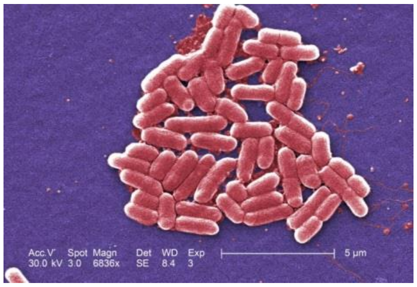
Chlorination Cost Savings

How a city of 55,000 reduced disinfection chemical costs by 62%

Measuring And Monitoring E. coli

The presence of bacteria in wastewater plant influent and the dangers they pose to human health and the environment requires disinfection (usually by chlorine) of treated effluent before discharge. E. coli bacteria are used as a proxy indicator for all types of bacteria which may be present in the effluent, and treatment plants are therefore required to hold E. coli levels in the effluent to permitted levels.

E. coli bacteria
Photo credit: Janice Haney Carr/CDC



Since bioavailable chlorine in the effluent can itself be a biohazard, it also may be subject to regulation and may have to be removed from the effluent. The costs of chlorine disinfectant and the cost to chemically scavenge chlorine from the effluent with sodium bisulfate (NaBs) are a significant part of the operating budget of a treatment plant that disinfects with chlorine.

The Costs Of Operating Without Live Data

The amount of chlorine- either as chlorine gas (Cl2) or sodium hypochlorite (hypo) required to meet a given plant's disinfection goals and maintain effluent bacteria at or below permit requirements will depend on a number of factors, including the quantity of bacteria carried in the process stream at any point in time, the treatment plant's flow rate, and the usual demand factors (ambient temperature, pH, ammonia content, contact time, etc.) present at that time.

Because a traditional E. coli culture assay is a manual process that requires many hours to perform, it is not possible for wastewater treatment plant operators to adjust their chlorination dosing levels to accommodate changes in the actual quantity of E. coli present in the matrix in real time. Instead, they will establish a chlorine treatment schedule that contains enough safety margin to guarantee an abundance of chlorine (so that the plant's minimum

About the LiquID™ Station

The LiquID™ Station from ZAPS Technologies (pictured below) is an innovative optical instrument for continuous water quality monitoring. The automated online instrument analyzes a continuous flow-through stream from a pressurized water sample line using multi-spectral light and software algorithms, and uses no reagents nor produces any waste other than the original sample (which is returned or wasted as appropriate). With this method, the **LiquID** is capable of monitoring a wide range of water quality parameters in a number of different industry applications, including those relevant to municipal water and wastewater treatment, water reuse systems and industrial process control.

disinfection goals will always be met) even during the plant's worst-case operating scenario. The facility operator then bears the costs of over chlorination, both in terms of chlorine and (when required) dechlorination via NaBs or $NaHSO_4$.

Corvallis, Oregon Wastewater Treatment Facility
photo credit: Dan Hanthorn

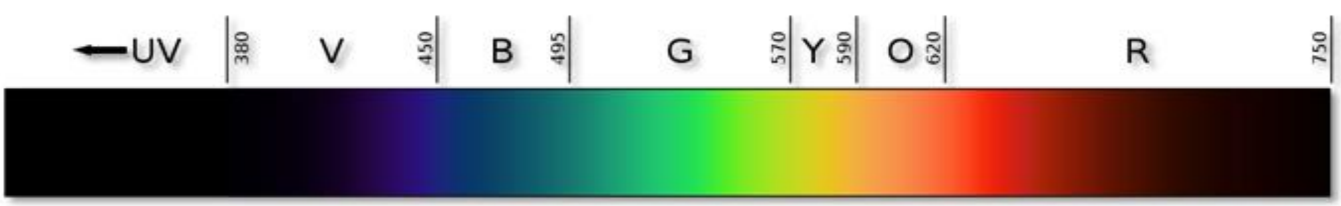
For example, according to Dan Hanthorn, recently-retired wastewater operations manager of the Corvallis, Oregon Wastewater Treatment Facility, the historically-established Cl_2 dosing at the facility was 2.2mg/L to yield a residual setpoint (after worst-case demand factors were accounted for) of 0.7mg/L, with a typical effluent Cl_2 residual of 0.4mg/L at the end of the disinfection process.

To effectively maintain a 0.00mg/L Cl_2 residual in the final effluent under all operating conditions and control loop fluctuations then required a NaBs dosage rate of 0.7mg/L to accommodate the residual chlorine in the flow, yielding a 0.3mg/L positive NaBs residual in the final effluent.

Cost Reduction Via Continuous Monitoring With LiquID™

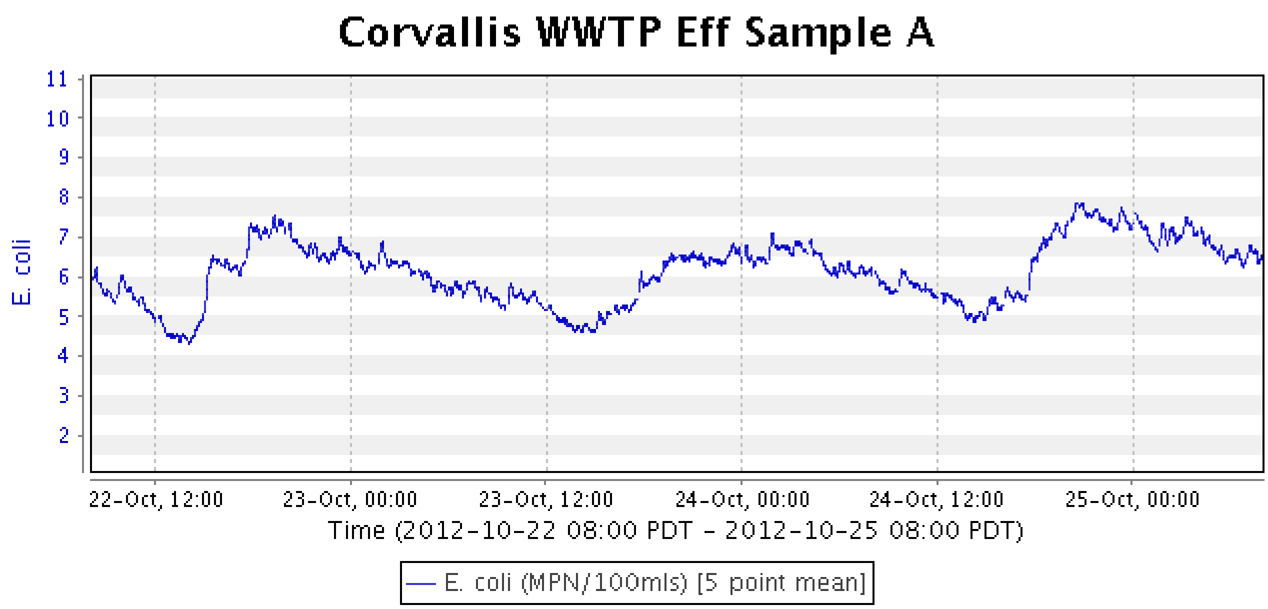
The **LiquID ™** station from **ZAPS** Technologies is the first and only water quality monitoring system to allow automated, real-time measurement of actual E. coli load in a wastewater treatment stream on a minute-by-minute basis. As such it offers plant operators their first opportunity to close the treatment plant process control loop around the instantaneous E. coli levels in the matrix- that is, to pace the addition of chlorine with E. coli measurements on timescales measured in minutes instead of days- and stop paying the costs of over-chlorinating for worst-case conditions.

The **LiquID** station directly measures the quantity of E. coli using a precisely-controlled beam of light to probe the matrix stream. When the beam strikes the bacteria, it causes them to fluoresce at a wavelength which is specific to living E. coli cells. The strength of this *fluorescence signature* (which is directly proportional to the quantity of living E. coli cells present in the stream at that instant) is measured by the **LiquID** station's detector system. The **LiquID** station's on-board computer then converts the fluorescence measurements into equivalent E. coli concentrations and reports these to the user's computer via a secure web link.



According to Hanthorn, the Corvallis WWTF is no stranger to new technologies; being situated in the home town of Oregon State University furnished ample opportunities for them to test technologies under development and keep an eye towards new instruments in the industry. As it turned out, the Corvallis WWTF was already measuring TSS, cBOD, COD, NH3, and Nitrate+Nitrite using a **LiquID** station installed in March of 2010 at their final effluent discharge point. Hanthorn took further advantage of this existing instrument by having the **ZAPS** technical team add new algorithms to its data processing program which enabled it to also monitor E. coli concentrations in their final effluent. This would allow the Corvallis WWTF staff to determine whether the **LiquID** station could save money by reducing the usage rates of both Cl2 and NaBs at the Corvallis treatment plant, without elevating the risk of exceeding permit levels of E. coli or excess chlorine.

Success in this new role would require the **LiquID** station to make continuous, accurate, and timely E. coli measurements in the field, process those measurements into actionable information, and then transmit that information to the plant operators. Below is a sample of the E. coli count data that the **LiquID** station began to generate in the Fall of 2012.



Reducing Cl2 And NaBs Dosages With The LiquID

In January of 2013, with the **ZAPS LiquID** station reporting E. coli in real time, the Cl2 dose was successfully scaled back to yield a residual of 0.4mg/L. However, the **LiquID** station also showed that during low flow days, and especially during low flow periods within low flow days, elevated E. coli counts became more pronounced. These spike events were successfully captured and reported to the plant operators by the **LiquID** station, and attributed to poor Cl2 mixing during low flow periods. Moving the hypochlorite feed location to the secondary clarifier overflow trough for better mixing prior to measuring the initial Cl2 residual resolved this issue- a process control improvement directly related to the data stream provided by the **LiquID** station.

This modification in turn opened the door to further reductions in the initial dosage of hypochlorite. In response, the NaBs dosage could be reduced to neutralize the new, lower final effluent Cl2 residual of 0.1 mg/L, and provide a NaBs residual of 0.2 mg/L. This could in turn be achieved with an applied dosage of NaBs of just 0.3 mg/L. Later that January, the initial Cl2 set point was cut to 0.2 mg/L, resulting in an effluent residual that was almost always 0.00 mg/L before dechlorination. The NaBs residual set point was reestablished at 0.1 mg/l, and with no residual Cl2 demand to neutralize, the typical applied NaBs dosage could be further reduced to only 0.1 mg/L.

The Result: $75,000/Year Savings From The LiquID Station

The annual chemical savings from the changes to the E.coli pacing processes described above are currently calculated to be $75,000/year, or fully **62% of the previous annual chemical budget** of the Corvallis WWTF. Real-time E. coli data allowed the Corvallis, OR WWTF staff to fit the treatment process to the actual conditions present in the treatment stream with confidence, while at the same time increasing effective oversight of this critical regulatory parameter.

Achieving these low dose rates required new, low range Cl2 probes and NaBs analyzer recalibration to reliably measure the new very low residuals and control chemical feed rates- but the overall cost savings speak for themselves. Hanthorn believes that with the accumulation of further **LiquID** station process monitoring history, NaBs usage may be suspended seasonally or perhaps eliminated entirely from the treatment process.

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