AISEM XX Two pages abstract

A MODEL-BASED APPROACH FOR ENERGY OPTIMIZATION OF REAL WASTEWATER PUMPING STATION

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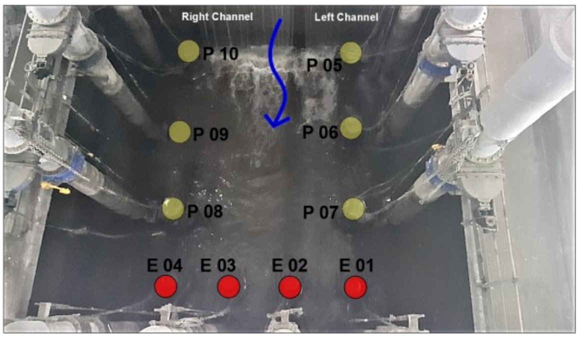
Abstract

Water Sector is a very important energy consumer. In the Campania Region (Italy), it represents the 3% of the total energy consumption, and it is the 30-40% of the total public energy bill [PEARC, 2009]. The energy consumption of Wastewater Treatment Plants (WWTPs) is often high and relevant energy saving potential estimates are available in literature [Castellet, 2016]. Consequently, many authors developed strategies and tools to increase the understanding of plant processes and support the energy efficiency of the plants [Castellet,2018; Torregrossa, 2018]. In WWTPs, pumping stations represents one of the most important energy consumer [Torregrossa, 2017] and consequently their optimization can contribute to improve the energy balance performance of WWTPs. The aim of this manuscript is to propose a model-based approach to optimize the operation of a real WWTP pumping station. A specific case study is analyzed: the South Pumping Plant of the Nocera WWTP. Such system uses about the 20% of the energy consumed by the plant, and, consequently, its operational and energy optimization is mandatory for an efficient management.

The case study

Nocera Wastewater Treatment Plant serves five municipalities in the Campania Region, treating domestic wastewater of 105,000 inhabitants. Moreover industrial wastewater (mainly tomato industry) are also treated reaching a total seasonal load of 300,000 PE during summer.



Start Level				Stop Level		
Level No	Setting [m]	Pump "P"		Level No	Setting [m]	Pump "P"
1	2	P1		1	2.2	P1
2	2,2	P2		2	2	P2
3	2,3	P3		3	1.8	P3

Fig. 1: A picture of the pumping system and the actual start/stop setting.

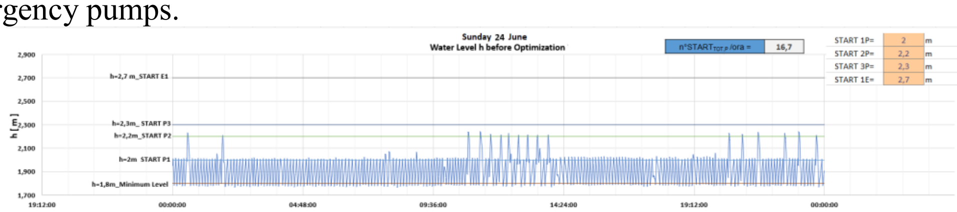
Water comes in the plant through two main pumping system, namely the Northern and the Southern Pumping systems. In present work the Southern Pumping plant is analyzed, since it represents about the 20% of the total energy consumption of the plant [Pucci et al., 2016]. This system has a nominal discharge of 1656 m3/h, while the peak discharge is 6516 m3/h.

The inlet discharge can be very variable, both for rain events or during the summer, in which the food industries concentrate their most important activities. Operations of the Southern pumping station were analyzed in dry weather conditions first. The operation of the pumps is governed by ON / OFF control with cyclical rotation work sequence. The start/stop of the individual units is regulated by the signal transmitted by the level gauge of the tie rod in the suction tank.

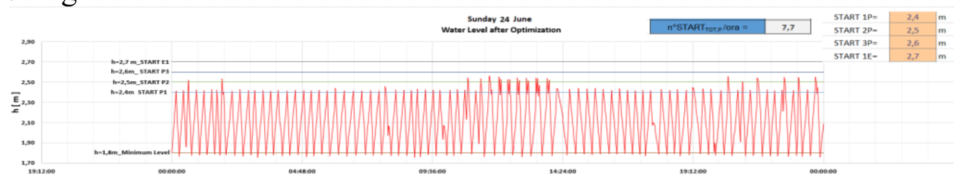
The proposed approach

First of all a numerical model of the pumping system was built. The model can reproduce water level time history under an assigned inlet discharge. It was calibrated using one week of collected data. This dataset represents a dry-weather week. The results are very sensitive to the time step used in the simulation: large errors can appear if a too large time step is assumed in the computation. This is due to the fast variations of water level during the pumping (see section 2). After intensive tests, the time step of 10s was found as a good compromise between accuracy and computation time need. The algorithm tries to optimize the activation heights of the pumps in order to reduce the daily activation number of the pumps.The following constraints need to be taken into consideration:

1. minimum sump height h_{MIN} = 1,8 m, to avoid cavitation;
2. Emergency pumps are switched off because the investigation takes into account only dry periods. The emergency level must be avoided, i.e. water level is below the starting height of emergency pumps.



a) Original Setting



b) Optimized Setting

Figure 2 -Water level time history before and after the optimization (Sunday)

As an example, in Figure 2 it is drawn the water level time history in a day (Sunday) using the original setting (a) and the optimized one (b). As can be observed, the start/stop number can be reduced of about 50%.

Conclusions

The analysis of activation height shows that it is possible to reduce the number of activations by 50% or more. This reduction has a direct impact on the operational life of pump components and an effect on energy consumption. Currently, direct measurements of energy are not available. Future works will take into consideration an extended set of variables.

REFERENCES

Castellet-Viciano, Lledó, et al. “The Relevance of the Design Characteristics to the Optimal Operation of Wastewater Treatment Plants: Energy Cost Assessment.” *Journal of Environmental Management*, vol. 222, 2018, pp. 275–283., doi:10.1016/j.jenvman.2018.05.049.

Castellet, Lledó, and María Molinos-Senante. “Efficiency Assessment of Wastewater Treatment Plants: A Data Envelopment Analysis Approach Integrating Technical, Economic, and Environmental Issues.” *Journal of Environmental Management*, vol. 167, 2016, pp. 160–166., doi:10.1016/j.jenvman.2015.11.037.

Pucci, Luca et al. “Optimization-based methodology for improving energy efficiency in wastewater treatment plants” Proceedings Ecostp IWA Conference – Cambridge, June 2016

Torregrossa, Dario, et al. “Pump Efficiency Analysis of Waste Water Treatment Plants: A Data Mining Approach Using Signal Decomposition for Decision Making.” *Computational Science and Its Applications – ICCSA 2017 Lecture Notes in Computer Science*, 2017, pp. 744–752., doi:10.1007/978-3-319-62407-5_56.

Torregrossa, Dario, and Joachim Hansen. “SK-DSSy: How to Integrate the YouTube Platform in a Cooperative Decision Support?” *Decision Support Systems VIII: Sustainable Data-Driven and Evidence-Based Decision Support Lecture Notes in Business Information Processing*, 2018, pp. 145–156., doi:10.1007/978-3-319-90315-6_12.