

# "Silent and Deadly"

Tim Wafer is Chlorine Dioxide Product Group Manager within Clearwater Technology Ltd. He has over 30 years experience within the Water Treatment Industry. Clearwater Technology Ltd are the pioneers of Catalytic Chlorine Dioxide Technology within the U.K. and Europe. They have made considerable contributions to ensuring the safe management of water systems within hospitals within the U.K. With their team of engineers and support staff, the exclusive catalytic technology of Clearwater Technology Ltd is now favoured throughout the food industry, prison service, et al. Where there is demand for water there is need for treatment.

## "Legionella within engineered water systems"

Within most buildings, optimum water conditions rarely exist: - cold water cannot be kept cold enough; hot water cannot be circulated and maintained hot enough to prevent opportunist pathogens from proliferating the system.

The perfect building design has yet to happen. Numerous hospitals are operational with less than perfect and over complicated water storage and distribution systems. The dangers of these systems are greatest with dead legs and low flow areas. These harbor low oxygen levels and provide the optimum breeding ground for the formation of biofilm. The biofilms, in turn, provide a safe habitat for pathogenic bacteria, such as Legionella, to proliferate.

Seeing is believing, and sadly biofilm is unlike peeling paint, where age and decay are evident.

Current legislation can be interpreted in such a way as to lead to a variety of management styles for water systems; e.g. temperature regimes and flushing combined with annual tank cleans and/or constant dosing with a biocide. Prevention should be the first line of defence.

## Biofilm

The combination of water and nutrients forms the basis for growth of micro-organisms. The movement of water creates an unstable environment for survival, conse-

quently micro-organisms have evolved in a manner which allows them to adhere to a substrate with great tenacity. When they find a suitable surface, they attach and initiate multiplication. Growth is rapid, with new cells attaching to each other as well as extending laterally across the surface creating a "woven matrix colony" in which other organisms can grow and develop. This matrix is often referred to and seen as slime.

There are a variety of nutrient sources within water systems. These include scale, sediment, corrosion products and other trapped organic and inorganic matter. The movement of water enhances the supply mechanism. Combine this with specific operating conditions, such as heat exchangers, calorifiers, etc..... with increased temperature, creating the perfect conditions to establish growth. The dominant population will consist of aerobic (oxygen seeking) and anaerobic (living without oxygen) bacteria interspersed with algae and fungi, which in turn support predatory organisms such as protozoa and metazoa. These predatory organisms graze and ingest bacterial cells for food.

Biofilm forms a safe habitat for pathogenic bacteria like Legionella to live and proliferate. A link has been established between amoeba, a predatory protozoa, and high levels of Legionella in a water system. Therefore, the control of biofilm within water systems is essential. As our climate conditions change more opportunities for biofilm development are being created. Biofilms are costly, they have an impact on energy, cause corrosion and increase frictional drag. Their presence poses a constant threat to health.



## Understanding Legionella

The Legionella group contains some 40 separate species and the species can be further sub-divided into sero-groups. Legionella pneumophila has at least 16 sero-groups of which sero-group 1 is the most significant and is predominantly associated with outbreaks of Legionnaires disease..... a pneumonia like illness.

It must be remembered that the Legionella organism favours temperatures between 20°C to 45°C for growth, with optimum growth achieved at 35°C.

**Survival in air :** - Legionella is contracted by inhalation. The survival rate of Legionella pneumophila in air is increased with relative humidity, survival is greatest at 90% relative humidity. Sero-group 1 survives better than any other sub-type, about 30% of the population remain viable after 30 minutes at 20°C and 60% relative humidity. These are typical temperature and air conditions found in many U.K. buildings.

**Survival in water :** - It is now widely accepted that Legionella can infect and multiply inside various protozoa - amoeba. Legionella can survive the processes used in drinking water purification and thereby enter the mains water distribution systems to be transported to buildings that will have optimum conditions favouring growth and survival. These amoeba can contain hundreds, even thousands, of Legionella. At low temperature (20°C) limited growth occurs, however, at 35°C Legionella multiply rapidly. When the expansion in numbers cannot be contained, the amoeba erupts releasing vast numbers of Legionella into the water system. It has been established that one amoeba can harbor enough Legionella bacteria to infect a human, and this single amoeba is small enough to be contained within one droplet of aerosolized water. Once the Legionella are released into the water they can be transported throughout a water system to outlets and disseminated in an aerosol, and if inhaled, can lead to Legionnaires Disease. Legionella is an organism that has found a particular ecological niche in engineered water systems.

**Susceptibility :** - Those most at risk from Legionella Pneumophila are –

- those greater than 50 years of age
- smokers
- those with a history of bronchial disease
- Patients on immunosuppressive drugs – i.e. transplant surgery
- greater prevalence in males

Spare a moment to consider the inhabitants of buildings to which you monitor the water supply!

The fatality rate from hospital acquired Legionnaires disease is particularly high, because the residents are generally so susceptible. Those who do survive Legionnaires disease can be left with chronic lung problems, physical incapacity and reduced lifespan.

## Legal Responsibilities <sup>1</sup>

During the 1980's, Britain experienced some of the largest outbreaks of Legionella and as a result, was one of the first countries to adopt legislation that governed the control of Legionella in water systems. Current legislation and guidance is as follows:-

- The Health and Safety Commissions Approved Code of Practice – ACOP L8 “The Control of Legionella Bacteria in Water Systems”

It effects all employers and those with responsibility for water systems in premises.

If prosecuted for breach of Health and Safety Law, and it is proven that the relevant provisions of L8 have not been adhered to, a court may find you at fault unless you can prove that you have complied with the statutory requirements in some other way that equals or betters the requirements of ACOP L8.

## Chlorine Dioxide within Hospitals and Healthcare

Chlorine Dioxide is being heralded as the "ideal, powerful anti-microbial agent" of the next decade, with a potential that is far reaching—"the gentle giant of available biocides".

To-date, Chlorine dioxide has been commonly used in large scale applications such as purification of municipal water supplies throughout many parts of the world. However, as the mechanisms for safe, simple and cost effective delivery of Chlorine dioxide emerge a whole new range of application areas are evolving.

Public awareness of the need to protect individuals from pathogens has reached an all time high due to the increased prevalence of Legionella, MRSA, SARS and other invasive pathogens. This had lead to an urgent need to modify treatment regimes and fuelled the requirements for a biocidal treatment that is fast acting, non toxic, non irritating and meets with regulatory body approvals. Chlorine dioxide offers all of these with a range of pathogen destruction unsurpassed by traditional biocides and their inherent side effects.

Do not be confused by the name, whilst Chlorine dioxide has Chlorine in its name, Chlorine dioxides chemistry is radically different from that of Chlorine. One atom makes all the difference. Chlorine dioxide is not Chlorine "in disguise", but a totally different chemical with completely different chemistry.

Clearwater Technology has pioneered a unique way to take the hassle out of conventional Chlorine dioxide generation utilising catalytic chemistry.

Catalytic Chlorine dioxide generation offers the following key features:-

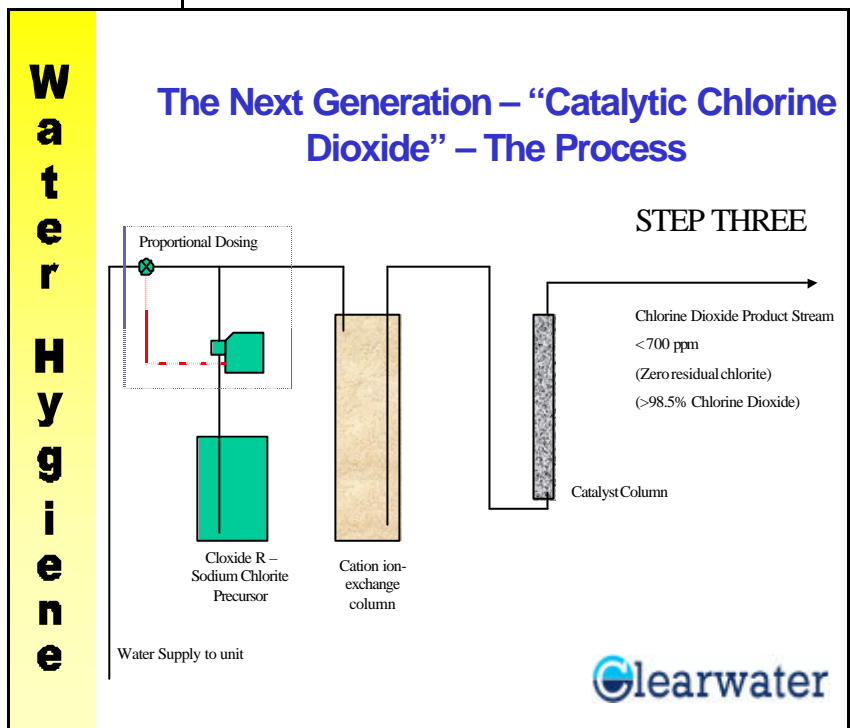
- Can dose directly into pressurised lines
- No high concentration Chlorine dioxide solutions (<700 mg/litre)

- Reduced risk of gassing
- No chemical mixing chemistries and demanding ratios
- No electro-chemical cassettes or water quality issues
- Produces an ultra-pure Chlorine dioxide solution
- Generation without the need for Chlorine or excess acid
- No residual chlorite in final Chlorine dioxide product stream

## The Generation Chemistry

### Stage One

Regardless of how you wish to produce Chlorine dioxide ( $\text{ClO}_2$ ), the precursor to  $\text{ClO}_2$ —Chlorous acid ( $\text{H}^+\text{ClO}_2$ ) must be generated.



The key to success is the production of a pure precursor without any residual Sodium ( $\text{Na}^+$ ). This is achieved by using cation ion-exchange resin in the hydrogen ( $\text{H}^+$ ) form. This enables all the sodium ( $\text{Na}^+$ ) to be removed from the sodium chlorite ( $\text{Na}^+\text{ClO}_2$ ) and replace it with hydrogen ( $\text{H}^+$ ) to form pure Chlorous acid ( $\text{H}^+\text{ClO}_2$ ).

When the cation resin reaches the point of ex-

haustion - i.e. all the cationic sites are in the sodium (Na<sup>+</sup>) form, the resin must be regenerated with a strong hydrogen (H<sup>+</sup>) source. This may be done either on-site or off-site, depending on the demands and logistics of the application.

The pure precursor increases reaction efficiency. The reaction of Chlorous acid to Chlorine dioxide is achieved in stage two.

### Stage Two

Stage two takes place within the "Catalytic Conversion Cartridge" and it converts virtually all of the Chlorous acid to Chlorine dioxide (>98.5%).

This extremely high conversion rate is unique to catalytic Chlorine dioxide chemistry and offers an instantaneous chlorite free, dilute solution (< 700 mg/litre). There is no storage of Chlorine dioxide with this technology - *production is controlled precisely to meet demand.*

The sheer growth of this technology is attributable to the increased demand for biocide production, utilising reliable, efficient, and tailored safe delivery systems that will :-

- Work effectively against a variety of bacteria, yeasts, viruses, fungi, protozoa, spores, moulds, mildews and other microbes.
- Exhibits rapid kill
- Effective at low concentrations
- Not pH sensitive
- Effective across a wide temperature range
- Environmentally friendly
- Eradicates biofilm and used as part of a preventative programme eliminates recurrence within pipework, equipment and systems.

Catalytic Chlorine dioxide combined with advanced new delivery technologies brings the power and flexibility of Chlorine dioxide into the 21st century.



Outdoor installation of Chlorine Dioxide unit at R.U.H. Bath

Regain control of the situation you face, before it takes control of you. Understand the dangers posed by bromine and the simplicity of an effective treatment regime.

## Summary

The evidence is clear, the proliferation of biofilm is widespread. Silent and deadly Legionella is lurking just around the "dead-leg" in any unprotected system, new or old.

Do you really want to stand before the man wearing the wig? Because that could easily be the worst case scenario, for the individual who is deemed as the one with responsibility to ensure the water systems are safe.

Sadly it will often fall on the shoulders of one person. Do you really have the courage to bury your head in the sand any longer?

## "Prevention is the cure"

### References

<sup>1</sup> Legionnaire's Disease - The Control of Legionella Bacteria in Water Systems Approved Code of Practice and Guidance. 2000. HSE Books ISBN 0 7176 1772 6

### Acknowledgements

Mike Gaunt—Engineering and Environment Manager, Leeds Teaching Hospitals NHS Trust.

John Roderick—Facilities Manager—Royal United Hospital—Bath.

Tim Wafer  
Chlorine Dioxide Product Group Manager  
Clearwater Technology Ltd  
[tim.wafer@clearwater-technology.ltd.uk](mailto:tim.wafer@clearwater-technology.ltd.uk)