COMPLIMENTARY

Instant Ocean®

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Advancing the Hobby of the Marine Aquarist

Shedd Aquarium Uses Instant Ocean® Sea Salt to Create Marine Habitats in Chicago

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The John G. Shedd Aquarium houses thousands of freshwater and marine species of animals from various habitats throughout the globe, making Shedd "The World's Aquarium." Designing and maintaining marine aquatic systems in the middle of the Midwest can be quite challenging. Shedd leads this opportunity head-on with advanced life-support filtration processes, a state-of-the-art water analysis laboratory, and incredibly talented staff. Since our animal environments are the most important component of a healthy animal collection, Shedd Aquarium starts by filling our marine habitats with Instant Ocean® Sea Salt.

Need three million gallons of seawater? Add 490 tons of Instant Ocean Sea Salt.

Water systems for housing marine animals can be broken down into three main types: open, partially open, and closed. When an aquarium is located near a source of high-quality natural seawater, this water can be circulated directly through the habitat and sent back to the source. There are many benefits to open systems. Obviously, when attempting to artificially replicate a natural seawater environment, having natural seawater available eliminates the problem of synthetically formulating the ionic components.

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SPECIAL EVENTS

- **SuperZoo 2009**
  The National Show for Pet Retailers™
  Sept. 15-17, 2009
  Mandalay Bay Las Vegas
  www.superzoo.org
- **MACNA XXI**
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  Atlantic City, NJ
  www.macnaxxi.com
- **IMAC West 2009**
  July 31–Aug. 2, 2009
  Long Beach. CA
  www.imacwest.com
- **World Reef Conference 2009**
  Featuring Midwest Frag Fest
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  www.worldreefconference.com

Bringing the ocean home.

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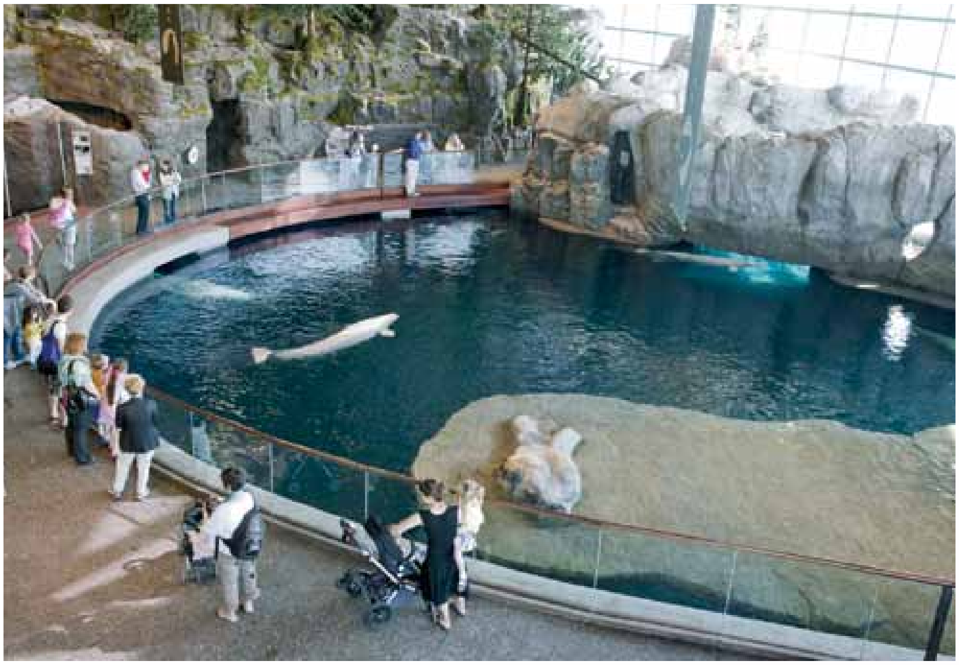
Semi-open systems are basically open systems with some minimal form of water treatment. Water is still taken from and returned to a natural water supply, but the water goes through one or more treatment steps before it enters the animal enclosure. Because marine enclosures are usually built for public display of the animals, semi-open systems typically include some form of mechanical filtration to improve clarity. In some cases compounds are added to stimulate flocculation of particles, which are then filtered out mechanically. Sterilization techniques are becoming more common in the design of semi-open systems. Ozone, ultraviolet radiation, and sometimes chlorine are used to pretreat the water before it enters the animal enclosure.



Above: Secluded Bay, a recreated Pacific Northwest coastline, is one of the most popular exhibits.
Below: Pacific white-sided dolphin in the new Oceanarium exhibit.

On account of Shedd Aquarium's Midwestern location, all of our marine enclosures are designed with closed life-support systems. Closed systems are fully self-sustaining ecosystems, with the same water recirculating through the exhibits and a series of treatment processes. The overall design of how the water in a closed life-support system is treated may vary, but the basic approach is the same. Closed systems are designed to provide an artificial environment that replicates the natural environment by maintaining proper water quality. In other words, the systems are designed to provide the animals housed in the exhibit with all of their water-related requirements while removing or controlling all of the elements that could prove harmful.

In 1930, when John G. Shedd, a former president of Marshall Field and Company, made a $2 million gift to build an aquarium in Chicago, there was just one way to get seawater for the Midwest marine systems — by train. The first million gallons of seawater was brought to Shedd in 20 railroad tanker cars that made eight round-trip voyages between Chicago and the Florida keys.

At the time, little was known about the chemical composition of seawater, and there would not be an option to purchase premixed, prepackaged salts for another 30 years. Today, Instant Ocean Sea Salt is used in all of Shedd Aquarium's marine systems, since the product is formulated for proper ionic composition, pH and alkalinity balance, and for ease of mixing and dissolution.

In the very early days of housing marine fish and invertebrates in aquariums, hobbyists and professionals alike understood the importance of starting with good-quality seawater. On the other hand, marine mammal systems usually have been designed with sodium chloride "brine" water. The higher density of saltwater, compared to freshwater, increases the buoyancy of the animals. Because dolphins and whales spend most of their time in motion, the increased buoyancy is necessary for these animals, which spend no time resting on land.

Arguably, marine mammals have been housed successfully in sodium chloride environments for decades. Nonetheless, because Shedd Aquarium strives to create animal environments that mimic the natural environment as closely as possible, we made the decision to switch to a complete salt mix in all of our Oceanarium water systems. During our recent $50 million renovation of the Oceanarium exhibit, the pools were refilled using over four hundred 2,450-pound Super Sacks® of Instant Ocean Sea Salt.

With careful coordination between Shedd Aquarium and Instant Ocean staff, 50 Super Sacks were delivered every day for eight days. The salts were slowly added in a custom mixing system, designed by Shedd staff, which required over 500 hours of manual labor and over 10 days of mixing, in order to reach our target salinity of 35ppt, or 3.5 percent.

Although the physical design of the enclosure and filtration processes is extremely important, one could argue that the water in which the animals reside is the most important component. Because of this, Shedd Aquarium has chosen Instant Ocean Sea Salt to refill our three-million-gallon Oceanarium habitats.

Shedd Aquarium is proud to partner with Instant Ocean in providing our animal collection with the best possible marine environments.

A CONTINUING SERIES

Part 5: Science Behind Synthetic Sea Salts

From the Labs of Instant Ocean

Visit www.instantocean.com to read the earlier installments of this continuing article.

OUTLINE

5. Characteristics of a Quality Synthetic Sea Salt

e. The pH and buffering of seawater. Natural seawater (NSW) has an alkalinity of about 2.4 milliequivalents per liter (mEq/L)[1], but this measurement is a little deceiving, because the ocean is saturated with buffers and there is little chance of much pH change in the ocean.

However, the pH and buffering capacity in marine aquaria, whether one uses NSW or a synthetic sea salt (SSS), are an entirely different matter. As mentioned earlier, nitrification produces a steady stream of hydrogen ions, consuming alkalinity and causing the pH to drop. Since most marine organisms are not adapted to withstand big changes in their environment, drops in pH can cause health problems.

For that reason, many sea salt makers increase or boost the buffering capacity of their products by adding chemicals—usually extra bicarbonate and/or boron—to their formula. In general, there are two sets of chemicals that contribute to the buffering capacity of the ocean and sea salts: the bicarbonate/carbonate system and the boric acid/borate system. In NSW, the addition of bicarbonate/carbonate supplies about 77 percent of the buffering capacity, while the boric acid/borate supplies the remaining 23 percent. Most synthetic sea salt makers choose to increase the buffering capacity by increasing the bicarbonate/carbonate portion. However, one sea salt has chosen to increase the boric acid/borate system significantly, increasing it to 12 times that of normal seawater (Holmes-Farley 2002). This completely reverses the above stated ratio of 77:23 to a ratio of 22:78 (bicarbonate/carbonate : boric acid/borate). As Holmes-Farley (2002) points out, however, studies have shown that elevated concentrations of boron are toxic to marine organisms. While not many studies have been conducted, one showed that the 24 hours LC50[1] of boron to a marine isopod was 28 ppm boron, which would be only half the boron in a solution made with this particular sea salt. For that reason, one should exercise caution before using a synthetic sea salt with excessive amounts of any chemical. It could be a case of too much of a good thing!

f. Extra amounts of certain elements. Besides those for boosting alkalinity, the elements most commonly added to a sea salt at values above those of natural seawater are calcium, magnesium and strontium. These three elements are continuously removed from the aquarium water by various reef-building organisms. Extra amounts of calcium, magnesium and strontium in a SSS reduce the need for the aquarist to remember to add supplements. Instead, aquarists can know that when they do their regular water changes, they are also replenishing these necessary elements. If one is maintaining a non-reef marine aquarium (fish only aquarium), it probably does not make economic sense to pay the premium price of a SSS with additional amounts of these three elements.

g. Total Organic Carbon (TOC). Organic carbon comes in two forms: dissolved organic carbon (DOC) and particulate (or non-dissolved) organic carbon (POC). Together, they make up the total organic carbon (TOC) in the system or sea salt. Most synthetic sea salts are composed of chemical compounds; therefore, the majority of the TOC in them is in the DOC form. The DOC comes from impurities in the base chemical compounds used to make the salt, because no manufacturer can afford to make a sea salt with absolutely pure chemical compounds. Almost all the chemicals used to make a SSS are inorganic—that is, there is no carbon in

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the chemical. Since some of the chemicals are of poorer quality, they contain impurities, some of which are DOC.

However, two types of sea salts may have substantial amounts of POC and, therefore, high TOC. They are natural seawater and sea salts from evaporative ponds (see section 3d in Volume 24, Summer 2008, available online at instantocean.com). Sea salts from evaporative ponds may contain the dried remains of organisms such as algae and bacteria, along with dirt and dust blown into the ponds, which are exposed to the atmosphere. All these sources and more contribute to an overall high level of TOC in SSS from evaporative ponds. The situation is the same for natural seawater, in that it contains bacteria, algae and other microscopic ocean organisms that can be removed only with a finest of filters. One can use UV or ozone to kill these organisms, but doing so does not reduce the TOC; it only changes the form from POC to DOC.

Other organics in a SSS, included deliberately, may include vitamins, some types of buffers, and EDTA, which could be used to chelate heavy metals. TOC levels vary widely in NSW, depending on the source or locale of the sampling. Seawater collected away from heavily populated coastal zones has a TOC value of about 1.4 mg/L (Pilson 1998). Generally, high levels of TOC can promote the growth of algae and other undesirable organisms, which can spoil the appearance of the aquarium. However, there are no studies demonstrating at what concentration of TOC these impacts will begin.

h. Manufacturing processes and quality control.

The manufacturing process itself also can be an important factor determining the final quality of the sea salt mixture. In order to achieve a uniform, homogeneous, well-packaged product at a competitive price, the process must ensure that the chemicals are clean and of uniform size (which may entail grinding them before adding to the mix), that the chemicals are added in precise amounts, that the mixing unit can produce a homogenous final product and, last, that it can be packaged efficiently.

Quality control is maintained by regular sampling and analysis of the raw materials and the finished product by skilled laboratory technicians. To ensure that a consistent, high-quality product is produced every time, every batch should be tested for major cations, anions, alkalinity and TOC, along with trace element analysis.

1 A LC50 is the Lethal Concentration to 50 percent of the test organisms at a designated time point (in this case 24 hours).

2 A milliequivalent is one-thousandth of the equivalent weight of an element or compound. When discussing alkalinity, the unit of measure is sometimes also expressed as parts per million (ppm) of calcium carbonate ($CaCO_3$). To convert from mEq/L to ppm $CaCO_3$ multiply by 50.

PUBLICATION INFORMATION

SeaScope® was created to present short, informative articles of interest to marine aquarists. Topics may include water chemistry, nutrition, mariculture, system design, ecology, behavior, and fish health. Article contributions are welcomed. They should deal with pertinent topics and are subject to editorial reviews that in our opinion are necessary. Payments will be made at existing rates and will cover all author's rights to the material submitted.

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