ENERGY SAVING MODEL IN A WASTE WATER TREATMENT PLANT - A PILOT STUDY

Monica Popa[1], Dana Sîrbu[1], Daniela Curşeu[1], and Marcel Sabin Popa[2]

[1] University of Medicine and Pharmacy Cluj-Napoca, Romania
Dept. of Environmental Health
Pasteur str., 6, 400349 Cluj-Napoca, Romania,
E-mail: dr_monica_popa@yahoo.com

[2] Technical University of Cluj-Napoca, Romania
Baia-Mare str., 25, 400171 Cluj-Napoca, Romania
E-mail: marcel.popa@tcm.utcluj.ro

ABSTRACT

The main objective of this pilot study is to reduce the global warming effect of the atmosphere by the reduction of the CO_2 emissions. With this aim specific energy saving measures are projected for implementation at the municipal waste water treatment plant of Cluj-Napoca. It will result a fully operational combined heat and power unit working on the biogas generated in the waste water treatment process.

Keywords: wastewater, treatment plant, biogas, greenhouse effect.

BACKGROUND OF THE ROMANIAN WATER SECTOR

In the last years the general approach regarding the water sector in Romania recorded important changes. In order to assure a sustainable development of the water sector and the compliance with the EU Directive according to the agreed conformation period for the entire territory of Romania, it was adopted a consolidation approach for the operation of the water and wastewater systems as part of a regionalization strategy.

After a period of more than four decades of centralized management, Romania decided to return to the local autonomy principle through decentralization, in this way transferring major and concrete responsibilities to the local public administration. One of these specific responsibilities mentioned in republished, refers to the obligation of local administrations to organize their operation efficiently and adequately in order to provide public services (Law of the local public administration [1]). A number of 32 major municipalities (of more than 100,000 inhabitants each) have benefited from capital investment programmes for rehabilitation of their water and wastewater infrastructure between 1990 and 2007.

In Romania, only 70 % of the population is connected both to water and sewage services and more than a half of the wastewater is untreated or insufficiently treated

(Popa, Curşeu, Sîrbu, Achimaş [2]). Until recently water and wastewater services were mostly operated by (often small) municipal utilities resulting in inefficient operations carried out at a sub-optimal scale, with limited technical and managerial capability to further develop the level of services. Now that Romania has become a member country of the EU, it must comply with the European Directive 98/83/EC on drinking water quality by 2015 and the Directive 91/271/EC on urban wastewater treatment by the end of 2018. For this reason, Romania intends for the period 2010-2015 to make the necessary investments to comply with the European drinking water indicators for e.g. turbidity, ammonia, aluminum, pesticides, nitrates etc. and for urban wastewater collection, treatment and discharge (Governement Decision no. 188/2002 [3]). Also by 2015 waste water collection and treatment is planned to be realized for a number of 263 agglomerations of more than 10,000 population equivalent (p.e.) and by 2018 in 2,346 agglomerations of between 2,000 and 10,000 p.e. In this view, the Ministry of Environment has accessed programmes (PHARE, ISPA) to support local authorities in creating strong and viable regional operators in the water sector, to ensure an adequate implementation of internationally financed projects and efficient operation of the utilities constructed with European funds.

The improvement of wastewater treatment will directly contribute to the implementation of the following directives of the European Union (EU):

- European Economic Community (EEC) Directive No. 76/190/08.12.1975 for bathing waters,
- EEC Directive No. 80/68/17.12.1979 on the protection of groundwater against pollution caused by certain dangerous substances,
- EEC Directive No. 85/337/05.07.1985 on the assessment of the effects of certain public and private projects on the environment,
- EEC Directive No. 86/278/04.07.1986 for environment protection, especially soil, in case of use of sludge resulted from wastewaters in agriculture,
- EEC Directive No. 91/271/21.05.1991 for urban wastewaters treatment.

OBJECTIVES

- Reduction of the greenhouse effect by utilization of the biogas resulted from the sludge digestion process in order to produce electrical and thermal energy.
- Training of the staff in the operation of the new technology.
- The elaboration of an additional project for the technological renewal of the aeration tank in order to increase the efficiency of the biological treatment and reduce the power consumption.

TECHNICAL PARAMETERS AND METHOD

The municipality of Cluj-Napoca, capital city of Cluj county, is located in the Transylvannia region, on the banks of the river Someş, at 44,18° Northern latitude and 28,63° Eastern longitude, and has a number of 330,000 inhabitants.

The Cluj-Napoca Waste Water Treatment Plant is situated approximately 10 km from the city. The biogas is produced by the sludge digesters which are processing the primary and the biological sludge resulted from the waste water treatment process. The mentioned process is an anaerobic digestion under the following conditions: volume of the digesters 2x4000 m^3; retention time 17-20 days; temperature 34-36°C; continuous mixing.

During the fermentation process the sludge is stabilized and there are resulted two main "products": the sludge which can be easily dewatered due to a lower organic content and the biogas which can be used as fuel for different purposes. This gas has about 65% methane, 30% CO_2 and different other gases like N, CO, H_2S etc. Before implementing the cogeneration unit, the biogas was burned in low efficiency boilers. The produced thermal energy can be used mainly to support the fermentation process, but also to heat buildings inside the waste water treatment plant (Popa, Sîrbu & al. [4]).

In order to reduce the greenhouse effect by the use of biogas as alternative source, the implemented technical solution is based on a cogeneration unit. The base of the cogeneration unit is the combination of piston combustion engine and electric generator, set at the common frame. Heat is recovered through heat exchangers, which take the heat from operation liquids (cooling liquid, oil), from flues and by glut engines also from feeding blend. The thermal energy is necessary both for the technological process and buildings heating in winter time. The installation is projected to be connected in parallel to the distribution network and supplies electrical energy through the low voltage network (0.4 KV) of the waste water treatment plant. The main components of the installation are comprised by a container with sound proofing.

The interior of the installation is divided into two functional compartments:

1. The control compartment, with the electric command, control and monitoring of the main parameters;
2. The motor generator compartment with the electrical and thermal energy producing equipment.

The main parameters of the CHP unit are:

- Fuel: biogas or natural gas
- Max fuel consumption: 138 m^3 per hour natural gas or 226 m^3 per hour biogas
- Max electric power: 455 KWe (670 KVA)
- Max thermal power: 711 KWt
- Overall energy efficiency: 85.5%

Economy effectiveness of the CHP is shown at parameter: production cost of electric energy. The average production cost of electric energy will be around 0.0161 Euro per kWh in comparison with 0.0595 Euro per kWh which is representing the tariff of electricity from a network of a distribution company.

PROJECTED RESULTS

Energy produced (total): ~3.59 MWh, representing ~60% from total energy consumption of the Waste Water Treatment Plant
Energy produced by renewables: ~1.300 MWh electricity
Economic benefits: ~100 000 Euro
Environmental benefits: Reduction of the greenhouse effect.
Behavioral changes achieved: increase attention for energy consumption, efficient management of the treatment works.

CONCLUSIONS

The positive aspects of project implementation will be good co-operation between consultant and beneficiary in project implementation and intensive know-how transfer in operation and maintenance from the supplier to the beneficiary.

Problems encountered are the present delays in project implementation with respect to the planning due to different approval procedures and due to the natural gas supplier who did not ensure in time the access to the gas distribution network, and also very limited service and maintenance support of the supplier in Romania.

Most medium and large sized urban waste water treatment plants in Romania have been constructed according to the same design concept, including sludge digestion and biogas utilization for combustion in energy inefficient boiler systems for the heating of sludge and buildings only. This project may have a wide impact on the management of waste water treatment plants, as it demonstrates in Romania that substantial costs can be saved through the utilization of the biogas for generation of electric power and thermal energy.

ACKNOWLEDGEMENTS

The paper was realized in frame of VIASAN Project no. 293/2003 and I-GLOB Project 42117/ 2008.

REFERENCES

1. Law of the local public administration, No. 215/2001, Bucharest, Romania, 2001.
2. Monica Popa, Daniela Curşeu, Dana Sîrbu, A. Achimaş Cădariu, The Removal of Wastewater from Healthcare Units – Monitoring Strategies and Risk Assessment, pp. 493-496, Proceedings of the International Conference on Automation, Quality and Testing, Robotics, Cluj-Napoca, 2004.
3. The Governement Decision no. 188/2002, The Approval of Quality Norms for Waste Water Discharge in Aquatic Environment, Bucharest, Romania, 2002.
4. Monica Popa, Dana Sîrbu, Daniela Curşeu, A. Achimaş Cădariu, Stoian Ioan, Ada Manciu, Approaches on Wastewater Management, CD Proceedings of the 9th International Conference on Energy and Environment, Sharm-El-Sheikh, Egypt, 2005.