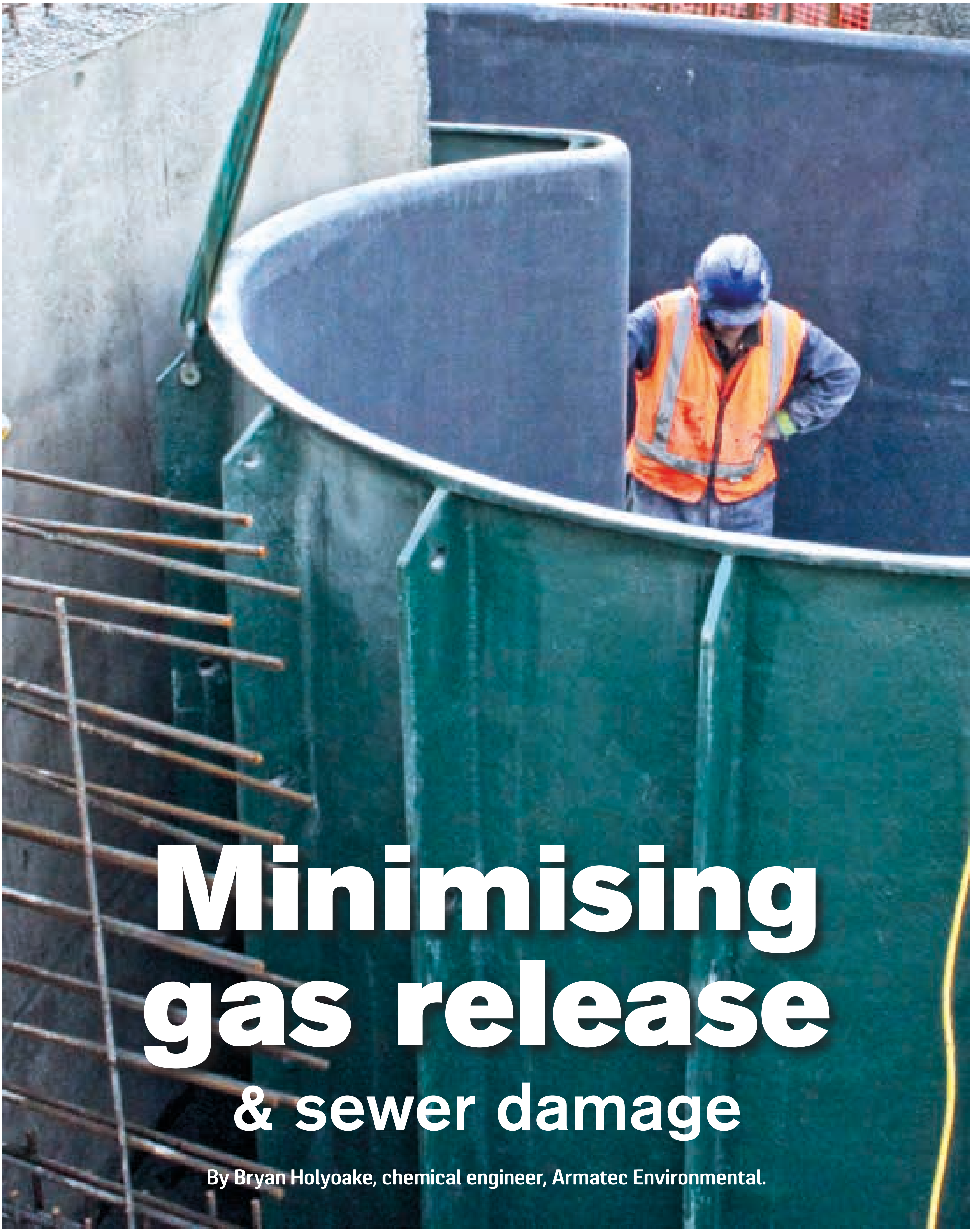


Minimising gas release & sewer damage

By Bryan Holyoake, chemical engineer, Armatec Environmental.

The air-water mixing behaviour in vortex drop structures delivers benefits to sewer networks.

Vortex drop structures are known to provide reliable and practical corrosion, water damage and odour release management in vertical drops through sewers. They do this by creating a controlled swirl down a dropper pipe and minimising exposed turbulence. However, vortex droppers provide additional installation, corrosion and odour control benefits both at the point of installation and downstream that are often overlooked. They can provide sewage network providers and operators cost savings and lead to longer asset lifespans and lower odour emissions – and can turn the typical design approach of laminar flow in sewers on its head.

Vortex drop shafts were firstly introduced by Drioli (1947) in Italy as an overflow structure for dams in Napoli. Nowadays 'Vortex Droppers' is a well-known technology and these structures are widely used in sewer systems to connect sewer mains characterized by large elevation gaps. Since Drioli, others have contributed to this field of study including Echávez

and Sotelo (1970), Knapp (1960), Jeanpierre, Lachal and Thienen (1966), Pica (1970) and Hager (1985), Kennedy, Jain and Quinones (1988) and many other more contemporary experts.

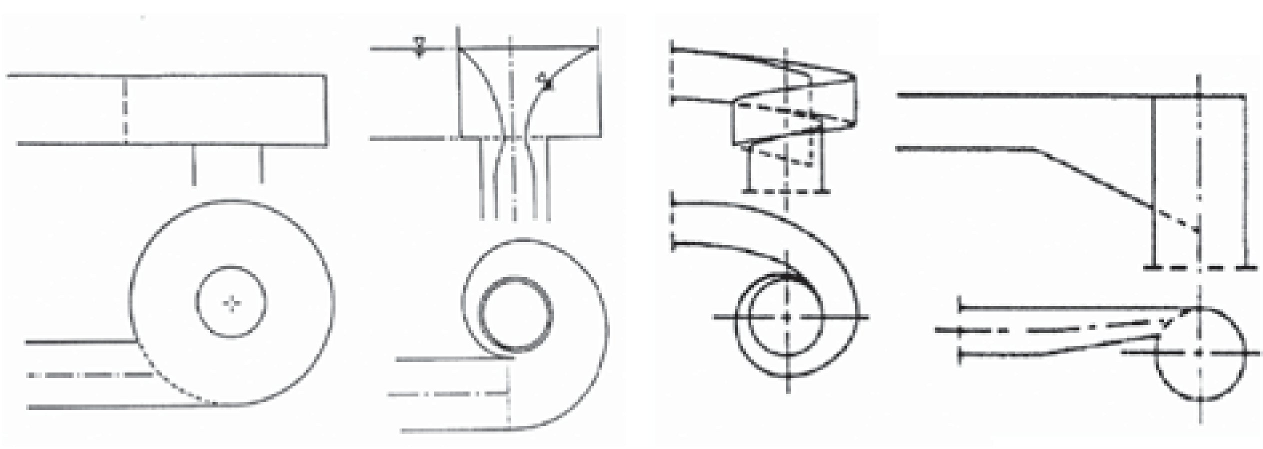
A vortex drop shaft is essentially constituted by three main parts: intake structure, vertical shaft, and outlet structure – of varying designs. In addition, a sufficient air circulation has to be provided to prevent choking phenomena and cavitation damage (Guidice, 2014). A vortex works by water and air entering the intake structure, where it is transformed into a swirling flow, that spirals down a vertical water pipe with both water and air pulled down the pipe (as an "air core") that then collapses into turbulent mixing. This results in a complex two-phase air-liquid mixture, that ranges between subcritical and supercritical flow.

There are many different structure approaches (see Figure) that create this flow – circular (a), scroll/screw (b), spiral (c) and tangential (d) are among some of the more preferred. At the outlet structure there is typically a "catchment pool" to contain the dropping mix and return it to laminar flow at the new, lower elevation.

This air-water mixing behaviour in vortex drop structures delivers the following benefits to sewer networks:

- Reduced odour emissions at the point of the vortex drop structure.
- Increased aeration of the sewage – turning anoxic and anaerobic sewage back to near aerobic conditions, leading to lower H_2S (hydrogen sulphide) production downstream.
- Oxidation of the entrained and dissolved H_2S, reducing concentrations and potential for downstream release.

In sewers, encouraging laminar flow is the standard design ethos for aiding control of corrosion and odour management – to prevent undesirable H_2S and other odorous and corrosive gases entrained in liquid from



(a) (b) (c) (d)

Different types of vortex intakes (adapted from Jain and Ettema, 1987).

release into a gaseous state. However, the introduction of turbulent flow in the vortex drop structures with the unique dynamics of spiral flow and air-water mixing in the drop pipe is how the above benefits are achieved. It uses the wastewater's own flow energy to suppress the turbulence which releases odorous and corrosive gases. The spiral flow creates a downdraft which traps airborne gases and forces air into the sewage flow to oxidize odorous gases.

Vortex drop structures deliver these benefits for no operating costs, with no additional inputs or controls – and reduce the reliance, costs, sizing and potential need for supplementary control systems such as chemical dosing and air scrubbing odour control devices – however every sewer design scenario is different.

Additionally, during installation of sewage infrastructure, the use of a vortex drop structure at a manhole means that excavation needs for incoming piping are significantly reduced, and the piping can be run at a shallower level towards the manhole.

The resulting lower H_2S concentrations in the sewer atmosphere and increased oxygen levels in the sewage lead to longer asset life and reduced corrosion, thereby lowering maintenance spend – a plus for all municipalities and a significant benefit to balance sheets.

Vortex drop structures can be designed in at construction (as shown on page 42), custom built as part of the sewage infrastructure, or integrated into existing infrastructure as inserts in manholes. They must be built in sufficiently robust, corrosion-resistant materials that can form complex curved shapes such as fibreglass, HDPE or stainless steel and be designed to handle the appropriate flowrates and contaminants with ability to function safely in high-flow events. Maintainability is also a key consideration.

The primary purpose of vortex droppers remains to safely transport liquid down a vertical distance while minimising gas release and asset damage. Vortex droppers have additional benefits of odour and corrosion reduction and cost savings that are not widely known and through the controlled turbulence they introduce, can greatly enhance the performance and longevity and reduce costs of sewage networks they are part of. **WNZ**

Page 40: Vortex dropper former – built by Armatec out of fibreglass and encased in concrete in Hobson Bay Auckland.

Opposite left: Vortex in operation.