STANDARDS, RULES, AND ANALYTICAL TECHNIQUES FOR SEWAGE SLUDGE MANAGEMENT

Dr. S.R.Ali*

* Professor,
Department of Civil Engineering, Faculty of Engineering,
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA
Email id: drsrali.engineering@tmu.ac.in

DOI: 10.5958/2249-877X.2021.00132.6

ABSTRACT

This article discusses the most common sewage sludge management techniques, as well as the unit activities and procedures that relate to them. Reclamation and adaptation of lands to specific needs; plant cultivation not intended for human consumption or food production; use in agriculture; use in construction; recovery of phosphorus, rare earth metals, or fats and use in industry; production of combustible pellets, granulates, or other usable materials such as absorbents; and storage on treatment territory Stabilization processing results in the creation of materials that may be contaminated with a range of organic chemicals. Because this method of management often involves dumping processed sludge on the ground, it has the potential to contaminate soil with unknown organic substances. Thermal processing of raw sewage sludge, on the other hand, virtually eliminates this possibility. The vast majority of organic stuff is converted to a simple, mineralized state. In this instance, the most serious concern is heavy metal poisoning of sewage sludge ash. The identification of heavy metals in ashes is, however, considerably easier than that of organic molecules. Chemical analysis may be extremely helpful in determining the environmental safety of sewage sludge that has been treated and handled. As a result, there are many analytical approaches in use that are likely to aid in the process of developing and implementing innovative economically and ecologically sound methods of sewage sludge reuse. The method of technical sewage sludge use at Gdansk's Wastewater Treatment Plant "Wschód" is also explained. The technical line has just been updated.

KEYWORDS: *Analytical Techniques, Disinfection, Fermentation, Sewage Management, Sludge Management*

INTRODUCTION

Sewage sludge management is becoming more and more of a concern. Directives are introduced in all European Union nations, requiring each member state to develop appropriate legislation. Management techniques that include storage are now being replaced by ways that lead to trash stabilization and safe recycling, according to European laws[1]. legislation, programs, and developmental initiatives Their goal is to encourage pro-ecological sewage sludge management, among other things. Storage-based management techniques are being phased out in favor of procedures that lead to stabilization and safe recycling. As a result of these techniques, valuable raw materials may be recovered from potentially hazardous materials, which can then be processed for use in agriculture, different industries, or heat and energy recovery[2]. The properties of sewage sludge vary at each step of processing. The microbiology of sludge is altered during disinfection; the methane fermentation process reduces total carbon content; and thermal processing, depending on the temperature, may result in sludge densification or even the transformation of all organic matter into inorganic molecules. As a result, several distinct types of processed sewage sludge are produced, each with its own chemical makeup. They may also differ in terms of physical characteristics, consistency, and even factors like pollutant toxicity and stability[3].

All of these variables may influence whether a substance is categorized as safe or dangerous. The above-mentioned parameter values may have an impact on modifications in processing technology and the development of new management techniques. As a consequence, it is critical that the resultant material be submitted to a thorough chemical examination at each step of the waste processing process[4]. Other approaches and analytical procedures will be helpful in each situation due to their variety. As a result, the choice of an appropriate analytical technique is influenced by the sewage sludge management strategy, which in turn influences the technology utilized to treat them. This research focuses on explaining sewage sludge management techniques and demonstrating the benefits and drawbacks of various approaches. Analytical techniques are said to be a strong instrument that aids in the management process[5].

We have included not only management methods reported in peer-reviewed journals but also acts related to raw and processed sludge management because the subject is still developing in some countries and there is a large number of legislation including European Union directives and many countries ordinances. The maximum allowed concentration of pollutants and key parameters are also included in the legal issues discussed. There are additional references to studies published in technical journals and publications[6]. The present applied technology at Gdask's Sewage Sludge Treatment Plant "Wschód" was described using as-built documentations, specifications, and flow sheets. This facility serves as an example of a growing treatment plant that uses cutting-edge technology to produce environmentally friendly and cost-effective raw sewage sludge management techniques. There are still instances when raw sewage is dumped into bodies of water nowadays. This is particularly common in developing and developing nations. The Federated States of Micronesia, for example, where almost 30% of sewage is discharged into the Pacific Ocean without being treated, is an excellent example. Treated sewage is also discharged into the sea, with just a portion of the solid component removed, increasing the carbon content in coastal waterways and causing excessive development of local fauna and plants[7].

Fortunately, since the ocean is such a vast body of water and coastal waters mix with ocean waters, eutrophication is seldom an issue. In bodies of water that do not have direct access to the ocean, such as the Baltic Sea, the situation is different. Two straits, Skagerrak and Kattegat, divide it from the Atlantic Ocean, preventing saltwater from freely mixing with ocean water. The introduction of raw sewage into such a tiny body of water would result in eutrophication occurring at a rapid rate. As a result, improving wastewater treatment procedures is critical to ensuring that sewage discharged into surface waterways and subsequently transported to lakes, marine, and ocean waters is free of biogenic chemicals like phosphates[8]. The European Union developed appropriate regulations, such as the Council Directive on Municipal Waste Water Treatment of May 21, 1991, to minimize environmental deterioration caused by eutrophication and the entry of hazardous chemicals into waterways, such as heavy metals. It is assumed that wastewater should be treated more completely in all regions prone to eutrophication, such as the

Baltic Sea catchment area. This regulation also applies to Poland, which is a European Union member state.

As a consequence, new wastewater treatment facilities are being constructed at an increasing rate, while older ones are constantly being upgraded. Regulations on sewage discharged into water or soil are becoming more stringent Ordinance of the Minister for the Environment on the criteria to be met when discharging sewage into water or soil & on chemicals that are particularly hazardous to the environment [9]. As a result, purifying procedures must still be enhanced. Excess sewage sludge is accumulating an increasing quantity of contaminants, not only organic ones. As a result, its application is becoming more of a challenge. In 2011, Poland alone generated more than half a million tons of sewage sludge by dry weight. It should be noted that these sediments are often hydrated to more than 90%, making their treatment an extremely difficult task. At Poland, surplus sludge is now kept for two years in landfills and sewage treatment facilities. The technique of storage was the most often utilized method of management. This is because sewage sludge must satisfy stringent requirements in order to be re-used, for example, in well-known agrochemical treatments[10].

DISCUSSION

They will vary based on the country and the uniqueness of the management style. Furthermore, all recycling and management techniques should be preferred approaches including the use of landfills, according to Directive 2008/98/EC of the European Parliament and the European Council. By 2020, landfills must have a biodegradable composition of 35 percent. It is also suggested that the finest available technology be utilized to deal with all types of trash and to create new alternative goods. Those goods must satisfy all legislative criteria for environmental safety in a broad sense. They are unlikely to endanger water, soils, air, plants, or animals, and they do not emit smells or other contaminants into the environment when used.

Over ten million tons of dry solid sewage sludge were generated in 2012. Approximately 40% of the surplus sludge was speeded onto land for agricultural purposes. If sludge is utilized as a fertilizer for producing crops for human consumption or animal feed, the biological and chemical safety of this material is paramount. When trash is utilized to restore soils to meet particular requirements, its physical properties may become increasingly significant. In all instances, however, excessively large, uncontrolled quantities of potentially hazardous substances seeping into the soil or groundwater cannot be tolerated. Heavy metals, grease, phenolic chemicals, and polycyclic aromatic hydrocarbons may all cause significant changes in the soil's flora and fauna, lowering fertility and altering other characteristics.

Different technical methods such as disinfection, stabilization on sludge drying beds, or stabilization using earthworms, as well as their combinations and/or alterations, may be used to prepare sludge prior to its usage, satisfy legal requirements, and be sufficient in terms of intended end-use. Apart from removing harmful bacterial flora, disinfection and stabilization processes on drying beds are used to prepare sludge for use as a fertilizer or for other treatments such as soil reclamation. This procedure causes dewatering of the sludge in addition to hygenisation. Compared to thermal processing, the investment and operational costs are far cheaper. Despite the fact that surplus sludge is usually 97-99 percent hydrated, drying is a critical process. If a basic drying step is skipped, the soil into which unprocessed sludge is put will undergo significant physical changes.

The quantity of organic carbon in sewage sludge is decreased when earthworms are employed to stabilize it, but the amount of accessible phosphorus rises. As a result, after approximately 100 days of stability, the carbon to nitrogen ratio decreases, improving the fertilizer's quality. The amount of potentially hazardous substances like heavy metals is also decreased throughout this procedure. This is most likely owing to the fact that these chemicals collect in the bodies of earthworms, which are then eliminated from the final product at the conclusion of the process. This is a benefit of this alternative method over traditional stabilization, since heavy metals in wastewater, particularly from industrial and huge agglomerations, may be a major issue, preventing the use of sludge in such treatments.

Anaerobic stabilization may be used instead of aerobic stabilization. In this scenario, in addition to the previously stated restriction on pathogenic fauna growth, the organic carbon content of the sludge is also decreased, resulting in a product with a lower C:N ratio. After fermentation, the sludge may be used in agriculture and soil reclamation. Biogas with a high methane concentration is also generated. Biogas was formerly handled as trash and burnt as methane in a torch flame. It can no longer be released directly into the atmosphere since it is a greenhouse gas with a twenty-five times greater greenhouse potential than carbon dioxide. It may, however, be utilized as a fuel and burnt in gas turbines to recover energy. Because the energy gained in this process comes from a renewable source, it is one of the most desired waste management methods. It may be utilized on-site or sold to the grid. Furthermore, getting electricity from biomass or other renewable sources reduces CO2 emissions. Even yet, there are certain drawbacks to this technique of sewage sludge management.

Fermentative microorganisms must be given the right circumstances to grow in order for the methane fermentation process to be successful. This process’s optimal and limit parameter are given. Furthermore, process inhibitors such as pesticides and other plant protection agents should not be present in sludge. To enhance the efficiency of the process, it is sometimes necessary to add excipients, such as enzymes, or to mix surplus sludge with other plant waste. The cost-effectiveness of the methane fermentation process for relatively big sewage treatment facilities, equating to many tens of thousands of people, is the constraint (PE). Although sludge from many smaller wastewater treatment plants may be collected, the expense of transportation limits the profitability of the methane fermentation process.

The fermentation process' precipitate may be utilized not only for agriculture and soil reclamation, but also for additional processing, such as thermal processing. There are a variety of sewage sludge thermal treatment methods available. Pre-treatment is required for the majority of them. Processing raw sewage sludge prior to thermal treatment is often required from a technical and economic standpoint. Drying is a very basic technical process that involves providing energy to a system in order to evaporate water and cause it to densify. This method may be used before any additional heat treatment. or the last stage, the result of which may be used in agriculture as stated in the preceding sludge stabilization techniques. Drying does not always necessitate the use of additional energy. As a result, there is no need to incur additional expenses.

Bio drying is an alternative that uses heat produced by microorganisms to complete the drying process. These technologies enable lower operating costs. Methane fermentation, which was mentioned earlier, could be a step before drying. When the final product, such as a pellet, appears to be low-caloric, it may find use in the construction industry, such as road ballast or other practical applications. Dried sewage sludge, on the other hand, may be utilized as a fuel in a number of processes if it is rich in caloric content. The most common method for treating and managing sewage sludge is thermal utilization. Other types of trash, such as medical or municipal waste, are also often incinerated. This is because the incineration process is one of the most well-known waste treatment methods.

The amount of sewage sludge disposed of is substantially reduced when it is incinerated. It is critical in highly populated areas such as Japan, where residents must contend with high sludge output and limited land availability. There has already been a 55 percent increase in the amount of sludge burned there. As previously stated, bio drying is an example of such a process. Another option is to utilize the thermal energy produced during the incineration process to heat amenity buildings on sewage treatment plant grounds or to pre-dry burned material. Alternatively, heat from sewage sludge combustion may be used to make clinker. Because sludge has a poor calorific value when prepared for incineration, it is sometimes essential to construct a co-incineration process with other energy utilities (coal, fuel oil or natural gas). The biogas generated in the plant may be used as a source of alternative energy. In this instance, it's crucial to see whether incinerating it in turbines for combined heat and electric energy cogeneration is more cost-effective.

The heat may then be utilized for social reasons, or for heating process utilities or early processing of raw materials, as stated above, while the electric energy can be used in the treatment plant or sold to the grid. In addition to the economic factors of choosing an energy utility, it is critical to consider energy demand, which is dependent on the calorific value of the sludge to be incinerated, and, more significantly, the potential of introducing additional pollutants into the final product. It is also feasible to transport sewage sludge to a heat and power plant, where it may be utilized as an admixture in the co-incineration of combustible utilities. Instead of being used as a fertilizer or a medium for soil restoration, sewage sludge may be used for another environmentally friendly purpose. In this instance, the process's starting raw materials are mainly ash left over after incineration. However, sewage sludge mixed with crushed granite rock may be used to make a safe and long-lasting brick. The pulp is burned after gravel is added to produce crystalline phases. Ashes and cementitious materials may both go through the solidification process.

These procedures are carried out to immobilize pollutants found in processed sewage sludge that may be harmful to the environment. This method may also be used to provide cementitious materials concrete form and shape. The characteristics of ash cement are determined by the reactants employed in the cementation process and their proportions. The addition of ashes from the energy sector to a cementation process is often needed to enhance the degree of immobilization of pollutants such as heavy metals. Solidified blocks in this condition may be kept in wastewater treatment facilities or waste dumps without presenting a danger to the environment. About 40% of the dry mass of trash is made up of ash.

CONCLUSION

According to existing regulatory restrictions, large quantities of hazardous chemical compounds that may arise in processed sewage sludge are out of control. Organic pollutants are the primary issue when sewage sludge management methods do not include high temperature treatment. Because of the intricate matrix, identifying this kind of contaminant is usually very difficult. In this scenario, analytical methods such as gas or liquid chromatography, as well as a variety of preparation procedures, may be required. Organic contaminants may come in a huge variety of sizes and shapes. All of this adds to the preparation, analysis, and, of course, the overall expense of the management process. It also has an impact on the time and expense of maintaining additional control over controlled media. As a result, dealing with sewage sludge that has been treated at a high temperature is easier in certain ways. Almost all organic molecules are obliterated. As a result, sewage sludge ashes are free of organic contaminants.However, since a large portion of the matrix is mineralized, ashes may include additional pollutants such as heavy metals or ions. However, heavy metal analysis at the European Union level may be less complex and less expensive.

Heavy metal removal, extraction, or immobilization from processed sewage sludge or sewage sludge ash may be critical throughout the management process. It is critical to create a safe technique for managing processed sewage sludge in order to reduce environmental risk. Poorly developed methods may result in chemicals being released into the environment, which can have a detrimental impact on the ecosystem and, as a result, human health. Each treatment plant's sewage sludge management method should be designed individually. Only thus can management techniques be justified in terms of both the environment and the economy. For the development of sewage sludge management techniques, comprehensive chemical characteristics as well as toxicity characteristics are required.

REFERENCES:

1. C. Adam, B. Peplinski, M. Michaelis, G. Kley, and F. G. Simon, “Thermochemical treatment of sewage sludge ashes for phosphorus recovery,” *Waste Manag.*, 2009, doi: 10.1016/j.wasman.2008.09.011.
2. J. Havukainen *et al.*, “Potential of phosphorus recovery from sewage sludge and manure ash by thermochemical treatment,” *Waste Manag.*, 2016, doi: 10.1016/j.wasman.2016.01.020.
3. P. M. Melia, A. B. Cundy, S. P. Sohi, P. S. Hooda, and R. Busquets, “Trends in the recovery of phosphorus in bioavailable forms from wastewater,” *Chemosphere*. 2017, doi: 10.1016/j.chemosphere.2017.07.089.
4. R. Li, W. Zhao, Y. Li, W. Wang, and X. Zhu, “Heavy metal removal and speciation transformation through the calcination treatment of phosphorus-enriched sewage sludge ash,” *J. Hazard. Mater.*, 2015, doi: 10.1016/j.jhazmat.2014.09.052.
5. C. Adam, C. Vogel, S. Wellendorf, J. Schick, S. Kratz, and E. Schnug, “Phosphorus recovery by thermo-chemical treatment of sewage sludge ash – results of the European FP6-project SUSAN,” *Int. Conf. Nutr. Recover. from Wastewater Streams*, 2009.
6. V. G. Greb, A. Guhl, H. Weigand, B. Schulz, and M. Bertau, “Understanding phosphorus phases in sewage sludge ashes: A wet-process investigation coupled with automated mineralogy analysis,” *Miner. Eng.*, 2016, doi: 10.1016/j.mineng.2016.09.014.
7. C. Adam, G. Kley, F.-G. Simon, and A. Lehmann, “Recovery of nutrients from sewage sludge – Results of the European research-project SUSAN,” *Water Pract. Technol.*, 2008, doi: 10.2166/wpt.2008.001.
8. B. Peplinski, P. Köcher, and G. Kley, “Application of the Rietveld method to the severely superimposed diffraction patterns of technical products containing a large number of solid solution phases,” 2006, doi: 10.1524/zksu.2006.suppl_23.29.
9. G. Jungmeier, “The Biorefinery Fact Sheet,” *Int. J. Life Cycle Assess.*, 2017.
10. J. Stemann, B. Peplinski, and C. Adam, “Thermochemical treatment of sewage sludge ash with sodium salt additives for phosphorus fertilizer production - Analysis of underlying chemical reactions,” *Waste Manag.*, 2015, doi: 10.1016/j.wasman.2015.07.029.