TrojanUV Solutions: Removal of Metaldehyde, a Pesticide Found in UK Drinking Water Sources

Hall Water Treatment Works – **Lincoln**, United Kingdom (UK)

PROJECT BACKGROUND

Anglian Water (Anglian) is one of the largest suppliers of drinking water and wastewater services in the United Kingdom (UK). Today, Anglian provides treatment services to an area greater than 25,000 km^2 (9,650 square miles) on the East Coast of England and operates over 1,250 treatment installations and maintains nearly 113,000 km (70,000 miles) of distribution and collection pipeline. In 2012, Anglian began construction of the new £44 Million ($66 Million USD) Hall Water Treatment Works (WTW) near the city of Lincoln located approximately 300 km (180 miles) north of London. This site draws water from the River Trent and is designed for the treatment and supply of 20 million liters per day (MLD) (5.3 MGD) of drinking water to Lincoln and other surrounding communities.

METALDEHYDE

The UK and the European Union have strict regulations controlling levels of pesticides in drinking water. Drinking water treatment facilities are required to produce potable tap water with less than 0.1 µg/L of any pesticide. In the UK, metaldehyde, a "molluscicide" used to control the spread of slugs and snails, has received particular attention given its widespread use.

Farmers sow their cereal crops in autumn, which can often be followed by periods of high rainfall. This can significantly increase the slug and snail population and devastate the crop if left untreated. Several wet autumns in recent years have led to an increase in the use of metaldehyde pellets to protect farmland. There are no known direct health risks associated with metaldehyde, but significant rain events result in the leaching of metaldehyde into water bodies, including the River Trent from which the new Hall WTW extracts raw water. As a result, concentrations of metaldehyde in this and many other UK surface drinking water sources are higher than those mandated by EU pesticide regulations.

METALDEHYDE TREATMENT OPTIONS

Filtration Using Activated Carbon

The traditional barrier used in the UK for the removal of micropollutants such as pesticides is granular or powdered activated carbon, sometimes in combination with ozone or UV. Early pilot testing demonstrated that the physical and chemical properties of metaldehyde made adsorption onto carbon limited when compared to the other commonly-found pesticides. As a result, longer contact times would be required as well as more frequent replacement of spent carbon. Collectively, this would result in higher capital and operating expenses and made carbon on its own a non-viable option for metaldehyde treatment.

Another observation was that metaldehyde would desorb (release) from GAC back into the water supply during times when concentrations of metaldehyde dropped.

CASE STUDIES

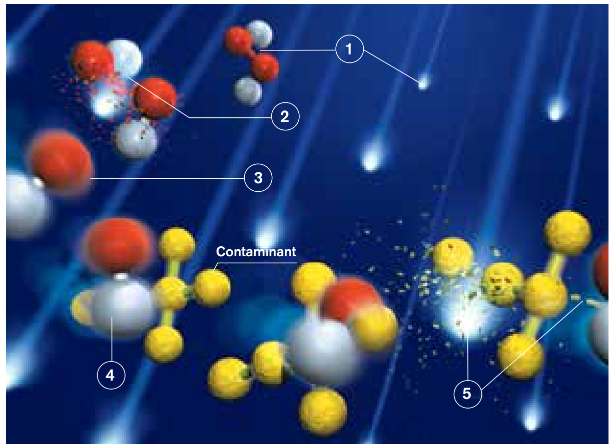
Advanced Oxidation

Direct degradation of contaminating compounds is in many cases a favorable treatment approach as opposed to adsorption which potentially removes contaminants but is unable to break them down into harmless components. Ozone is one means by which to initiate the oxidation of pesticides. However, for Hall WTW, there were concerns that relatively high levels of bromide in the raw water would lead to bromate formation, a known by-product of ozone treatment. Intensive sampling suggested that use of ozone could lead to bromate levels in excess of Anglian's production limit of 5 ppb.

As an alternative to ozone, Anglian decided to install a TrojanUVTorrent™ECT UV-oxidation system as part of a multi-barrier approach to ensure it produced a potable water supply that matched the high standards required by the regulators and customers (See Table 1). UV-oxidation uses the combined application of UV light and hydrogen peroxide (H_2O_2) to destroy chemical contaminants through a combination of UV-based photolysis and chemical oxidation (See Figure 1).

TrojanUV along with Anglian and its various partners, worked closely for nearly 10 years to develop suitable treatment for a range of micropollutants including pesticides. This extensive research and cooperation gave confidence that the final solution of using UV technology and H_2O_2 was the most cost-effective approach to providing the advanced oxidation required to significantly reduce metaldehyde and other known contaminants in the River Trent.

In addition to using UV-oxidation for pesticide treatment, the TrojanUVTorrentECT will also enhance the simultaneous disinfection of microorganisms as part of a multi-barrier approach to disinfection.



1 UV-oxidation requires two components: UV light and hydrogen peroxide.

2 When UV light is introduced to the water, the dissolved hydrogen peroxide molecules absorb UV light.

3 Highly energetic and reactive hydroxyl radicals are then formed.

4 Hydroxyl radicals react indiscriminately with environmental contaminants in the water.

5 Working simultaneously with direct UV-photolysis (the photochemical process that disinfects and breaks down contaminants using UV alone), these highly reactive radicals break down contaminants. Most contaminants are treated with a combination of UV-photolysis and UV-oxidation. Some, like NDMA, require only UV-photolysis.

Figure 1. UV-oxidation uses UV light and hydrogen peroxide (H_2O_2) to destroy chemical contaminants.

Treatment Method	Removed Metaldehyde	Easy to Operate	Lack of By-products	Low Embedded Carbon	Disinfection
Activated Carbon	*	**	***	*	**
Ozone	***	**	*	***	***
UV-oxidation	***	***	***	***	***

Table 1. Methods and capabilities for metaldehyde and pesticides treatment.

THE TROJANUV SOLUTION

The system at Hall WTW was originally designed to consist of three TrojanUVTorrentECT reactors and a H_2O_2 dosing system. However, the decision was made to install a fourth reactor in response to rising metaldehyde concentrations in the River Trent.

Each UV reactor installed at Hall WTW contains 96 lamps using TrojanUV Solo Lamp™ Technology. The Solo Lamp is a revolutionary new low-pressure high-output (LPHO) lamp designed for high UV output while maintaining the high electrical efficiency commonly associated with LPHO lamps. The result is a smaller and more energy-efficient UV system using far fewer lamps than an equivalent UV installation designed using standard LPHO technology.

CONCLUSION

Construction on the new Hall WTW began in May 2012 and the UV-oxidation system has been in full operation and delivering water to customers since the Summer of 2015. The Hall WTW site complements the UV-oxidation system located at the Drift WTW located in Cornwall, South-West England currently treating various pesticides, including metaldehyde.

FULL SCALE SYSTEM

SYSTEM DESIGN PARAMETERS

- DESIGN FLOW RATE: 20 MLD (5.3 MGD)
- UV TRANSMITTANCE: 80%
- METALDEHYDE TREATMENT: 0.45-log Removal
- ATRAZINE TREATMENT: 1.12-log Removal
- CLOPYRALID TREATMENT: 0.26-log Removal

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