Potential for energy efficiency optimisation in wastewater pumping systems

● Pump costs are a significant element of a utility's operating budget, so optimising wastewater pumping can provide a major opportunity to reduce operating costs. **EDUARDO VIVAS** and **PEDRO LEITE** describe an assessment undertaken in Portugal that identified significant savings.

The cost of pumping often represents the single largest operating budget item in water and wastewater systems. Optimising energy use in wastewater pumping systems may provide an opportunity to reduce utilities' operational costs and contribute to reducing their carbon footprint (HI & PSM, 2008; Ainger et al, 2009). For this reason, three main wastewater pumping stations in Portugal, operated by Águas e Parque Biológico de Gaia, EEM (Espírito Santo (175kW, 420 l/s), Valadares (41kW, 161 l/s) and Afurada (33kW, 246 l/s)) were assessed for the possible implementation of energy optimisation plans.

At pump level, the efficiency of the equipment may differ considerably from the theoretical information provided by manufacturers. This mainly happens because the pump may run below its best efficiency, or because pump efficiency significantly deteriorates over time (EC, 2001). In this context continuous pump performance and efficiency monitoring should be considered for the most critical and energy intensive pumps in any system.

Nevertheless, the largest energy savings may be achieved at system level through better design and control of pumping systems (EC, 2001). In fact, global efficiency mainly depends on the ability to cope with varying inflows, even if the installed pump has a reasonable level of efficiency for the operating point. Utilities should, then, perform regular energy optimisation studies, based on hydraulic models and actual pump performance and efficiency curves, to ensure that the best solution is being adopted.

Afurada pumping station. The sytem showed significant pump efficiency deterioration, so the impellers were replaced.

Wherever this is not the case, a financial evaluation of possible energy optimisation solutions should be considered, such as variable speed drives, multiple parallel pumps, pony pumps (smaller capacity pumps), and so on.

Energy optimisation plans

A new assessment and design approach for overall energy costs is needed as a result of real operating conditions. Developing energy optimisation plans could be considered.

For this, an estimation of the possible expected inflows (a flow duration curve) at the pumping station must be obtained. With that data, it is possible to model system behaviour and explore, through simulation, different pumping station configurations.

Applying these plans can be divided into five major stages:

- Overall urban system assessment: identify the system's potential critical points and guide the collection of data for infrastructures with high optimisation potential.
- Analysis of real operational conditions: continuously measure inflows and undertake pump performance tests to evaluate system performance
- Assessment of optimisation solutions: simulate the actual behaviour of the pumping system, and test and evaluate efficiency improvements with the optimisation solutions
- Financial analysis: evaluate potential investments through Life Cycle Cost analysis
- Follow up of optimisation results: measure the actual reduction in energy costs and check that the implemented solutions are adequate for the operating conditions

Case studies

Analysis of the real operating conditions in the Espírito Santo system showed that the existing pumps are oversized for the inflows measured. Several possible optimisation solutions were tested, but installing a pony pump offered the highest reduction in energy consumption (up to 42%), with a payback of eight months.

On the other hand, the Valadares and Afurada systems showed significant pump efficiency deterioration (about 50%). Therefore, it was considered that the best optimisation solution was to replace the existing impellers at both stations, which could bring 20% and 30% savings in operating costs respectively.

It should be stressed that a significant reduction in impeller efficiency during the initial period can derail these savings, which is why pump efficiency must be regularly checked. ●

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The importance of energy management in wastewater treatment

'The two major energy consumers in a wastewater system are the pumping systems and the treatment process,' explains Eduardo Vivas. 'The [energy used by the] pumping systems may reach a third or more [of overall usage], but it varies widely since it depends on the number and size of the pumping systems, and also on the type of the existing treatment process.'

A new design and assessment approach was needed, he explains, as pumps are mainly chosen as being the most efficient pump for the worst expected conditions (highest flow) in the system. 'However,' he says, 'systems where the pumping equipment is integrated normally have inferior pumping flow needs compared to the design flow, for a very long period of time. This situation means that during this low flow period the system will be operating at a higher power and, consequently, with a higher energy consumption than needed. Therefore, a different assessment approach [was needed] that could take into account the flow variability of the system (existing or expected) and adjust [pump operation] to meet the real needs.'

References

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