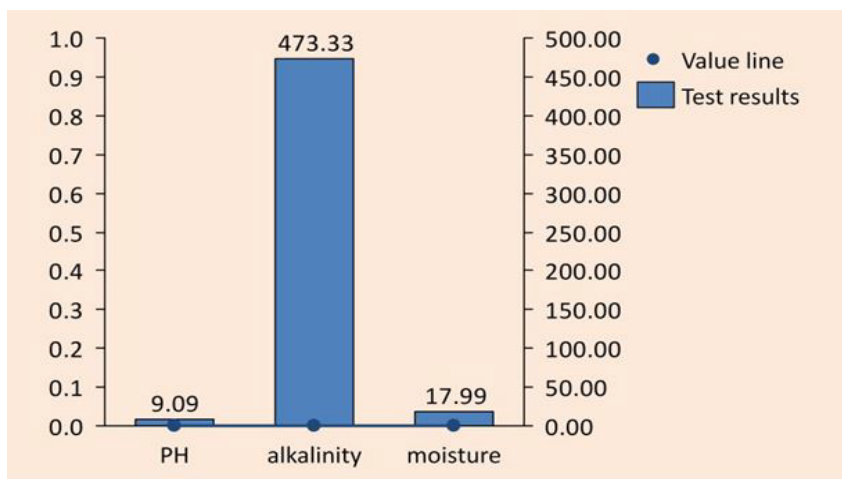


Figure 2. Some physical pollutants contents of dried textile sludge.

Types and Amounts of Chemical Parameters Content Determination in the Sampled Sludge

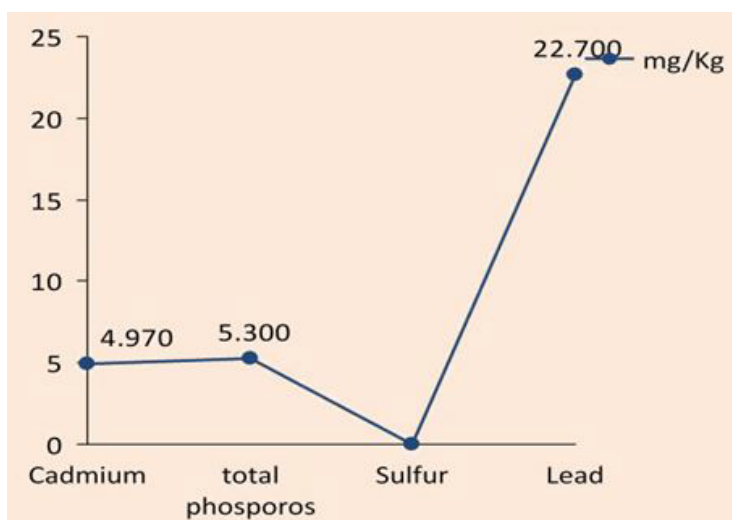


Figure 3. Chemical pollutants contents of dried textile sludge.

From Figure 3, the study found that the concentration of toxic heavy metals lead (4.97 mg/kg) and cadmium (22.7 mg/kg) were high. These result revealed that examined sludge sample contained relatively higher amount of heavy metals compared to ambient Ethiopian environmental standards of soil. The investigated sludge has high lead concentration which show us the way how soil, water and air polluted.

In other ways, as it was indicated in the above graph; total phosphorous was about 5.3 mg/kg and sulfur was not detected. The phosphorous content is one of the indicators for soil nutrient enrichment but from this study it has less phosphorous contents. Generally, Due to the above mentioned chemical pollutants in the sludge, it is possible to conclude that apply this sludge is not

safe to agricultural land and unsecured land fill around residents or working area.

Associated Public Health Risks from Land Application of Dried Sludge

During this study, availability and practicality of sludge management and disposal mechanisms were assessed. From the assessment, there were no legal requirements to categorize sludge either it is possible to reuse or dispose with other municipal solid waste. Ethiopia has been implementing precautionary and polluter pays principles to protect Environment and public health but till this study there are no well-constructed secure landfills which can accommodate the generation of large amounts of sludge. The disposal of both treated and untreated has a serious environmental issue because it contains harmful level of pollutants including toxic chemical (like lead and cadmium for this study), physical pollutants (pH and Moisture) and unknown pathogenic (bacteria, virus and protozoa). The disposal of these pollutants is a big concern due to the tendency of causing communicable and non-communicable disease to the public health. Hence, these can affect human and animals' health, and also environmental quality. In Ethiopian, around waste disposal sites Public pressures in such issues is constantly increasing because impacts of unsafe waste disposal have gradually been broadened. Currently, peoples are demanding healthy and safe environment to live. This implies the government and waste generator shall play their key roles to reduce, treat and dispose wastes in a place where safe to public health and environment.

From this study results physical and chemical contents of textile sludge have the possible public health risks on sludge handlers on site and around disposal site residents' but other detail research need to be conducted.

CONCLUSION

Currently, IPDC is a responsible government body to build and operate Industry Parks (IPs) advanced wastewater treatment facilities. This study aims to determine some physicochemical characteristics of sludge from a textile Common Effluent Treatment Plant (CETP) in Bole lemi 1 Industry Park, Addis Abeba, Ethiopia. There are several methods to handle sludge, each with advantages and limitations such as land use and landfills. To select the most suitable method, it is important to know sludge properties. By this study, sampled Bole Lemi 1 IP textile wastewater treatment plant sludge has contents of pH (9.09), alkalinity (473.3 mg/kg), moisture content (17.99%), cadmium (4.970 mg/kg), lead (22.70 mg/kg), total phosphorous (5.3 mg/kg) and sulfur was not detected. These results indicate that the sludge has physical and chemical pollutants which have also public health interests. With the apprehending facts, IPDC is in trouble due to lack of sludge standards, management, and transportation and disposal site. Therefore, handling sludge is one of the most important challenges in this wastewater treatment plant.

RECOMMENDATIONS

The generation of sludge from different industry parks is imminent. Therefore, researchers, policy makers and relevant stakeholders shall give proper attention for the following issues:

- Detail sludge characterization studies need to be conducted.
- Sludge management techniques and technological alternatives and best practices shall be studied and implemented.
- Policy makers shall establish standards, management practices and disposal mechanisms.
- Secure landfills shall be studied, designed, and operational for sludge disposal.

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