COST-EFFECTIVE SELF-PRIMING PUMPS FOR WATER INTAKE

Vertical sump pumps and submersible pumps require full disassembly of the pump and flanges for maintenance. Horizontal pumps with an external priming device require instrumentation and control signals for start/stop procedures. Even a small quantity of solid particles can block installations with back valves at the suction pipe.

Typical installation of the AHLSTAR self-priming pump.

Sulzer’s AHLSTAR self-priming pump offers a reliable, cost-effective solution in suction-lift pumping installations, and is especially suited as a seawater intake pumps in small to medium-sized desalination plants, and water treatment plants. With its internal liquid ring vacuum impeller, it is able to prime the suction pipe. Easier installation and maintenance help lower life cycle cost. No back valve or external priming device is needed, saving in instrumentation, pipe works, and control signals. The pump is easy-maintenance due to its horizontal dry-mounted, back pull-out design.

OVIVO DESIGNS AND CONSTRUCTS ADVANCED WATER TREATMENT PLANT USING MBR-RO TECHNOLOGY

Viterra is a global agribusiness providing premium quality ingredients to leading global food manufacturers. Its Tamworth malt facility has a grain capacity of 45k tonnes, supplying malt both domestically and internationally. With Viterra’s holistic approach to water management and conservation of this precious resource, an Advanced Water Treatment Plant (AWTP) was required by the company to treat malting steep water to a quality suitable for reuse within the facility.

Ovivo Australia designed and constructed a cutting-edge AWTP using MBR (membrane bioreactor) and RO (reverse osmosis) technology. MBR technology was used because it is highly suitable for the treatment and filtration of municipal and industrial waste. The MBR and RO perform all the necessary steps to treat the influent to a condition suitable for reuse within the client’s facility and to maintain discharge agreement conformance for the reject stream generated.

The malting steep waste is initially screened, balanced and pH corrected, and biologically treated to reduce BOD/COD, Nitrogen and Phosphorus. Permeate is drawn through two immersed membrane trains reducing TSS levels and pathogens. The MBR permeate is further treated through a dual-stage RO system to remove dissolved content and pH-corrected before being stored for reuse. The process designed by Ovivo incorporates the use of a bio-selector that conditions the wastewater prior to bio-treatment and enhances biological phosphorus removal.

The AWTP which is capable of treating a hydraulic load of 300kL per day, can recover 75% of the wastewater, equating to around a 50% reduction in the client’s reliance on local potable water supply.

Ovivo was able to provide the client with capital cost savings over conventional activated sludge systems. The AWTP performed the same function but with a reduced footprint and associated civil installation costs. The technology used resulted in a compact and efficient means of improving water quality and is well suited for reuse applications. The AWTP, which was delivered as design, build and operation (DBO), enables water savings of 50ML per year.

The AWTP allows water savings of 50ML/a.

The aeration system comprises Ovivo’s AEROSTRIP Fine Bubble Diffusers, a high performing membrane diffuser that has provided high SOTR against power input. Efficiency has been shown as 4–4.2kg O₂/h per kW input. Optimisation of the positive displacement blowers is achieved through Ovivo’s DO control strategy.

With proper management of the sludge age and MLSS, permeability of the submerged membrane modules has been found to be consistent and well above accepted levels of 300 LMH/Bar. The membrane flux rate selected reflects the high residual COD that is commonly experienced in industrial trade waste, when compared to sewage, due to slow or non-biodegradable organic fractions.

Even though the designed influent data is much lower than actual influent loads, the recovered water surpasses design estimates. The excess biomass generated by the aeration phase is wasted through the MBR tank and dewatered using a horizontal solid bowl decanter centrifuge. The output of the centrifuge is a spadable cake that is beneficially reused within the region. Centrate is captured and returned to the head of the plant.

The plant is controlled via a SCADA system that allows for remote monitoring and trending. Automation is critical to the long-term success of the wastewater treatment plant.

Validated UV
for drinking water & wastewater

Validated UV Small Footprint Energy Efficient

UV DISINFECTION OF DRINKING WATER – INNOVATION, DEVELOPMENT AND OPPORTUNITIES

The development of UV disinfection technology over the last decade is now meeting demand for an effective, low-cost, non-hazardous and environmentally friendly water disinfection technology.

UV is the part of the electromagnetic spectrum between visible light and X-rays. The specific portion of the UV spectrum between 185–400nm has a strong germicidal effect.

There are two main types of UV technology, based on the type of UV lamps used: low pressure and medium pressure. Low-pressure lamps have a monochromatic UV output (limited to a single wavelength at 254nm), whereas medium-pressure lamps have a polychromatic UV output (between 185–400nm).

DNA has its maximum absorption at both 200nm and 265nm (Von Sonntag, 1986). Maximum absorption does not occur at 254nm, the wavelength produced by low-pressure lamps and often wrongly assumed to be optimum wavelength for killing microorganisms. At 200nm most absorption occurs in the ‘backbone’ DNA molecules of deoxyribose and phosphate. At 265nm, UV absorption mainly occurs in the nucleotide bases: adenine, guanine, cytosine and thymine (and uracil in the case of RNA). The most common products resulting from damage by UV radiation are thymine dimers, which are formed when two adjacent thymine molecules become fused. The formation of these dimers and other photoproducts prevents the DNA from being able to replicate, effectively killing the cell.

In some cases, UV is effective above 265nm. It has been shown, for example, that the optimum wavelength for destroying Cryptosporidium parvum oocysts is 271nm (15% more effective than 254nm) (Linden, 2001), while the optimum wavelength for Bacillus subtilis is 270nm (40% more effective than 254nm) (Waites, 1988).

In addition to DNA and RNA, UV also causes photochemical reactions in proteins, enzymes and other molecules within the cell. Absorption in proteins peaks around 280nm, and there is some absorption in the peptide bond (-CONH) within proteins at wavelengths below 240nm. Other biological molecules with unsaturated bonds may also be susceptible to destruction by UV – examples include coenzymes, hormones and electron carriers. The ability of UV to affect molecules other than DNA and RNA is particularly interesting in the case of larger microorganisms such as fungi, protozoa and algae. In these microorganisms, although UV may be unable to penetrate as far as the DNA, it could still have a lethal effect by damaging other molecules.

Recovery from UV Damage

The need to recover from or repair UV damage is common to virtually all micro-organisms that are regularly exposed to UV light in nature. Known as reactivation, the process can take place in both light and dark conditions and is called.

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respectively, photoreactivation and dark repair. The ability to reactivate varies significantly depending on the type of UV damage inflicted and by the level of biological organisation of the microorganism. The repair mechanism is not universal and there are no clearly defined characteristics determining which species can repair themselves and those that cannot.

The part of cells most vulnerable to UV damage is the DNA and RNA. This is due partly to its unique function as the repository of the cell’s genetic code, and also because of its highly complex structure and large size. It is hardly surprising, therefore, that all known molecular repair mechanisms have evolved to act upon the macromolecular nucleic acids, particularly DNA.

In photoreactivation, repair is carried out by an enzyme called photolyase, which reverses the UV-induced damage, while in the case of dark repair it is carried out by a complex combination of more than a dozen enzymes. To begin reactivation (both light and dark), these enzymes must first be activated by an energy source – in photoreactivation this energy is supplied by visible light (300–500nm), and in dark repair it is provided by nutrients within the cell. In both cases, reactivation is achieved by the enzymes repairing the damaged DNA, allowing replication to take place again.

Common strains of *E. coli* contain about 20 photolyase enzymes, each of which can repair up to five thymine dimers per minute – this means that, in a single cell, up to 100 such dimers can be repaired per minute. 1mJ/cm$^2$ of UV produces approximately 3000–4000 dimers (Oguma, 2002) so, theoretically, damage induced by 1mJ/cm$^2$ of UV can be repaired in just 30 minutes.

**Repair After Exposure to Low and Medium Pressure UV**

Low-pressure UV lamps have traditionally been used in water treatment plants because their UV output at 254nm closely matches the absorption peak of DNA bases at 265nm. A number of studies, however, have shown that microbial DNA is capable of photoreactivation after exposure to low pressure UV (e.g. Sommer et al., 2000).

Because of these findings, and because of the increased use of medium pressure UV lamps in water and effluent treatment, recent research has begun to look at whether medium pressure UV can permanently inactivate the DNA of microorganisms. It has been suggested that, because the broader wavelengths emitted by medium pressure lamps not only damage DNA but also cause damage to other molecules, it is, therefore, much more difficult for cells to repair their DNA.

The recent research compared the effects of low pressure and medium pressure UV on the ability of microorganisms to repair their DNA. In their tests they compared the ability of *E. coli* to recover in photoreactivating light after being exposed to different amounts of low and medium pressure UV. *E. coli* was used in the study as it is a useful ‘biological indicator’ of disinfection efficiency in water systems. The results of these studies showed a significant difference in photoreactivation following low- and medium-pressure radiation. While high levels of photorepair were observed after low-pressure irradiation, with maximum repair occurring after 2–3 hours, there was virtually no photorepair after medium pressure treatment. This was particularly the case at higher log reductions (log 3 and above) (Oguma et al., 2002, Zimmer et al., 2002 and Hu et al., 2005).

Zimmer et al. proposed a number of reasons why medium pressure UV causes irreparable damage, while low pressure UV does not. One hypothesis is that there is a synergistic effect between the various wavelengths emitted by medium-pressure lamps that causes irreparable damage to the DNA. Another possible explanation is that the repair enzymes themselves are damaged. According to Zimmer et al., while absorption of UV by proteins is considered of little importance to cells, any damage to repair enzymes would be critical due to the fact that there are so few of them present in the cell.
All these studies concluded that polychromatic medium pressure UV radiation was more effective than monochromatic low-pressure UV at causing permanent, irreparable damage to the DNA of E. coli.

Conclusion
The UV industry has matured considerably over the last decade. The advantages of medium-pressure UV are becoming more apparent as a way of permanently destroying microorganisms. More research in this area is required, especially in real water treatment plants.

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References


