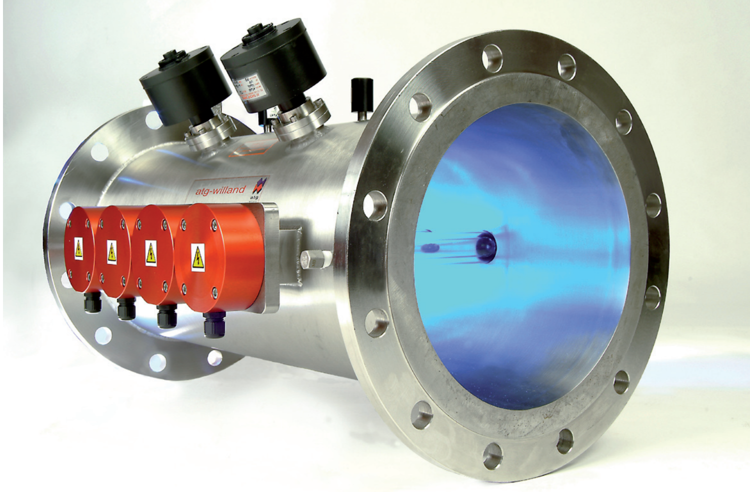
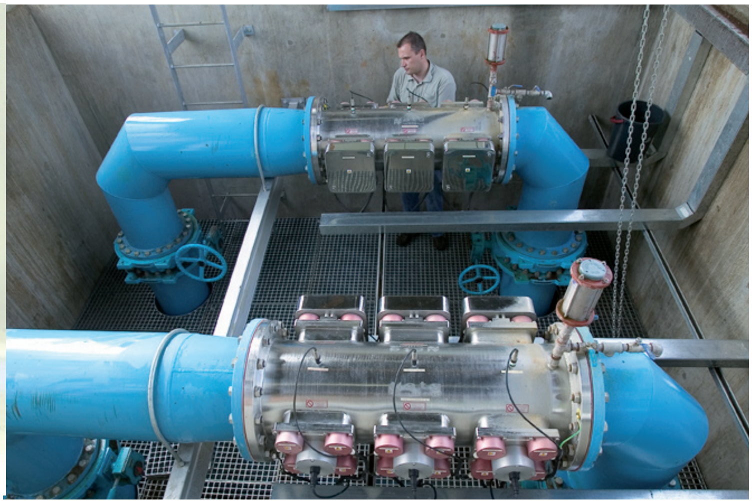




Are UV systems set to

dominate the municipal industry in a water stressed world?

The use of Ultra Violet (UV) light has now become standard practice in most municipal waste water treatment processes. Effluent is now starting to be recognised as a valuable resource, not a problem that needs to be dumped. Many waste water facilities are being renamed as water reclamation facilities, and whether the waste water is being discharged into a river, being used to irrigate crops, or injected into an aquifer for later recovery Ultraviolet light is now being used to ensure water is free from harmful organisms. atg UV's Technical Director Tony Leigh looks in detail at the advancements and future for UV.

Ultra Violet light was discovered in 1801. It took over 100 years to develop lamps and power supplies on a commercial scale, and a 0.2MGD drinking water plant in Marseilles, France briefly used UV light in 1910. Chlorine was the disinfectant of choice, and UV was really only used in municipal context where chlorine could not be used, or where the distribution main was itself being used as a contact vessel and the first consumers lived adjacent to the point of injection. UV light was used successfully throughout industry with brewers, pharmaceutical plants and fish farmers adopting the technology quickly.

UV gained prominence in applications where the water was itself used as the product, (bottled waters, beer, carbonated soft drinks), or where the water has a process application (wafer rises by ultra pure water, Clean in Place applications, product rise and chase applications, Ballast Water, well field injection).

As the customer base expanded, so did the process application. UV was now being used break specific chemical bonds, sometimes by direct photolysis, but more often by the creation of highly reactive hydroxyl (OH-) radicals. Photolysis applications now include dechlorination, de-ozonation, the removal of TOC from ultra pure rise water in the semiconductor industry, and recently as a barrier to counter the threats caused by the endocrine disruptors and both metabolized and un-metabolised pharmaceutical compounds found in wastewater.

Above: ETS UV systems removing combined chlorine and disinfecting pool water in the USA.

By the year 2000 several key drivers had led to the technology being routinely incorporated into wastewater processes; a flight from chemical

The world is quickly running out of drinking water. Critically the drivers are accelerating; population growth, a warming climate, drought, urban sprawl, waste and excess. According to the World Bank, water usage has increased by 600% since 1900, as the world's population has increased by 200%.

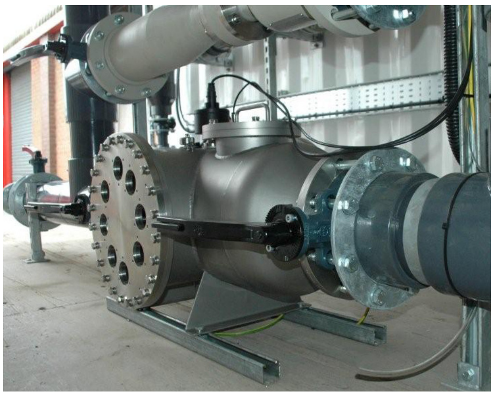
It is logical to use reclaimed waste water ("re-use") for applications such as crop irrigation, and the application of UV ensures that the water is free from pathogens such as e-Coli, Leggionella and Cryptosporidium.

regimes, a desire to avoid potentially carcinogenic disinfection by-products, increasing attention to the discharge of chlorine as an active substance into a receiving watersheds, and the growing re-use of tertiary treated effluent.

The early applications for re-use were limited to golf course irrigation, however applications have expanded to use the reclaimed waste water for Aquifer Storage and Recovery (ASR), and broad non potable industrial uses. The ASR applications are popular in coastal regions where aggressive water abstraction has led to brackish, saline water permeating into the water table from the sea. The ASR processes injects highly polished reclaimed effluent as a buffer between the water table and the ocean.

How does UV work? UV light between 250nm and 270nm is absorbed by the DNA in all living matter, or RNA in the case of a virus. The light causes cross bonds within the DNA structure to vibrate to the point of rupture. The UV light breaks the cross bonds in the DNA, and forms dimers. Once these bonds are broken, normal cell function quickly ceases. Replication, assimilation of food and respiration are all permanently interrupted, resulting in non viability of the organism.

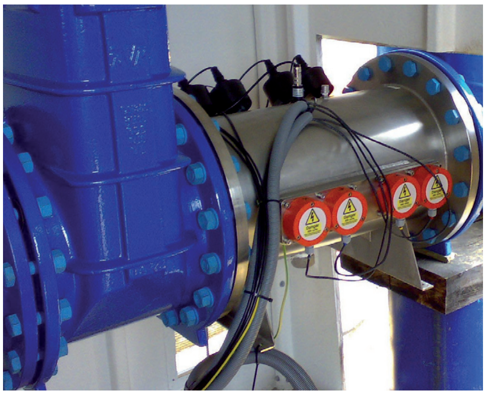
The ease of kill for most organisms is well understood, and companies such as atg, Trojan and ETS in the US maintain databases quantifying the ease of kill.



Above: A Medium Pressure atg UV system being validated to demonstrate performance.

A number of research groups have shown that the effects of UV light can be reversed, particularly in sunlight. This "light –repair" process occurs when the organism receives a low dose of UV light, and is then subsequently exposed to sunlight, in an open channel for example. The repair process is enabled by an enzyme called Photolyse, which is triggered by sunlight. This phenomena has led to open channels being covered, or the process being contained in pipe. Several organisms have now developed resistance to chlorination, largely as a consequence of the evolution of the organism and the chemical being dosed at low levels for so long.

These resistant or "emerging" organisms include Cryptosporidium, and Giardia. No species has demonstrated any resistance to UV light to date, and it is unlikely to occur given the basis of kill using UV light involves the destruction of the genetic material.



Above: atg UV system installed at Anglian Waters Pitsford Drinking Water Plant as a result of a Cryptosporidium out break in 2008.

Lamp technology is based around either Amalgam or Medium Pressure lamps. Both lamp types are used by the leading companies, and each type has specific strengths and weaknesses. Model performance is predicted using Computational Fluid Dynamics (CFD), and usually off the shelf software is customised by the manufacturer to accurately gauge performance.

UV systems destined for drinking water applications are validated using a third party test house to demonstrate system capability, and usually a non pathogenic surrogate such as MS 2 phage or Bacillus Subtilis is used to verify actual system performance. ETS and atg have verified the performance of a number of reactors in the USA, in each case iteratively improving the predictive models.

The Future: All the water that will ever be is, right now. (National Geographic) The world is quickly running out of drinking water. Critically the drivers are accelerating; population growth, a warming climate, drought, urban sprawl, waste and excess. According to the World Bank, water usage has increased by 600% since 1900, as the worlds' population has increased by 200%.

Water demand doubles every 21 years. The worlds' population is forecast to increase again by 50% to 9 Billion people, causing 80 countries to face shortages of water by 2050. Agricultural use of water accounts for more than 70% of treated water use, and rising standards of living (meat, not grain in diets) will accelerate this trend. Therefore it is logical to use reclaimed waste water ("re-use") for applications such as crop irrigation, and the application of UV ensures that the water is free from pathogens such as e-Coli, Leggionella and Cryptosporidium.

In the USA alone 36 states will face a severe shortfall of water by 2013, and many of these states are those that also face energy shortfalls. Re-use will be applied to a wider variety of industrial applications, and can be used for cleaning, chasing, and cooling applications. In many areas, it will probably need to be directly consumed, given the dire forecast many analysts are making.

The era of cheap water is now drawing to a close, and price increases are inevitable to fund the repair or rehabilitation of aged infrastructure. Increasingly water conservation will become the norm, and wastewater, once seen as a nuisance to be dumped will be seen as a valuable resource. A non chemical disinfection process such as UV will play a key role as the planet realizes how valuable clean water actually is.

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