Commentary on the article - "Integrating Aeration Control Solves Underperformance" published in the Water Environment & Technology (WE&T) Magazine

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3 articles

Henryk Melcer (Senior Process Engineer - Brown and Caldwell), Tom Jenkins (President at Jentech, Inc.), David Redmon (President at Redmon Engineering), Adam Klein (Senior Process Engineer - Brown and Caldwell), and Amanda Summers (Civil Engineer at Pierce County, Wash.) collaborated on the above titled article in the *Water Environment & Technology (WE&T)* Magazine's July 2019 issue (WWW.WEF.ORG/MAGAZINE); stating "*Problem aeration systems need a systematic approach to correct control and process shortcomings and to optimize performance and energy savings*".

The referenced article is an accurate reflection of the state of our industry. Unfortunately, "problem aeration" is a common deficiency that exists in many plants. This deficiency directly impacts a utility's ability to optimize the performance of secondary treatment and the largest use of power at the facility, aeration.

To better understand this commentary, it's prudent to step back and review the root causes for "problem aeration". There are three criticals to get the most from the biological processes at a wastewater treatment plant: right-sized equipment, asset management, and operations. The first item, right-sized equipment or lack thereof, is the direct result of the industry's focus on capacity and the effluent standards that have been the basis of the industry since the early 1970s; BOD and TSS reduction, and more recently ammonia. The combined result is plants with large reactors and grossly oversized blower solutions; both limiting the turndown capabilities of the process.

With the growing conversation surrounding nutrients; Biological Nutrient Removal (BNR) is an emerging plant design and operating objective. Unlike BOD reduction and nitrification, BNR processes require specific residual oxygen levels. This operating requirement changes the design requirements for equipment. Now turndown, in addition to capacity, are critical to the performance and optimization of the biological process and energy use.

The biological process engineering community is on the verge of a paradigm shift. As appropriately stated by Dr. J. Robert Clinton, a paradigm shift is: *"the change of a controlling perspective and the perceptive result of that change so that one perceives and understands reality in a different way"*. For example, Cindy Wallis-Lage, President of Black & Veatch's Water Business, mentioned at the 2019 WEF Nutrient Removal and Recovery Symposium - "*what happens if we change our perception of a wastewater treatment plant and invest and operate the facility as a nutrient production facility?*"

The paradigm shift that is underway with the development of smart digital solutions is all around us. The application of these solutions in the water space uniquely addresses the root causes associated with "problem aeration". The referenced article highlights a conventional engineering approach to a problem; collect data, analyze the data, and adjust. This is a discrete action to an observed deficiency. In contrast, smart digital solutions continuously analyze data, learn, and apply site specific knowledge in unique ways.

From an operations perspective, the operational specificity of advanced biological processes is beyond what can be cost effectively supported with manual operations. Furthermore, conventional PID control solutions are poorly suited to these applications, and even with frequent re-tuning, these solutions rarely provide stable performance. The application of floating control appears to provide more stable aeration control; however, the performance of both solutions is lacking when combined with dynamic setpoint optimization including ammonia-based aeration controls. Variable setpoints introduce additional non-linearity into the control problem for which linear based control methods, such as PID and floating, are sub-optimal.

Smart, or next-generation digital solutions use model-based algorithms. With self-calibrating analytics, these solutions provide precise and accurate automation performance; all without a requirement for post-commissioning tuning.

The paradigm shift to smart solutions extends beyond automation. Now, empirical design variables such as aeration alpha and oxygen uptake rate are monitored in real-time. With the application of this knowledge, equipment sizing can be completed with greater accuracy. This results in not only better system performance, but a greater return on invested capital.

The third critical is asset management. Of course, more robust, failure free equipment and instrumentation would be a welcome advancement. However, in the present, smart solutions plan for failure. With multi-level fault detection (FD) analytics and user preferences for isolation and recovery protocols (IR), operators know how the plant will be operated over a range of fault conditions.

In the current paradigm, preventative maintenance is used to reduce equipment failures and maintain instrumentation accuracy. Smart FDIR solutions not only monitor for faults, but changes in operating performance. In the case of fine bubble diffusers, these products are subject to fouling. Fouling negatively impacts the operating efficiency and pressure of the diffuser. Impacts on volumetric operating efficiency can be as high as 25%. This requires 33% more air for the same level of treatment. In terms of pressure, losses approaching 1psig are possible. For a 15-foot deep reactor, a 1psig increase diffuser loss represents a 15% increase in the overall system pressure and an estimated 11% increase in operating power. By monetizing changes in operating efficiency, reliability-centered maintenance analytics broaden the reach of computerized maintenance management systems (CMMS) for improved utility value.

"This industry is at the tipping point of a paradigm shift; both in terms of process performance and operations. Smart solutions and the intelligent use of existing plant data is pivotal to this shift and getting the most from the plant."

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