The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 2018

Volume 4, Pages 127-131

IConTES 2018: International Conference on Technology, Engineering and Science

SCADA Assisted Control of Biological Treatment Plants: Subaşi Example

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Abstract: A disadvantage of collective life is the problem of collective waste. Water is the most important source of life. The fresh water obtained from the nature is contaminated and returned to the nature. In bulk settlements, there is a large amount of waste water. High amounts of waste water can not be cleaned naturally in a rapid manner. For this reason wastewater treatment facilities have been established in settlements. Waste water entering these facilities is cleaned by biological methods and given to nature. The purification is made of bacteria-based. In the treatment process, the number of bacteria and the amount of water entering and leaving the water cleaning are measured and process control is carried out. In this study, control of a wastewater treatment plant located in Edirne Subaşı was done by PLC. Sensors located in the field are processed by PLC and data is transferred to SCADA. The equipment was controlled on the SCADA according to the received data. Level control, oxygen control, flow control, dosing control are some of these controls. All these inspections can be carried out on a single center via SCADA.

Keywords: PLC, SCADA, Automation control, Waste water

Introduction

The state in public places offers services to people by collecting some taxes. Providing drinking water and disposing of waste water is one of them. In this study, technological control of wastewater treatment plant will be done. This study was carried out at the waste water treatment plant in the town of Subaşı in Edirne Meriç district. Subaşı is a settlement of Meriç District of Edirne Province in Marmara Region of Turkey. To the south of the city center is the west of the town of Meriç Subaşı, 7 km to the town center and 95 km to the city center. The average height of the Subaşı settlement on a flat area varies between 10 m and 50 m. Subaşı location is shown in figure 1.(Mühendislik, 2015)

Figure 1. Place in Subasi map of Turkey

A biological treatment plant will be controlled by a single center according to the desired values. The equipment in the field will be controlled to ensure that the set values entered by a qualified person are provided in the fastest and continuous manner. In biological waste water treatment facilities, the treatment of polluted water is carried out by bacteria(Grady Jr, Daigger, Love, & Filipe, 2011; Henze, van Loosdrecht, Ekama, & Brdjanovic, 2008). The pollutant ratio and the oxygen balance of the entering water are important for controlling the number of bacteria to be maintained. According to the bacteria measurements, it is necessary to adjust the amount of oxygen. This problem which is taken as a closed loop control system has been solved by PLC. According to the information received from the oxygen sensor in the field, the air source (blower) is supplied with air at different flow rates. At the same time, level, ORP and Ph value are continuously monitored in the facility.

In section 1, describes the way the plant works as a control system. The control equipment used in part two is mentioned. The control algorithm and control method described in section 3 are described. Finally the results and the discussion are presented.

Wastewater Treatment Plant

Subaşı Municipality Wastewater Treatment Plant was selected with a capacity of 2,500 people. Daily per capita wastewater flow rate was accepted as 100 lt / person. Accordingly, the total wastewater flow rate is calculated;

$$Q= (2{,}500 \text{ day} \times 100 \text{ lt/person.day}) / (86{,}400 \text{ s/day}) = 2.89 \text{ l/s} = 250 \text{ m}^3\text{/day}$$

A wastewater treatment plant with a capacity of 250 m3 / day will be designed in Subaşı Municipality(Mühendislik, 2015). The entering dirty water is collected in the promotional structure. The water level is measured here and the water is sent to the oxidation trench. There is a 300m3 water collection volume at the entrance promotion center where the methane gas sensor is measured against gas build-up and the aspirator is controlled. The polluted water sent to the oxidation trench by the inlet structure is cleaned here by bacteria. The water is moved back to the recycle structure with the displacement difference and then it is sent back with the recycle pumps. Cleaning is provided in this process. Then clean water and sludge are separated. The plant flow chart is also a SCADA image as in figure 2

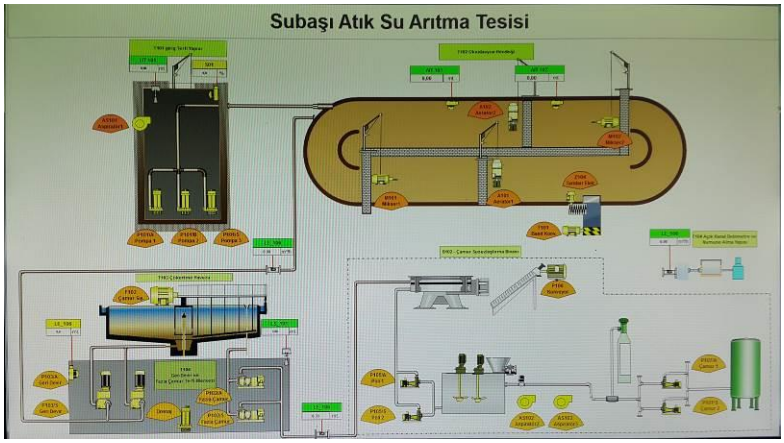

Figure 2. SCADA Main Screen

In this study, the amount of oxygen in the oxidation trench was checked. The air flow rate is set according to the entered oxygen set point. Air flow supply blowers. Frequency inverters are used to control the speed of these motors. Mixers were used for homogenous distribution of oxygen. In this process, the oxygen content was controlled by closed-loop control. Images related to the facility are as in Figure 3

Figure 3. Subaşı waste water treatment plant

Hardware

PLC is used as controller in the plant. Siemens S7-1200 model DC / DC / DC 1214 model as well as digital and analog models have been added. PLC is connected to a local network via industrial Ethernet. There are PLC, SCADA (computer), HMI, and Drives on the network. Network structure is as follows figure 4.

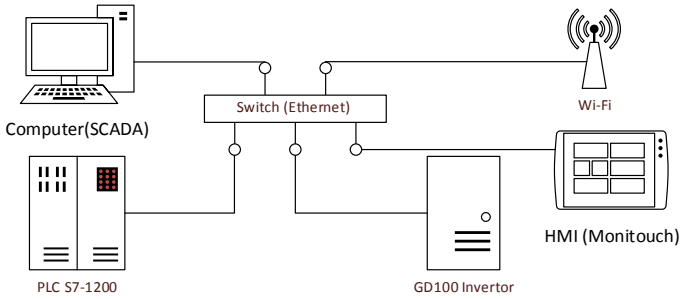

Figure 4. Network topology

A software is developed on the PLC for the devices that communicate with each other in the network structure(Bolton, 2015; Webb & Reis, 2002). In the software, various scenarios can be checked by SCADA, Dashboard or field. According to the key position, operator side control is determined. If SCADA is selected, the whole plant is controlled via a single point. It also collects data from all the senors as long as SCADA remains connected. The collected data is archived both on average and total value on a monthly monthly basis.

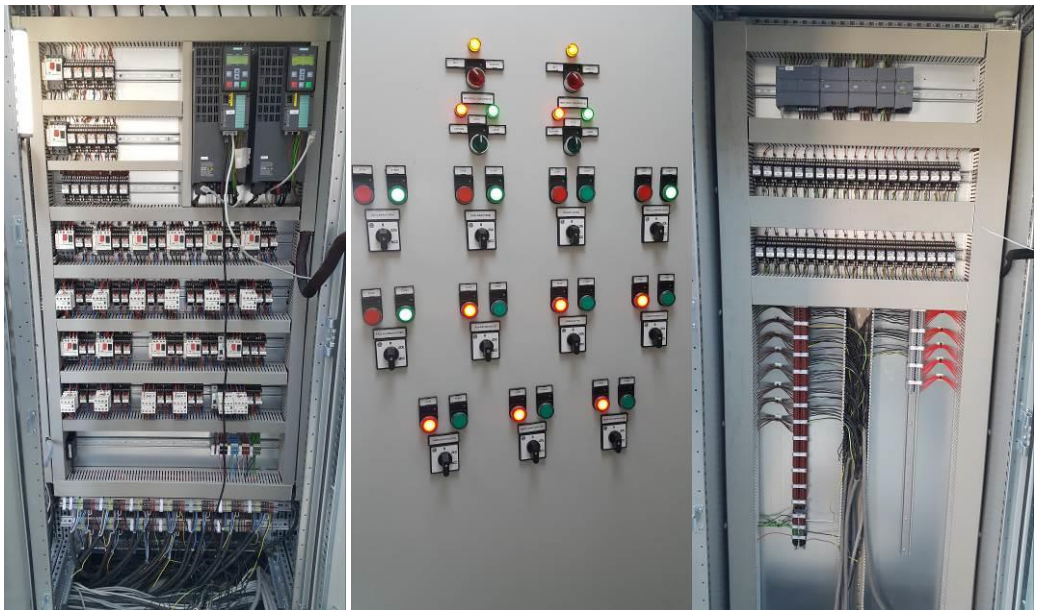

Figure 5. Hardware

In case of a problem on the SCADA, a touch panel is placed to start the inverter, adjust the frequency and set the set point(Aydoğdu, Hasırcı, & Akçay; Bejan, Iacob, & Andreescu, 2009). Monitouch brand HMI panel was used in 10" dimension. Communication with sensors in the field is taken from the 4-20mA analog value. These values are set on the sensor. Online oxygen measurement is provided by HACH SC200. Some of the equipment used are shown in figure 4.

Control Algorithm

Closed loop control was performed according to the set value entered via SCADA(figure 5). The speed of the frequency inverter is set at the output. PID coefficients were selected experimentally. The PID module can also be used to limit input and output signals(Li, Tang, & Liu, 2011). The PID control block in plc is as shown in Figure 6.

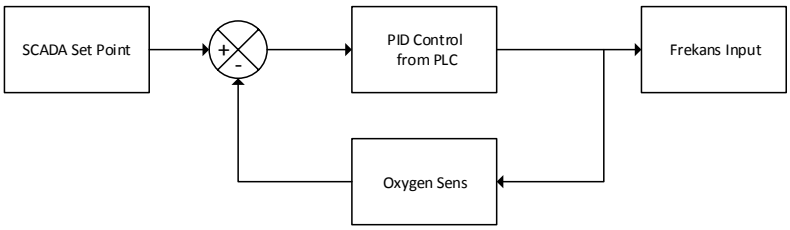

Figure 6. Closed loop Control Algorithm

The oxygen reading through the sensor is converted to oxygen information in a linear manner. In the same way the output value is given to the inverter via the analog output. In this way, the amount of oxygen entering the oxygen level is adjusted.

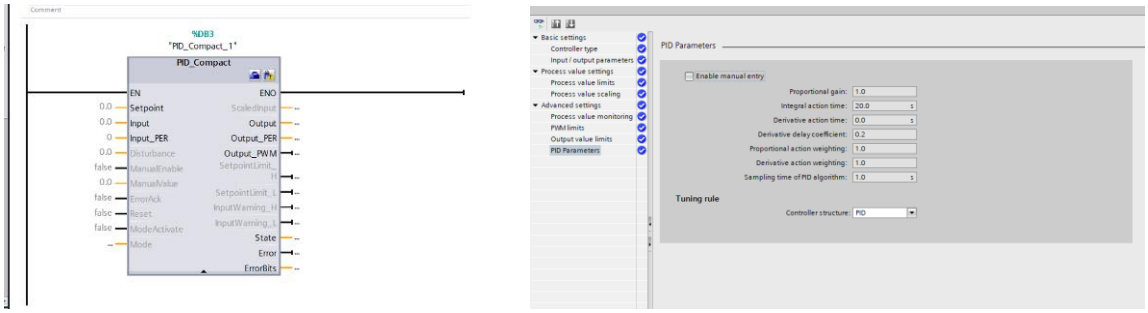

Figure 7. PID Control Module in PLC

Conclusion

In this study, control of wastewater treatment plant of Edirne Subaşı town was carried out via SCADA. PLC is used as controller. In the facility where domestic wastes will be treated, the treatment is done biologically. The oxygen level was controlled by PLC via the PID control algorithm for the bacteria to survive the treatment with the bacteria contained in the oxidation tank. The pumps have a daily average capacity of 250 m^3. All pumps are operated automatically and manually via SCDA. Pumps have been checked with sensor data from the field.

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