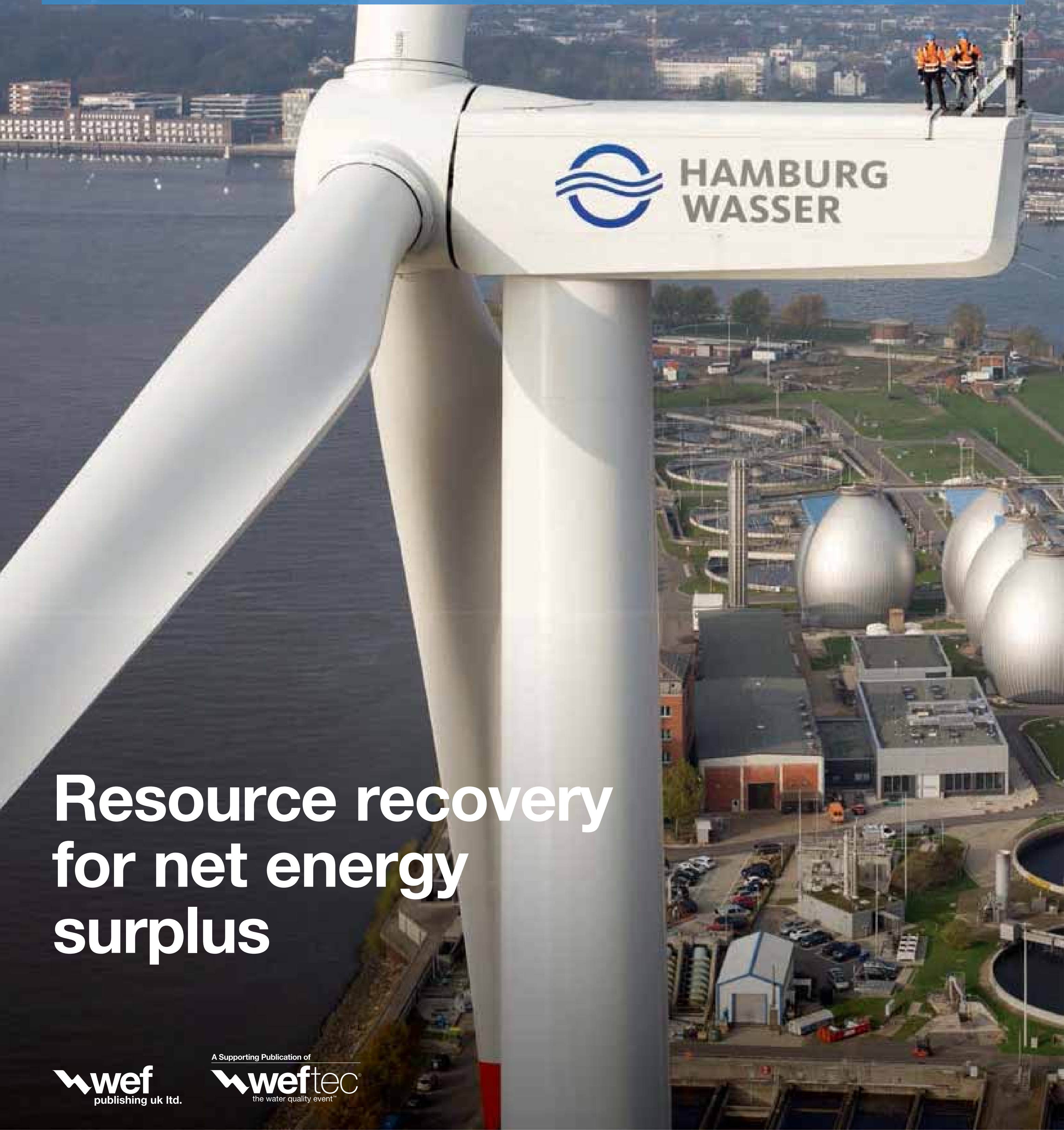
world water

Volume 39 / Issue 2
March / April 2016



Resource recovery for net energy surplus

wef publishing uk ltd.
A Supporting Publication of weftec the water quality event™

Biological treatment keeps Fiji beaches and ocean pristine

Protecting waterways by relying on an eco-friendly bioreactor technology makes practical business and economic sense. BioGill Senior Technical Engineer, Max Garavaglia explains how an onsite treatment technology treats and recycles domestic wastewater at an island resort in Fiji.

Fiji's Mantaray Island Resort opened its doors to travelers as an eco-resort in 2014. Renowned for having one of the best house reefs in Fiji and known for the manta rays that visit the nearby waters every year, Mantaray Island Resort has always made protecting the environment and marine reserve a key priority. BioGill bioreactor technology, an Australian invention, has helped to protect the local reefs and waterways by treating wastewater onsite and recycling the water for garden reuse.

Prior to 2010, the island's rudimentary sewage treatment plant discharged effluent of poor quality, which adversely affected the local coral reef ecosystem, causing algal blooms in a 10- to 15-meter wide zone extending out from the low-tide line.

In 2010, the existing facility was retrofitted with a BioGill bioreactor system to treat relatively strong and refractory wastewater to a standard suitable for reuse and to reduce the nutrient load that was being discharged into the ocean. The plant was upgraded to treat up to 15 cubic meters per day (m^3/) of influent from the kitchen, showers, staff quarters, and leachate from Clivus-Multrum composting toilets to produce water suitable for reuse via sub-surface irrigation. The system has been operating reliably for more than five years.

The existing treatment facility consisted of a rectangular fiberglass tank with three main compartments measuring approximately 2 m^3 in volume each and including:

- Primary treatment operating as a conventional septic system with three chambers to promote the separation of solids and an oily scum layer
- Aerobic compartment containing coral and a small aeration system consisting of bubblers
- Settling tank with a small pool filter attached for final polishing.

When compared to typical raw sewage, the biochemical oxygen demand (BOD) and the nitrogen level measured by Total Kjeldahl Nitrogen (TKN) in the influent, were on average 3.3 times and 2.8 times stronger respectively. This was consistent with the water conservation measures used on the island.

The existing tank was emptied of the coral medium; the filter and aeration systems were removed; and the tank was plumbed and retrofitted so that it would act as a septic system to separate settleable solids and surface scum. Pipe outlets with manual ball valves were fitted at the top and bottom of Chamber 1 and 2 to enable the oily surface scum and sludge that settles on the bottom to be drained to two absorption pits.

A centrifugal submersible pump was installed in Chamber 3 to deliver primary-treated water to two BioGill core units totaling 640 m^2 of membrane area. A centrifugal submersible pump was also installed to recirculate the content of Tank 2 over the gills for approximately 21 hours per day.

At the end of the recirculation period, suspended solids in Tank 2 were allowed to settle for 90 minutes before the treated water was pumped out into the irrigation network via a new calcium hypochlorite dosing system. Once every week, the remaining water in Tank 2 (approximately 3 m^3) was emptied into an absorption pit using a dedicated submersible pump.


Treatment facility after the refit with the new BioGill units in the background.

BOD reductions up to 96 percent

Upon commissioning, the average BOD and ammoniacal nitrogen NH_4 from the influent wastewater was 662 mg/L and 39.9 mg/L, respectively. Independent testing from the National Water Quality Laboratory Suva reported that the BioGill system produced a final effluent with an average BOD of 25 mg/L (96 percent removal efficiency) and an average NH_4 of 1.9 mg/L (95 percent removal efficiency). The total nitrogen was reduced on average from 112 mg/L to only 24 mg/L (79 percent efficiency). Total suspended solids in the treated effluent were also low and measuring on average 9.6 mg/L.

Continued on page 48

How the technology works

BioGills are above-ground, non-submerged bioreactors that incorporate flexible membranes referred to as gills. These gills are provided in multiple suspended loops supported in the vertical position using engineered spacers. Water is distributed over the top of each loop and flows down and over the surface of the gills. Microorganisms attach themselves on a patented micro-ceramic gel matrix applied on the membranes and grow on both the air and the liquid side of the gills. The hydrophilic 5-nature of the gills creates wastewater capillaries, allowing the air-side biomass to feed on nutrients from the water side.

Biomass on the gills grows in a very different manner than conventional biofilms. In BioGills, nutrients from the wastewater and oxygen from the air side of the gills diffuse into the biofilm from opposing directions. This counter diffusion of oxygen and nutrients also promotes microbial stratification within the biofilm itself. Biomass growing on the air side is aerobic and consists of aerobic heterotrophs and autotrophs bacteria. Biomass growing on the liquid side is not aerated and consists of facultative aerobic bacteria, which rely on electron acceptors other than oxygen. Furthermore, enzymatic secretions of the biomass can diffuse into the liquid, effectively breaking down refractory organic components such as fats, oil, and grease.

BioGill bioreactors are operating in 17 countries across three continents, treating a variety of wastewater from sewage treatment for remote communities to large-scale industrial water treatment for multinational companies. The technology has also received numerous awards and accreditations from government authorities and the private sector.

Continued from page 27

Samples of the groundwater exiting the resort from the sand at the low-water mark showed low Total Organic Nitrogen (0.57 mg TON/L) and nitrate levels (1.6 $mgNO_3^-/L$), well within the Fijian standard for environmentally sensitive areas (TON < 10 mg/L).

The low nitrogen levels in the groundwater entering the reef was attributed as the major cause of the recession of the algal bloom at the low-tide level and the regeneration of the reef seen during the nine-month period following the commissioning of the BioGill treatment system.

A report compiled after nine months in operation showed no sign of membrane fouling or deterioration and no decrease in treatment performance consistent with all other BioGill systems operated so far. The findings demonstrate that the technology is simple, reliable, and economical, given its energy consumption rate of 1 kWh/m^3 of treated effluent. The simplicity of operation and maintenance makes this technology suitable for remote sites and developing nations without the need for skilled staff to operate the system.

Author's Note

BioGill Senior Technical Engineer, Max Garavaglia is based in Sydney, Australia.

Continued from page 21

the city. The most recent class included Optiktechnik, which makes laser-based, optical sensors and instrumentation to improve monitoring and control of key particle processes in water and wastewater treatment. Radom creates instrumentation to identify toxic trace metals in water, waste-water, industrial processes, and food and drugs. Current Data is a watershed-focused water quality data collection and information system using a sensor array and mobile app with cloud storage and analysis tools to lower the costs of data collection and increase its use in critical water quality decisions. In the BREW's inaugural class, Meter Hero focused on water consumption data and social networking to drive conservation programs.

Drinking water and wastewater are not the only categories of water sector advances in big data. On the groundwater front, Wellntel, provides a real-time understanding of well and surrounding water table dynamics, provided through constant measuring and reporting of water levels. Both Imagine H2O and the Water Council's BREW program recognized this firm for its innovation. Managing stormwater in real time is the focus of both EmNet and OptiRTC, while companies like H2Ometrics provide cloud-based visualization tools to better plan stormwater and sewer operations.

Cloud-based solutions provided by innovators will help water utilities of all sizes advance smart water infrastructure. Smart water innovation has even emerged from firms better known for other IT sectors such as network giant CISCO or mobile devices leader Qualcomm. With innovations developed by entrepreneurial startups and large companies including IBM, GE, and OSIsoft, an exciting future is already underway for big data solutions in smart water infrastructure.

Authors' Note

Barry Liner is the director of Water Environment Federation's Water Science & Engineering Center, based in Alexandria, Virginia, USA. Pam Kenel is the solution lead for Smart Community and Water Analytics in Black & Veatch's Smart Integrated Infrastructure business, based in Gaithersburg, Maryland, USA.