USING HYDROXYL RADICALS TO MITIGATE HYDROGEN SULPHIDE – AN ODOUR CONTROL STRATEGY AT THE COURTICE WPCP

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ABSTRACT

The Regional Municipality of Durham (The Region) is the eastern segment of the Greater Toronto Area, along the Lake Ontario Shoreline and north to Lake Simcoe. The Courtice Water Pollution Control Plant is located in Clarington on the eastern edge of the Region. It is one of eleven WPCPs owned and operated by the Region.

The Courtice WPCP receives its sewage from a 1050 mm force main travelling 6.4 km, which contributes to hydrogen sulfide (H_2S) formation. The odour of the H_2S in and around the area has caused complaints from local industry and from internal plant staff, and has caused severe corrosion on plant piping and HVAC units. This led the Region to investigate the levels of H_2S and collect some data detailing the concentration.

Several potential opportunities to mitigate the odour were reviewed before settling on a new-to-wastewater, green technology – Hydroxyl Generation.

Two Hydroxyl generating machines were installed on the upper influent chamber. These generating units produce free radical hydroxyls, mimicking naturally occurring conditions in the Earth's atmosphere, which cascade through the headspace in the chamber neutralizing the H_2S to elemental sulfur and water before it can escape to the outside air. The hydroxyl generators draw clean air from outside, charge the moisture within that air in a multi-frequency UV chamber, before discharging it to the environment being treated. No contaminated air enters the Hydroxyl unit.

The hydroxyl units were tested in various locations and with one and two units running. Test results were collected in all instances and ultimately it was demonstrated that the hydroxyls mitigated the H_2S odours and corrosion

The Region is currently reviewing this technology in several other applications, including chemical storage and sewage pumping stations.

INTRODUCTION

The Courtice Water Pollution Control Plant (WPCP) is owned and operated by the Regional Municipality of Durham and provides a nitrified secondary effluent discharge to Lake Ontario. The sewage collected by this facility is provided by the City of Oshawa and Town of Courtice. The plant has an Environmental Compliance Approval (ECA) average daily flow rating of 68 200m3/day and a peak daily flow capacity of 180 000m3.

The collection system of the Oshawa/Courtice area consists of 655 km of collection pipe, 10 sewage pumping stations, and services approximately 162 000 people. All of the sewage collects at the Harmony Creek WPCP where the flow is divided so that 60% of it is pumped through the Harmony Creek sewage pumping station to the Courtice WPCP.

The force main feeding Courtice WPCP is a concrete reinforced 1050 mm diameter pipe discharging at an overflow chamber which contains a 6 m weir to maintain a full level within the force main. The sewage continues to a junction chamber then flows to the headworks facility. The force main has an average hydraulic retention time (HRT) of 2.8 hours at current average day flow. This HRT increases throughout the night and into the morning, causing an increase of H_2S expelled during the morning as flow increases.

The Courtice WPCP has typically had H_2S concerns, demonstrated by the odour in the area, and the corrosion on the copper and brass components within the headworks building. The plant staff had noted the premature failure of HVAC related mechanics, heavy black flaking on copper pipes and a general bad odour making the headworks a health and safety concern. But until recently there were no other buildings in the surrounding industrial park so no immediate need for odour control was required. But with the construction of other facilities in the area this facilitated the need for odour control.

INVESTIGATION OF ISSUE

Initially, the odour was assumed to be coming from either the headworks building or the inlet weir chamber. Directly surrounding the inlet structure and the headworks building are lower elevation areas where the H_2S remained until the daily breezes picked up and flushed it out, making it difficult to pinpoint the origin of the odour. The plant staff monitored the daily average air direction and speed, which helped determine an approximate area. To further identify the problem location an ODALOG Hydrogen Sulfide gas detector and data logger was used in various locations to monitor and identify the initial source and the level of H_2S. The initial tests identified the bulk of the odour arose from the influent chamber upstream of the headworks building and downstream of the inlet chamber weir. Measured H_2S levels averaged 58 mg/L, spiking at 130 mg/L.

With this knowledge appropriate potential alternatives were reviewed to see which made the most sense.

1. Chemical addition at Harmony Creek Sewage Pumping station.
   Pros: Low initial start-up cost, requires pump and chemical storage.
   Cons: High long-term cost for the volume of flow treated, additional storage of chemicals.
2. Aeration of flow.
   Not feasible for this installation
3. Carbon filters:
   Pros: Known to the Region, relatively easy to use.
   Cons: Large footprint, high energy consumption, requires structure.
4. Biofilters.
   Pros: Known to the Region
   Cons: Large footprint, high energy consumption, requires structure.
5. Hydroxyl.
   Pros: small footprint, low energy consumption, no contaminated air flows through units, modular design potential.
   Cons: Not known to the Region

A set of ideal criteria already existed for selecting the unit. The location of the odours had no electrical supply and no structure to house any sort of unit. So the solution had to have a small footprint, a weather proof construction and require a small electrical supply. Also, a benefit would be to draw outside air through the odour control unit rather than discharge malodorous air into it. Due to the issue being H_2S the ideal solution would limit contact with contaminated air.

SOLUTION

After some research a relatively new odour control system was identified as being in use in Europe. The units met all criteria and had a proven track record. Unfortunately acquiring a pilot test was difficult. Then a local supplier of similar technology, hydroxyl generation, was located and a pilot test was easily arranged.

The test began with one MVP 14 unit installed at a location downstream of the junction chamber where an electrical supply and a wind sheltered area was present. This area allowed the trial to treat the headspace above the sewage entering the headworks building. Within minutes of the unit being turned on the smell of H_2S in the immediate area was no longer noticeable. Within 15 minutes, the air entering the headworks building was also beginning to smell better. Testing continued in different location from June 2014 to September 2014 with one to two units. In all cases a reduction in odour was noticed. However, the Odalog H_2S continued to show high results, which sometimes doubled the expected H_2S concentrations, when there was no odour identified. The service representatives at Detection Instruments, where the unit was purchased, identified that the unit was acting incorrectly, giving incorrect results. The Odalog was unable to measure the hydroxyl radicals. This was identified by examining the milliamp output vs. the H_2S reading which the technician at Detection Instruments was able to identify as incorrect.

Knowing this information, a "sniffer" system was developed using a vacuum pump, tubing, and an ABS housing for the Odalog. This allowed the unit to be slightly removed from the direct reaction of the H_2S and hydroxyl which immediately enabled the Odalog to begin collecting readings of a better quality.

The final location of the hydroxyl generation equipment was found to be the junction chamber upstream of the headworks building so two units were installed there and electricity was run. Measurements were taken before the units were turned on and the average H_2S was 58 mg/L with a maximum concentration of 130 mg/L. After the two hydroxyl units were started, under the same conditions as the previous test, and sampled through the "sniffer" as well, the measured H_2S dropped to an average of 6 mg/L with a peak of 16 mg/L. The H_2S measured at the headworks building was 1 mg/L. Also, the health and safety concerns in the headworks building were put to rest and the air became much fresher smelling.

It is important to note that hydroxyls, an OH free radical, though more oxidative than ozone, chlorine, and hydrogen peroxide, does not possess the same threats to human health. Several studies were presented to the Region to support this claim, and though the units could potentially create very low levels of ozone, it is extremely short lived and therefore not considered hazardous.

TABLE 1 – OXIDATION POTENTIAL

Oxidizing Agent	Electrochemical Oxidation Potential (EOP)	EOP Relative to Chlorine
Hydroxyl Radical	2.80	2.05
Ozone	2.08	1.52
Hydrogen Peroxide	1.78	1.30
Chlorine	1.36	1.00

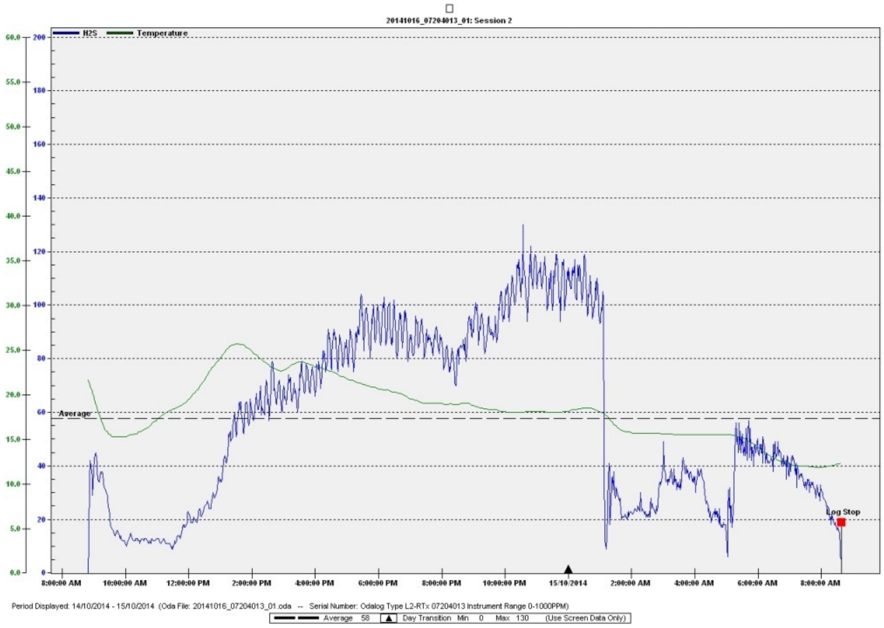

Figure 1 – Data Logged Results of H_2S Concentration with no Odour Control

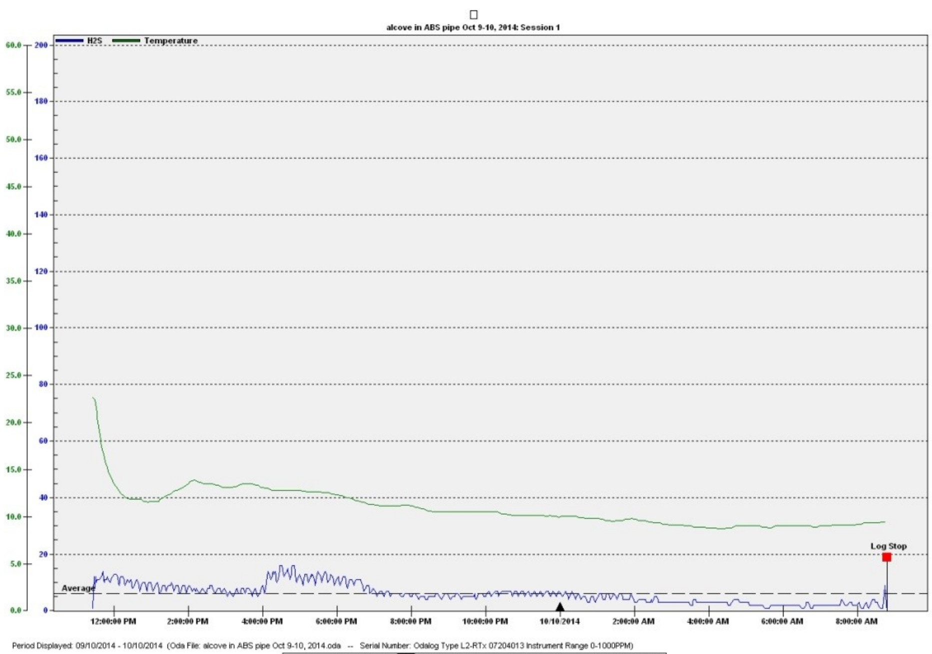

Figure 2 - Data Logged Results of H_2S Concentration with two Odorox MVP 14 Hydroxyl Generating Odour Control units

DISCUSSION

On top of the odour reduction benefits, the corrosion reduction benefits, and general health and safety concern improvements the hydroxyl units have demonstrated other economic benefits. The large units at Courtice each are only 1 square meter in size, other installations use an in-duct unit which is about 0.1 square meter. This greatly reduces any required structures to house the units. Also, the operating cost of Courtice's MVP 14 requires about $7.00 per day of electricity and requires less than $5000 in consumables (UV bulbs) every 8000 hours.

Due to its small footprint, low capital cost, and low operating cost these hydroxyl units, which are come in different sizes and configurations, have successfully mitigated the H_2S concerns at the Courtice WPCP. It is a modular system which can be increased in size or decreased in size as conditions change, hydroxyl generation on this scale mimics natural hydroxyl formation making it a green technology with zero negative contribution to the environment and it requires no additional chemicals or filter media to replace and dispose of.

Success of the hydroxyl units are still being demonstrated at the Courtice WPCP and at several other locations. Regional staff have found that it works well to lessen the effects of sodium bisulphite off-gas in chemical storage areas, it reduces the odours of ferrous chloride storage areas, and it works very well in the wet wells of sewage pumping stations (SPS). Several installations have since been conducted at the Newcastle WPCP headworks, the Liverpool SPS, Michael Blvd SPS, and Cochrane SPS.

In conclusion, the Region was able to source a locally supplied, low energy, green alternative to control the H_2S concerns at the Courtice WPCP. While other technologies are known to be effective in their own right, hydroxyls have proven their worth in these installations.

ACKNOWLEDGEMENTS

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