

## **Capturing Algae with Textiles**

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### **Algae issues**

On July 28, 2009, a horse died inhaling hydrogen sulfide gas emitted by decaying algae on a beach near Saint-Michel-en-Greve, Brittany, France. See the news story at: <http://www.cbsnews.com/stories/2009/08/28/ap/world/main5272011.shtml>. The news story does not mention it, but if bacteria digesting the algae are producing hydrogen sulfide, then they are also producing the greenhouse warming gases methane and carbon dioxide.

The bacterial decomposition of algae threatens beaches around the world with similar fates. Brittany's Cote d'Armor region is particularly impacted because of its sunlight, shallow waters, flat beaches, and an excess of fertilizers. Some rivers in the area reach up to 70 mg/L of nitrate and some groundwaters up to 100 mg/L. The fertilizers are both chemical, made from methane, and natural, including untreated pig excrement and treated human wastes.

Fertilizer runoff threatens more than beaches by causing algae blooms at sea. Relatively little of the algae wash up on the world's beaches. Bacteria digesting the algae deplete all the oxygen in the water. Those sea creatures which cannot move to find oxygen die, and the ocean algae bloom becomes a dead zone.

### **Capturing algae at sea with textiles**

In-ocean algae harvesting may employ the Salter wave-pump<sup>1</sup> modified with filtertubes, as shown in Figure 1. The wave-pump details are not shown in Figure 1, which focuses on the filtertubes. The wave-pump is a cylinder floating on the ocean surface. Wave crests pass through check valves (not shown) in the wall of the cylinder. That is: wave crests raise the water level in the cylinder while the check valves prevent the higher water level from leaving during the wave troughs. The Salter pump was invented to pump the lower density seawater down where it mixes with cooler and therefore higher density water. The invention uses this pumping action to wash water and algae into the cylinder and thence into the filtertubes. Water escapes through the pervious filtertube textile. Algae are retained in the filtertube.

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<sup>1</sup> S.H. Salter, "A 20 GW Thermal 300-metre<sup>3</sup>/sec Wave-energized, Surge-mode Nutrient-pump for Removing Atmospheric Carbon Dioxide, Increasing Fish Stocks and Suppressing Hurricanes." Institute for Energy Systems, School of Engineering, University of Edinburgh, EH9 3JL, Scotland, 2009  
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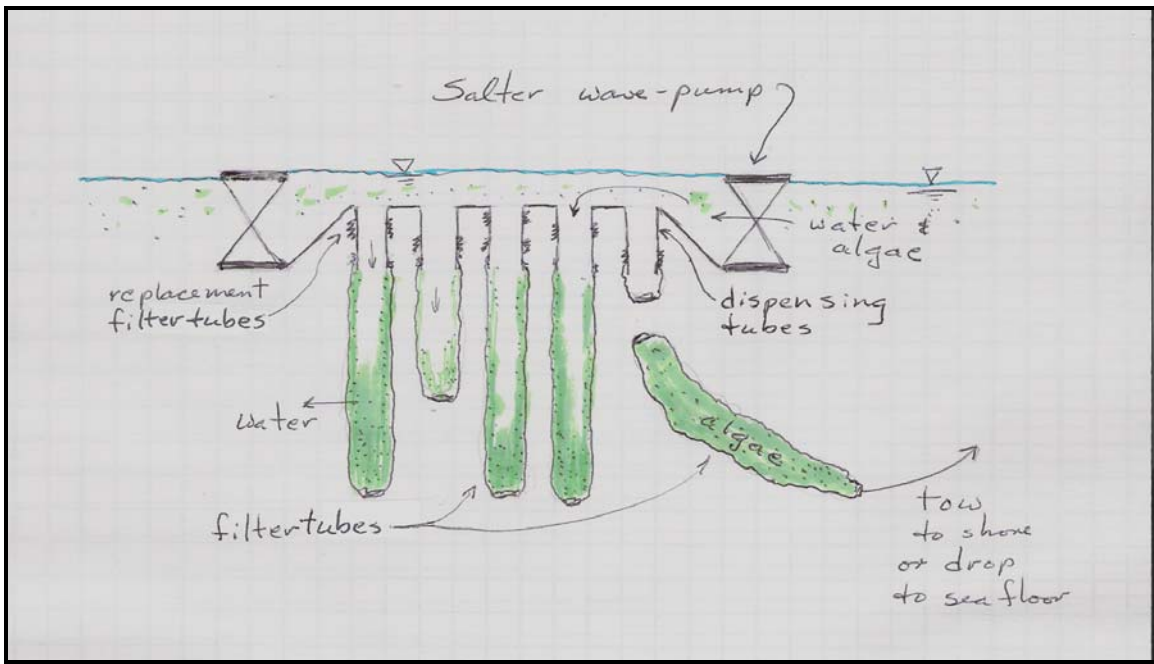


Figure 1 – vertical section of wave-pump algae-filter

The filtertubes have been prepositioned, while open on both ends, on dispensing tubes. As each filtertube is filled with algae, it is pulled off the bottom of the filtertube dispensing pipe. The pulled-off and algae-filled tube is then transported to an energy conversion facility or disposed on the sea floor.

During underwater transit, the algae can be dewatered with constricting bands around the filter tubes. While stored on land or transported on a barge the water will continue draining from the filtertube and improving the energy density of the remaining algae. Energy conversion possibilities include co-firing with coal or bacterial production of methane in gas-tight containers. It may be economic to recycle the tube filters, in which case they may be turned inside out to extract the algae or bacterially digested remnants.

As each filtertube descends on the dispensing pipe, a mechanism (not shown) closes the end of the tubefilter. The mechanism may be a drawstring that can double as a tow line. Or each end of the filter tube may have springy bars. The springy bars are held open by the dispensing pipe, but close as they slide off the dispensing pipe.

Each dispensing pipe carries several pre-positioned filtertubes. As one filtertube is filled and removed, a replacement is pulled into position for filtering by the departing filtertube

The wave-pump algae filter may be moored or free-floating as it dispenses algae filled filtertubes with relatively little attention. The Salter wave-pump has provisions for using the wave energy to propel the wave-pump to new locations or to hold a location against moderate wind and current.

## Capturing algae on the beach with textiles

A different kind of wave-pump may be employed on a beach in the surf-zone. It is constructed almost entirely of sand-filled textile tubes. Figure 2 is a vertical cross-section of the beach wave-pump taken perpendicular to the shoreline. On the right is the ocean with a broken wave running up the beach. The right-middle is a ramp formed from sand-filled textile tubes. The middle is an area enclosed by the sand-filled textile tubes that has been filled with algae-containing water from previous waves. On the left a filtertube extends from the wave-pump. In plan view (not shown) the ramp is parallel to the beach and the other three sides are straight sections or an arch of sand-filled textile tube. The beach wave-pump may or may not employ an impervious liner. Without an impervious liner the water will leak slowly through the sand-filled textile tubes at a rate determined by the qualities of the sand filling material. This leaking may be substantially slower than that draining through each filtertube.

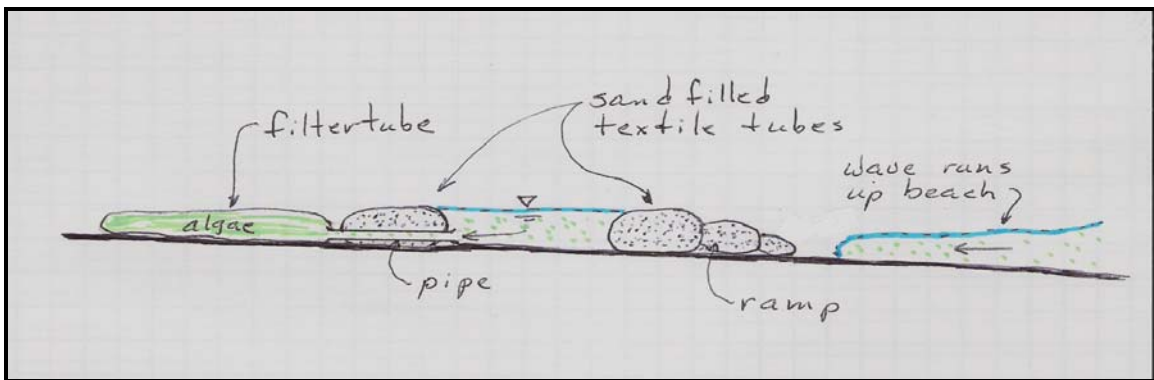


Figure 2 – Vertical section of beach wave-pump with algae filtertube

The relatively fast escape for water would be via the algae filtertubes, which are laid out horizontally. Waves will wash water and algae up the ramp and into the enclosure. The water will escape the walled enclosure via the pervious filtertubes. The algae will be retained in the filtertubes.

Another alternative, when dealing with some thick wet algae deposits, the same type of dredges used to fill the textile tubes with sand could fill filtertubes with algae directly.

The beach wave-pumps can be located at different elevations along the beach to address tidal changes in sea level. When a wave-pump is left dry by the retreating tide, people and equipment (shovels, front loaders, and suction systems) can dump algae inside the wave-pump walls. The return of a higher tide will bring waves to fill the beach wave-pump, which will then push the algae into the filtertubes. The filled tubes can be floated and towed to sea and transported to a facility where they are recycled for energy or fertilizer or both. The energy conversion may be a bacterial anaerobic digestion process or co-firing with coal or other biomass.