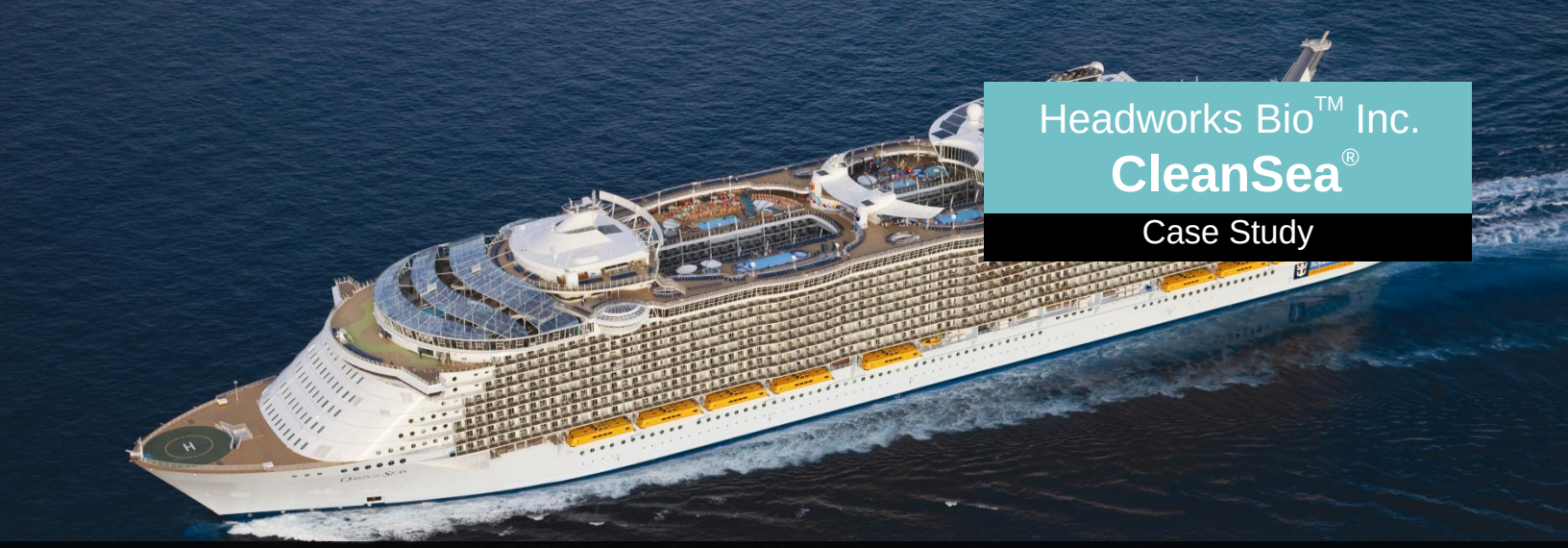

Headworks Bio™ Inc.

CleanSea®

Case Study

OASIS OF THE SEAS The Royal Caribbean Cruise Ships

The successful management of the world's marine environment has unique challenges when compared to land based environments. The oceans encompass a huge area to manage, their political boundaries are blurry and conditions in one small area can have serious impacts on much larger, far removed areas. With the acquisition of Hydroxyl Systems Inc earlier this year, Headworks has expanded its entry into biological treatment systems, including the growing market of cruise ship waste water treatment.

Headworks Bio recently completed the installation of today's state of the art method for wastewater treatment available on cruise ships, the CleanSea® system. This unique design was implemented on Royal Caribbean's Oasis of the Seas, the largest cruise ship in the industry.

At the core of the Headworks CleanSea system onboard Oasis, is the ActiveCell™ biological treatment process. These biological treatment basins mimic the oceans' natural treatment cycle for wastewater contaminants. In fact, the process can be thought of as a "nature accelerated™." To understand the core of biological wastewater treatment technology it is helpful to learn a bit about the cycle occurring in nature's own massive treatment basins -- the oceans.

Understanding marine biology involves knowing a bit about the chemistry of dissolved oxygen. Dissolved Oxygen (DO) in sea water is an important factor in maintaining a healthy environment for marine creatures. Just like humans, most marine creatures need oxygen to survive; the difference being marine animals use some form of gills for respiration rather than lungs. As the sea water moves across their gills, oxygen is removed and transferred into the animal's blood.

Oasis of the Seas Fast Facts	
Length Width	1,187 ft / 360 m 208 ft / 65 m
Passengers & Crew	~8,400
Hydraulic Capacity	3,000 m^3/day 0.79 MGD
Typical Flow	2,000 m^3/day 0.53 MGD
Max. Influent BOD Max. Influent TSS	~1,500 mg/L ~850 mg/L
Headworks Bio meets Alaska State Discharge Standards	
Effluent BOD Effluent TSS	< 15 mg/L < 15 mg/L

The CleanSea System installed on the ship's hull during ship building. The biological treatment basins are located in the far corner of the block.

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Certain species living closer to the ocean's floor, such as worms, small clams, and various bacteria, require low levels of dissolved oxygen in the range of 1 mg/l (milligrams of DO per litre of water). At the other end of the spectrum are spawning migratory fish and their larvae which can require DO levels in the 5 – 6 mg/l range. Areas with less then 0.2 mg/l of DO are said to be anoxic and are unable to support most forms of life.

Protecting the oceans' DO levels from negative impact by human activity is one of the primary reasons to treat wastewater before discharging from a receiving basin.

Due to the biological process that occurs, DO levels decline in receiving basins when certain contaminants contained in wastewater are introduced. Basically, naturally occurring or artificially introduced bacteria eat specific contaminants in the waste stream and use the DO from the basin for respiration. As the bacteria colonies multiply, and as the contaminants are consumed, oxygen is depleted from the basin. While this is good for the bacteria (aka "bugs"), the oxygen depletion is damaging for the fish and other aquatic life forms that are left 'gasping' for air.

In similar fashion, the CleanSea process mimics the ocean's treatment, but within an obviously smaller volume and footprint. In fact, the process is so elegant in its design that it requires significantly less space than conventional treatment systems. The basins or reactors (tanks) Headworks Bio employs use a proprietary carrier, the ActiveCell™, which allows biological film to grow inside and maintain a healthy colony of bacteria. The "bugs" acclimate naturally to live off the contaminants contained in the wastewater introduced into the system.

A close-up view of Headworks' ActiveCell Bio-Carriers shows the Biofilm responsible for consuming influent contaminants

In addition, the basins are aerated to provide adequate DO levels in the tanks to support the biological colonies. As the waste stream moves through the basins, the contaminants are reduced naturally. What flows out the end, is a mixture of non-oxygen depleted water and dead bugs.

By performing this process in our treatment basins, the waters of the world including our oceans, lakes, rivers, streams and other receiving waters, do not have to process the wastewater generated by the terrestrial animals of the world. This leaves the oceans' DO for what it was intended; that is, for sustaining the vast array of sea creatures that can't live without it.

One of the CleanSea Aerated Basins shown during commissioning. In regular service this tank will contain ActiveCell Bio-Carriers and will be full of wastewater. The air will give the bugs the oxygen they need for respiration.

Headworks Bio is very proud to be part of the growing trend towards protecting one of the earth's greatest resources and are looking forward to staying at the front line in the fight against pollution. If you have questions about how these systems can be utilized in your ship, oil and gas operation, food processing plant,or municipal plant, head straight to Headworks Bio at hw@headworksusa.com or visit our website at www.headworksusa.com.

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