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Monitoring of Operation of Electric System by Radiocommunication Devices and Energy Consumption in Wastewater Treatment Plant

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GOAL OF THE STUDY

This paper describes the design and application of a monitoring system applicable in small and medium sized wastewater treatment plants. Projected capacity of plant is 1600 equivalent population, where data are used to determine the technical condition of the equipment and to optimize the operating parameters of plant.

METHODOLOGY

The 8-bit ATmega 2560 microcontroller is used as basic communication interface between Ethernet communication module W5100 and the sensors parts in monitoring system. Memory is used for storing the monitored data of operational states and also for backup of the data. The real-time values are obtained using the ZS-042 module. Access to the data in the monitoring system is provided by an online connection using an LTE wireless communication network.

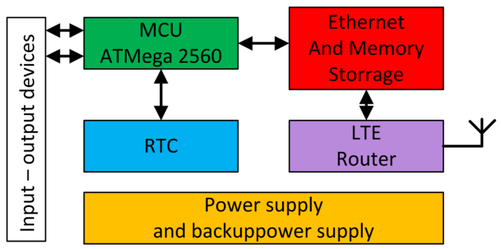

Fig. 1. Block diagram of monitoring system in WWTP

The variability of the values and the linear increase or decrease of the energy consumed by the WWTP as well as the amount of treated wastewater is expected to vary during the 12-month period of 2021. The energy consumption indicator during monitored period in WWTP can be defined as follows:

$$ECI_{QM} = \frac{E_M}{Q_M} \quad (1)$$

where: ECI_{QM} characterizes the amount of energy consumed to treat a given amount of wastewater during the period under study, EM (kWh/M)characterizes the amount of energy consumed during the period under study, QM (m^3/M) characterizes the wastewater flow rate during the period under study. The assumption is a normal distribution of measured values in the statistical set, which is represented by each month, and it is possible to approximate the given values by a linear dependence for the monitored period in the following form:

$$E = b \cdot E_{mes} + q \quad (2)$$

where: E represent approximated consumed energy during monitored period (kWh), E_{mes} is obtained value of energy in WWTP (kWh) and a and b are regression constants calculated by data analysis.

MAIN RESULTS FROM THE STUDY

During the monitoring period January 2021 to December 2021, the wastewater flow in the treatment plant was monitored and the total flow 23 161 m^3 during the period was found. The total electricity consumed at the wastewater treatment plant during the reporting period was 58 183 kWh. The statistical analysis of the distribution of the energy consumption values during the period under consideration in the relevant months is shown graphically in figure Fig. 2

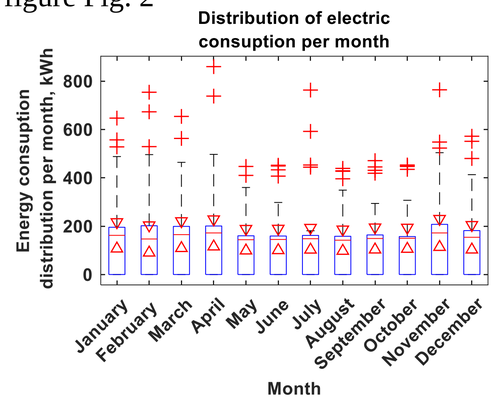

Fig. 2. Energy consumption in WWTP during monitored period

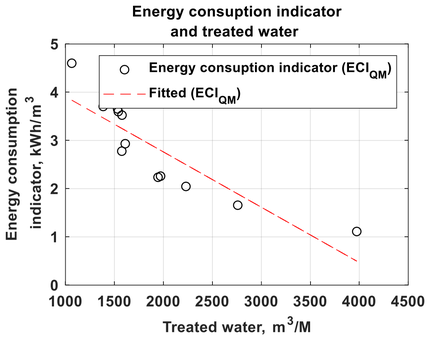

Fig. 3. Energy consumption indicator for period of WWTP

The highest amount of energy per m^3 of wastewater was consumed at the beginning of the operation of WWTP, reaching a maximum value of 4.6015 kWh/m^3, while the median value of energy consumed during the study period was 2.8550 kWh/m^3.

CONCLUSIONS

In this work, we have proposed a method and a conceptually simple system for monitoring the operation of a wastewater treatment plant, where the system can be used to obtain operational data in the field of water and wastewater management of small and medium sized plants. The proposed system for monitoring operating variables with radio communication systems can be used together with the Industry 4.0 concept as well as in plants where it is necessary to have important data about the process and to react in time to the situation in order to operate the system efficiently.

ACKNOWLEDGMENT

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