Executive Summary

FEASIBILITY STUDY OF ENERGY RECOVERY BY INCINERATION - A CASE STUDY OF THE TRIANGLE WASTEWATER TREATMENT PLANT

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Wastewater Treatment Plants (WWTPs) require a significant amount of electricity throughout the water treatment process. WWTPs also need to dispose their sludge waste, a by-product of the wastewater treatment process, which is another significant expense. But, some sludge management options provide more benefits than others. Wastewater sludge is a biomass and thus energy can be recovered from it. Among the various energy recovery methods, incineration looks promising and has many advantages. Previous research has shown that per unit sludge, incineration may be able to recover twice the amount energy compared to anaerobic digestion. The energy then can be used for generating electricity or for other thermal applications. In addition to its energy recovery performance, incineration also has the advantage of greatly reducing the volume of sludge (approximately by 95%), and rendering the remains inert due to high temperatures. On the other hand incineration requires high capital and operational and maintenance (O&M) cost and can produce a substantial air emissions, requiring sophisticated air emission control equipment.

To get a better understanding of sludge incineration as an energy recovery option, and to help local WWTPs explore sludge disposal alternatives, Triangle Wastewater Treatment Plant (TWWTP), a small-sized WWTP located in Durham County, North Carolina was selected. It currently has no energy recovery system. A feasibility study was conducted to evaluate incineration as an energy recovery and sludge disposal option for the TWWTP. Three aspects were looked at to answer the feasibility question: 1) The system's energy (in this case, electricity) generation performance; 2) A cost-benefit analysis; and 3) An environmental impact assessment.

The analysis was structured in a way to compare the TWWTP's current sludge disposal method i.e. composting. A business-as-usual (BaU) scenario was defined under the assumption that the disposal rate remains the same in the future, while the wastewater flow steadily rises to reach the plant's designed capacity in 2035. Huber Technology's "sludge2energy" energy-recovery system was narrowed down on as the ideal plant design and slightly adjusted to fit TWWTP's context.

An energy balance model was created to simulate the sludge2energy pilot plant operation for an hour. It was noticed however that TWWTP's sludge had a higher thermal value than that used in the sludge2energy system's pilot plant. This meant a larger, 200 kW turbine option could be explored for the proposed plant, up from the 80 kW of the pilot plant, increasing the net electricity generation.

Energy generation projections were made for two scenarios: 1) Only sludge is used as fuel, 2) Sludge as primary fuel with natural gas backup. The plant performance was also judged from the point of view of it being a sludge disposal solution. Applicable federal, state and local policies and incentives were explored and a net present value of the project was calculated. Finally the environmental impact of sludge incineration was compared to the current sludge disposal solution.

Corresponding to our research questions, the results were: 1) The modified sludge2energy system can generate a maximum of 1200 MWh annually providing 20% of TWWTP's requirement in 2016. This fraction is likely to decrease as the wastewater flow and hence electricity consumption increases; 2) As an electricity generator, its electricity is too expensive. As a sludge disposal method, it is again more expense than the current solution. The net present value (NPV) is approximately negative $14 million for both the fuel scenarios; 3) The environmental impact of this incineration system is lower than the BaU disposal solution, due to comparatively lower life cycle air emissions and greater waste volume reduction.

But despite being an environmentally friendlier solution, sludge incineration, specifically in the case of the TWWTP is not feasible due to financial considerations. Several factors including high investment and operational costs, low calorific value of sludge, and low electricity rates in North Carolina have all lead to the negative NPV, with the most significant driver being the O&M costs, making the incineration plant a bad investment. Due to limited time, this study cannot be considered a comprehensive decision-making guide. Future studies need to bolster it by incorporating technical, legal and a deeper financial analysis. However, we still recognize the value of energy recovery by sludge incineration. Therefore, we suggest that the TWWTP continue monitoring the various factors that affect the plant feasibility.

Approved

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