By Eugene M. Natarius, Ph.D., P.E.

Odor and Corrosion Control:

Insert Assembly Improves Sewer Drops

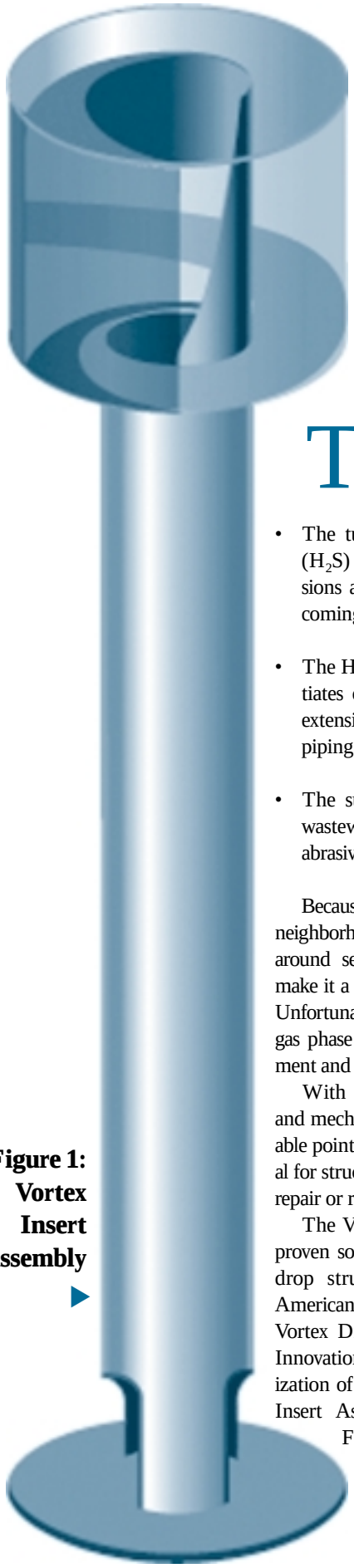

Figure 1: Vortex Insert Assembly

Typical sewer drops create free-falling streams of wastewater, leading to three serious problems.

- The turbulent flow releases hydrogen sulfide (H_2S) and other odorous gasses. These emissions are the cause of public odor complaints coming from areas surrounding sewer drops.
- The H_2S emission from the drop structures initiates chemical processes that result in rapid, extensive damage to concrete and metal sewer piping and mechanical equipment.
- The substantial kinetic energy of the falling wastewater damages the structure walls by abrasive wear.

Because odor profoundly affects the livability of neighborhoods, property value and the environment around sewer drops, public works organizations make it a priority to prevent or treat the emissions. Unfortunately, present technologies for liquid and gas phase treatment require a large capital investment and expensive continuous maintenance.

With the combination of chemical corrosion and mechanical wear, sewer drops are very vulnerable points in conveyance systems. It is not unusual for structures, even with plastic lining, to require repair or rehabilitation every five to seven years.

The Vortex Drop Method is an effective and proven solution for the problems associated with drop structures. In September of 1999, the American Public Works Association awarded the Vortex Drop Structure with the 1999 Technical Innovation Award. A new and more versatile realization of the Vortex Drop Method is the Vortex Insert Assembly (VIA). The VIA, shown in Figure 1, is a simple, pre-fabricated insert for existing or new drop structures. Made from relatively inexpensive materials, the VIA installs quickly and converts a typical sewer drop into an energy dissipater and aerator. It operates with a slight vacuum, preventing emission of odorous gasses. Air is drawn in and vigorously mixed with the wastewater, oxidizing the hydrogen sulfides. The VIA also solves the problem of structure abrasive wear by removing direct contact between the flow and structure walls.

Principle of Operation

Figure 2 shows a diagram of the VIA installed in a drop. The VIA can be made from non-corrosive materials such as PVC, high density polyethylene (HDPE) and fiberglass. The vortex form at the top has a decreasing radius channel and a supercritical slope that creates accelerating spinning flow. No entrance flume or other complex components are needed to create the necessary acceleration. The vortex form is contoured to maximize acceleration over a relatively short distance, and eliminates all means for gas emission.

The flow is directed through a special top cut into a vortex shaft with a smaller diameter. The top cut is shaped to mirror the flow velocity profile, ensuring proper function regardless of flow fluctuations.

The flow continues spiraling downward in a combined field of gravity and centrifugal forces. Due to the sharp reduction in diameter and significant increase of centrifugal forces, the flow maintains intimate contact with the vortex shaft wall. This creates a stable air core. In the vortex shaft, the flow drags air down creating a slightly negative air pressure above the vortex, preventing gas from escaping up and out of the structure. Therefore, the air is entrained and mixed in with the wastewater.

The most intensive processes of vigorous mixing and aeration occur in the submerged part of the vortex shaft. The wastewater is saturated with oxygen at this point, practically eliminating all dissolved H_2S.

The flow exits the vortex shaft at the bottom into an energy-dissipating pool. The remaining flow energy is dissipated through mixing and internal friction. A calm flow saturated with air exits the energy dissipating pool to the effluent line.

As a result of this process, in the time it takes for the wastewater to pass through the structure, the wastewater is dramatically changed. The oxygen level is boosted, dissolved H_2S concentration is dropped to immeasurable levels and the flow is made tranquil.

Each vortex insert assembly is optimized for its installation using three parameters: inner drop shaft diameter, drop height and design flow rate. From these measurements, the ideal form and shaft dimensions are derived.

The assembly is specifically designed for fast installation. It is prefabricated for its destination structure to minimize the on-site labor and installation time. The process of installation consists of simply lowering the VIA into the open drop structure, and sealing around the influent connection. Should access be needed to the lower lines during the structure's lifetime, the VIA can be designed for easy removal and reinstallation. For cases where flow bypassing is especially difficult, the VIA can be designed for insertion directly into falling flow.

Installation

The vortex drop method has been used in the Minneapolis/St. Paul metro area since 1998. Experiments were conducted at multiple installations of drop structures to measure H_2S concentration in the pipes and air quality in areas surrounding the installations. Multiple wastewater samples were taken simultaneously upstream and downstream of the drops, and analysis showed a significant decrease of dissolved H_2S and a sharp rise in the dissolved oxygen concentrations downstream of the structures. The results of air quality monitoring around the drops indicated no H_2S gas emission.

At previously troublesome interceptors, chemical feed for odor has been eliminated by using the drop method. Even more significant savings will be seen over the life of the interceptors since no repair or rehabilitation due to corrosion will be needed. Most importantly, odor complaints from adjacent homeowners have disappeared.

Applications

The vortex insert assembly is designed for odor and corrosion control in all types of sewer drops, forcemain discharges, pumping station wet wells and interceptor joint structures having a drop from four feet to any practical height.

Another use for the VIA is on lines immediately upstream of wastewater treatment facilities. The oxygen boost facilitated by the Vortex drop improves wastewater characteristics and can realize substantial energy and chemical cost savings.

For more information on the Vortex Insert Assembly and the Vortex Drop method visit www.vortexflow.com.

About the Author:
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Figure 2:
VIA Installed in Drop Structure