Energy saving in wastewater treatment plants

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Abstract. This paper uses data from the Chisinau Wastewater Treatment Plant (WWTP) (2018 year) to analyze the potential for energy recovery from wastewater treatment plant via anaerobic digestion with biogas utilization with electricity generation. These energy recovery strategies could help offset the electricity consumption of the wastewater treatment plants and represent possible areas for sustainable energy policy implementation. We estimate that anaerobic digestion could save approximately 14,444,918 kWh annually in Chisinau WWTP. Anaerobic digestion is widely considered as an environmentally friendly technology for sewerage sludge. This study aims to highlight the potential as well as to provide a starting point for further studies regarding the treatment as sewerage sludge using anaerobic digestion in Republic of Moldova and recovery energy that could further reduce electricity cost and reduction of sludge cake.
Keywords: wastewater treatment, energy, sludge, anaerobic digestion, biogas.

1. Introduction

Wastewater collected from municipalities and communities must ultimately be returned to receiving waters or to the land or reused [1]. Chisinau WWTP has been constructed in successive phases and is operated by "*Apa Canal Chisinau"* (ACC). The wastewater flow rate was approximately 435 thousand m^3/day (yearly average) with average chemical oxygen demand (COD), 5 day biological oxygen demand (BOD_5), and total suspended solids (TSS) concentrations of 900 mg/l, 300 mg/l, and 500 mg/l respectively. Chisinau WWTP has been largely oversized and is currently running at only one third of its capacity (142 thousand m^3/day). The wastewater treatment process features the conventional steps of a medium-load activated sludge plant modified with contact stabilization tank for the aeration of returned activated sludge to the head of secondary treatment. The lack of an appropriate sludge treatment line combined with extremely poor conditions of the works and pieces of equipment and the absence of online sensors and of control systems impede the optimal operation of the plant. The current practices in sludge management by dewatering and drying in geotubes must be changed since they cause significant odor problems in the city especially in nearby settlements.

This is a study of analyzing scenario in terms of their technological and economical feasibilities focusing on the sludge management processes to increase the sustainability of the WWTP operation in Chisinau by using biogas recovered from waste activated sludge (WAS). The formation of biogas composed of mainly CH_4 and CO_2 in anaerobic digester

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processing WAS as the substrate is proposed for rendering organic load produced in the secondary treatment and reducing solids content of WAS.

2 Methods

2.1 Data collection

The existing Chisinau Wastewater Treatment Plant dates back from the 70s and was built in several stages although it has never worked at full capacity according to the best of our knowledge. About 35-40 % of the works are being used currently. The treatment of wastewater in Chisinau WWTP takes place in several stages as follows:

a) *The Preliminary Treatment* consists of two physical operations: screening and sand removal. Screening (six pieces, 10.5 or 16 mm for spacing) removes large solids, which are retained by the screens. The main reasons for screening are to protect the pumps and pipe works, downstream treatment units and tanks. The sand is removed by sedimentation through grit chamber (with four sections).

b) *The Primary Treatment* consists of primary settling process. Primary settling tanks (4 cylindrical tanks with a volume of 4500 m^3 each) allow solids to settle gravimetrically with the settling velocity of 0.7 m/s minimum. Primary sludge is transferred directly to geotubes to be dewatered.

c) *The Secondary Treatment* is a conventional activated sludge process (aeration and secondary settling) modified by contact stabilization of returned activated sludge (RAS) which is 70 – 80% to maintain the bacterial population in the reactor. There are currently 6 aeration tanks in operation with (2 – 22500 m^3, 4 – 12500 m^3) with 10-15 days solids retention time (SRT). The secondary settling tanks (volume 4500 – 9000 m^3 each, four work out of eight) remove mixed liquor suspended solids (MLSS) produced in the aeration tanks by gravitational force. The clarified wastewater is discharged to the receiving water body (Bac River) and sludge is dewatered in geotubes.

d) *The Sludge Management* is simply dewatering of primary and secondary sludge in geotubes followed by landfills. The mixture of primary and secondary sludge used to be stored directly on sludge platforms (32 ha) for dehydration, which generated serious odor problems. The geotubes were implemented in 2009 as a quick and easy attempt to mitigate odor issues generated by the sludge platforms and it proved to be quite efficient in odor removal. Sludge is pumped into the geotubes and are added the polymers, which makes the solids bind together and water separate. Clear effluent water simply drains from the geotube through the small pores in the specially engineered textile. The decanted water is returned to the head of plant. After the final cycle of filling and dewatering, the solids remain in the bag and continue to density due to desiccation as residual water vapor escapes through the fabric. Volume reduction can be as high as 90 percent. When full, the geotubes (appr.600 kg each) and sludge cake are deposited at a landfill. Thus, capital cost of sludge management can be estimated as 391,308.8 €/year (160 Geotubes) [2]. After dewatering process, geotubes are opened and the sludge cake is transferred by trucks to a landfill site. The geotubes generated approximately 500,768.30 m^3/year of sludge in 2018.

Nowadays, the Chisinau WWTP is powered with electricity 100% from the grid. The main power consumption apparatus in the plant are pumps and blowers. All other auxiliary power needs such as lighting and potable water pumps are also supplied from the grid. This data are essential for predicting the energy requirements for an alternative power system before doing an upgrade. The average yearly was calculated as 19,450,795 kWh and cost including all taxes was 1,623,436.073 Euro/year or 0.083 Euro per kWh. For a 24 hour