Abstract ampliado

EXTENDED ABSTRACT

Title: Optimal asset management in wastewater treatment plants

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Abstract:

During the last few years, experts in the wastewater treatment sector have concerned about the loss of the efficiency of the process due to the deterioration of the infrastructure. There are more than 30,000 wastewater treatment plants (WWTPs) in Europe. WWTPs comprise a large number of assets of different nature which are very valuable from the investment and the operational and maintenance point of view (Marlow, 2010). For this reason, some authors (Allbee, 2005; Foley, 2005) have suggested that a greater effort must be made by wastewater policy makers to manage them efficiently.

It is understood that a lack of maintenance has consequences for the deterioration of the equipment, which would rise progressively. As a result, it has been necessary to schedule some routine maintenance of the equipment. If the durability of the equipment is optimised, the costs associated to the failures and the replacement of the assets are reduced. The most effective maintenance plan is based on predictive techniques, since it could minimise the interruptions of the process in which the assets are involved, improving its productivity and the economic efficiency of the company.

The entirety of the assets that a WWTP comprises is mainly grouped into electromechanical equipment, network systems, and civil construction. Each kind of asset has been designed to carry out a specific function, such as pumping or driving the wastewater along the process, or retaining the wastewater in order that different physic-chemical and biological processes take place. Thus, the deterioration of the assets of a WWTP depends on their function, the construction material, and how long they have been working.

As time goes by, the deterioration of the assets increases, the maintenance costs gain more importance because of the repairs, and their efficiency gets reduced (Younis& Knight, 2010). Moreover, as a consequence of the deterioration, the electromechanical equipment consumes more electricity, which increases the operational costs of the process (Rojas &Zhelev, 2012).

Different methods that have been applied to diagnose the conditions of the assets, such as fuzzy logic, artificial neural networks, and regression techniques (Azadeh, Ebrahimipour &Bavar, 2010; Muralidharan&Sugumaran, 2013; Sakthivel, Sugumaran & Nair, 2010).The fuzzy logic method obtains its information from sensors or controllers previously installed on the equipment, and then according to a set of logical rules established by a group of experts it offers a result. These output variables can also be transformed into physical values, so that the operator obtains a result according to the parameters collected. Artificial neural networks are structures based on the learning mechanism of the human brain: these are very effective when the aim is to model the use of certain parameters(Du &Swamy, 2010; Hrycej, 1992; Kleiner&Rajani, 2001; Sadiq, Kleiner, &Rajani, 2004). Finally, the most used technique is the regression model, which tries to relate statistically different variables and then offers a result. The main drawback of the last technique is that it requires a historical or a wide sample of data. It can take different functional forms, but requires that certain hypotheses be corroborated in order to obtain a robust model.

These techniques focus mainly on specific operating parameters. However, if we want to assess the condition of the assets more accurately, we should consider multiple factors. These kinds of factors can be grouped into physical, environmental, and operational (Altayeb Qasem et al., 2009; Hassan Al-Barqawi&Zayed, 2006; Hudson & Haas, 1997; Kleiner&Rajani, 2001), and they will affect the assets in different ways. Hence, their influence should be quantified. For this purpose, the Multi-Criterion Decision Making (MCDM) technique can be useful, since it enables us to combine the existing scientific and technical information with expert knowledge. There are several methods, such as the Analytical Hierarchy Process (AHP) and Multi-Attribute Utility Theory (MAUT) that can be very helpful.

Throughout this paper, the authors aim to assess the level of deterioration of one of the most important pieces of equipment in the entire water cycle, including the WWTPs: the centrifugal pumps. There are mainly two types: submersible centrifugal pumps and non-submersible centrifugal pumps; whose aim is to move the wastewater through the different areas that make up the treatment process. The first ones, suffer a greater deterioration due to the fact that they are in continuous contact with the wastewater. For this reason, the current study will focus in these ones.

Being able to define the condition of a certain asset would help to optimize the decision making process. For this purpose, a Multi-Criterion Decision Making (MCDM) technique could be used as a methodology. The method chosen is the AHP. It will be used in combination with the MAUT. Then the information obtained will be used to develop an index ranging from 0 to 10, where the maximum value describes a favourable condition and the minimum value is a state of high degradation.

In a second stage, the assessment of the factors that accelerate the deterioration will allow to implement adjustments in order to extend their useful life, improve the energy efficiency of the process, plan a maintenance strategy that includes both predictive and preventive tasks, and finally, justify the equipment replacement.

Palabras Clave: centrifugal pump, deterioration, asset, wastewater treatment plant

Clasificación JEL:

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