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Explosive water hammer in a dissolved air floatation system: a case study

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ABSTRACT

The Stromlo Water Treatment Plant (WTP), owned and operated by Icon Water, has a dissolved air flotation (DAF) system incorporated into its multi-media filtration process. The DAF function operates intermittently and infrequently to reduce solids loading on media filters. Since its commissioning nearly two decades ago, persistent water hammer events were observed when reactivating offline saturators. Multiple attempts were made to improve matters, however these changes were largely reactive, inadequately documented and of unknown effectiveness.

In February 2018, during the start-up phase of an "operate-to-maintain" campaign, a communication breakdown during a shift change led to a series of system valves being operated in an incorrect sequence. This resulted in a severe water hammer event that caused extensive damage to multiple elements of the DAF system, rendering it inoperable. Fortunately, no personnel were harmed.

Water hammer modelling (using commercially available software) failed to replicate the extent of the observed damage. Additionally, interviews with operations personnel indicated worsening water hammer effects when operating the DAF saturation vessel outlet valves. These findings prompted Icon Water to redesign the system to prevent recurrence.

Initial redesign concepts proposed by external parties focussed almost exclusively on modifications to the water side of the DAF saturation vessels (such as installing variable-speed drives on all pumps) and massively reinforcing pipe supports ("survival upgrade"). However, these proposals did not address the ongoing (though less severe) in-service water hammer at the saturation vessel outlet valves, nor did they consider measures to prevent operator error. This highlighted the need to prioritise system operability and suitability for intermittent

operation in the redesign process.

The subsequent system modifications successfully eliminated all instances of water hammer during DAF operation at Stromlo WTP. Operators have also reported increased confidence in the system's safety and functionality after its operation was simplified.

While commissioning the modified system, we made an unexpected discovery: the primary mechanism behind the February 2018 incident was the backflow of compressed air into the pump system discharge line, followed by its isentropic expansion—releasing energy equivalent to 1 kg of gunpowder. This failure mode is inherent to all saturation vessel-based DAF systems lacking fully submerged water inlets. By sharing these findings, the authors aim to improve awareness among DAF system owners and operators, so that they can better evaluate their vulnerability to this hazard.

KEY WORDS

Dissolved air floatation, water hammer, isentropic expansion, intermittently operated system, operability

BIOGRAPHY

Steven is the Senior Process Engineer within Icon Water's Major Plants team. He is a Chartered Chemical Engineer with nearly twenty (20) years of experience in the water industry. He holds a Bachelor of Engineering (Chemical)/Bachelor of Science (University of Adelaide), a Graduate Certificate in Reliability Engineering (Federation University Australia), and is currently completing a Master of Engineering Management (Southern Cross University). Steven has presented technical papers at Water Industry Operations Association of Australia (WIOA) annual conferences on multiple occasions, winning Best Paper Overall (NSW) in 2023, and for this paper in July 2025.

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