

Energy Audit Methodology and key performance parameters (KPI) in Small WasteWater Treatment Plants.

B. M. D'Antoni *, S. Longo**, E. Akkersdijk***, L. Stefani****, E. Parelli**** and F. Fatone*

* Department of Biotechnology, University of Verona, Strada le grazie 15, Verona, Italy
(E-mail: benedettomirko.dantoni@univr.it; francesco.fatone@univr.it)

** Department of Chemical Engineering, Institute of Technology, Universidade de Santiago de Compostela, Rúa Lope Gómez de Marzoa, 15782, Santiago de Compostela, Spain
(E-mail: Stefano.longo@ucs.es)

*** Aggerverband, Sonnenstraße 40, Gummersbach, Germany
(E-mail: Erik.Akkersdijk@aggerverband.de)

**** ETRA S.p.A, Progetti Innovativi Ricerca e Sviluppo, via del Telarolo 9, Cittadella, Padova, Italy
(E-mail: l.stefani@etraspa.it; e.parelli@etraspa.it)

Abstract

Energy consumption represents one of the most important operative costs of wastewater treatment plant (WWTP). In this regard the determination of energy consumption allows to obtain energy saving opportunities in small WWTPs.

The proposed work presents an innovative energy audit methodology in WWTPs, which allows to determine KPIs in the different treatment stages. The energy audit is in progress and will be carried out on 15 small WWTPs located in Italy, Spain and Germany. The obtained results will be compared with the benchmark and energy saving opportunities will be considered

Keywords

Energy audit; key performance parameters; benchmarking; wastewater treatment plant

INTRODUCTION

In WWTPs, the electricity consumption represents an important energy requirement in Europe. In Europe most of the total WWTPs are small plants (65%). The agglomeration size range of these WWTPs is between 2.000 and 10.000 PE (Foladori, 2015). In small WWTPs the energy consumption is relatively low due their size but they have high specific energy consumption. The energy consumption represents a significant part of the operative cost of WWTPs, however, this energy consumption could be reduced by operational adjustments and suitable design (Panepinto, 2016). Energy audit methodology and key energy consumption indicators were proposed in order to evaluate energy consumption and energy saving opportunities in small WWTPs (Foladori, 2015). The aim of this study is to propose an innovative energy audit methodology for the evaluation of WWTP energy efficiency.

MATERIAL AND METHODS

A first step of this work was a review of WWTPs energy-use performance in order to develop the benchmark. The energy aggregated consumption data of 369 WWTPs and 125 disaggregated data of WWTPs were collected. For disaggregated data, the energy consumption for each equipment and treatment process was included. This benchmark was developed based on the size and the process treatment classification of the WWTPs. 15 small WWTPs located in Italy, Spain and Germany with an average population equivalent (PE) between 1.000 and 10.567 PE were considered for the energy audit (Table 1). In this energy audit methodology, the different processes of the WWTPs were classified into 7 treatment stages, as following:

- Stage 1: Preliminary treatment (Influent pumping, screening, grit removal, etc.);
- Stage 2: Primary treatment (Primary clarification);
- Stage 3: Secondary treatment (Biological reactors, Secondary clarification, etc.);

- Stage 4: Tertiary and advanced treatment (Sand Filters, UV disinfection, reed-beds, etc.);
- Stage 5: Sludge treatment (thickeners, sludge stabilisation, belt presses, dewatering, etc.);
- Stage 6: Return liquors treatment (reject water, Anammox, struvite precipitation, etc.);
- Stage 7: Odour treatment (chemical scrubbers, incinerators, bio filters, etc.).

A pre-audit survey has been conducted in order to consider all the electro-mechanic devices operating in each stage of the studied WWTPs. The energy audit is in progress and toroidal transformer, power analyser and remote control systems will be installed in this month for online energy consumption acquisition. Moreover, a sampling campaign will be developed in all WWTPs to evaluate the load of pollutant removed in each treatment stage.

The next step of this methodology will be the calculation of different key performance parameters (KPIs) in each treatment stage of WWTPs, such as for example, kWh/m³, kWh/kgBOD_{5removed}, kWh/kgCOD_{removed}, kWh/kgTN_{removed}, kWh/kgTP_{removed}, kWh/kgNH_{4removed}, kWh/kgTSS_{removed}, kWh/kgTS_{processed}.

Table 1. Size of the small WWTPs studied in this work.

WWTP	Country	Size [PE]
Cervarese	Italy	7.000
Lindlar	Germany	8.965
Brenzinger	Germany	9.052
Volperhausen	Germany	8.461
Ründeroth	Germany	8.883
Bruch	Germany	4.461
Brunohl	Germany	10.518
Engelskirchen	Germany	10.567
Ordenes	Spain	7.500
Allariz	Spain	6.500
Cerceda	Spain	1.000
Mino	Spain	9.000
Ponte do Porto	Spain	4.000
Mondariz	Spain	6.000
Vilalba	Spain	10.000

RESULTS AND DISCUSSION

Once the remote control system will be installed, the energy consumption data of each electro-mechanic device will be reported on energy audit template. The results of the sampling campaign will be used in order to calculate the KPIs in each stage treatment. At the end of the energy audit methodology, the obtained values will be compared with the benchmark and energy saving opportunities will be considered.

REFERENCES

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