Self-powered Dechlorination

This article introduces a creative approach to eliminate some harmful chemicals from drinking water as one of the 100 innovations that shape “The Blue Economy”. This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market
The world market for chlorine in 2010 is estimated at $24 billion dollars, based on a global production capacity of 80 million tons. Whereas the United States has lost 1.3 million tons in production to attain 13.8 million tons for the same year, Europe gained 500,000 to reach just over 9 million tons, it is China that added massive output capacity reaching 25 million tons in 2010 representing about one third of the global market. While global demand is set to expand between 2011-2015 at an annual rate of 4.4 percent, the Chinese are expected to increase their capacity in 2011 with an additional 2 million tons.

Chlorine is produced by subjecting ordinary salt to an electric current. Since chlorine is highly reactive with water, mercury was used to neutralize the process. The American chlorine industry still consumes 79 tons of mercury for approximately 14 million tons of chlorine. The European industry has committed to phase out all mercury by 2020 but admits to still release 0.93 grams of mercury per ton of chlorine. Chlorine was invented in Sweden by Karl Scheele over two centuries ago. The City of Pittsburgh was - exactly one century ago - the first one to blend sodium hypochlorite (or chlorine) into public drinking water to control bacteria. This lead to a dramatic increase in demand, and a markedly reduction of epidemics.

Chlorine dissolved in water reacts with iron and manganese, and subsequently reacts with bacteria effectively controlling the spread of diseases. However, cyst forming protozoa (Cryptosporidium) cannot be eliminated even in high concentrations. The American Wisconsin State Hospital established that 80 percent of residual free chlorine enters the human body through skin absorption. While most effective for decades in public health management, chlorine does cause allergies and has been linked to cancer, arteriosclerosis and anemia. The chronic accumulation causes protein damage that leads to dry hair and rashes, and creates a large number of free radicals which accelerate aging.
The Innovation

Ever since the United States Environmental Protection Agency (EPA) advised municipalities to reduce and limit the amount of chlorine in drinking water, there has been a broad search for alternatives. However, its use is mandated by laws and ordinances. Public health officials are reluctant to substitute chlorine, or try alternative chemicals like the powerful triclosan (polychloro phenoxy phenol) which run the risk over time to cause even more unintended consequences. The advantage of chlorine is that its adverse impacts are well known. The option has been to continue to apply chlorine into drinking water systems but have it removed before consumption. The use of filtration based on activated charcoal, minerals or even ionic exchangers have resulted in a major new growth industry with hundreds of suppliers. However, the filters are wasted ending up in landfills continuing to contaminate and often rely on higher energy consumption than was required to make chlorine in the first place.

Hu Bor Yu, Liu Chen Panc, Liang Teh Ming, researchers at the Industrial Technology Research Institute (ITRI) of Taiwan observed how the flow of (chlorinated) water, contains kinetic energy, which his colleagues successfully exploited to generate electricity. This electric power generated by the pipe flux increases its laminar flow by applying a simple geometric change, the pipe turns smaller. The electricity thus generated is applied to the anode, and the created electrolyzer eliminates in situ the chemical potential of residual chlorine. The process requires no external energy, does not consume any materials, reacts fast in the flow of the water at the instant itself, is durable, cheap to install and requires no maintenance. The performance improves as the flow rate increases and the water temperature rises.

The potential applications stretch beyond chlorine. The same process can destroy perchloric acid (HClO₄), sodium sulfite (NaSO₃) and related impurities in water that are detrimental to our health. This creates an innovative approach to water purification where traditionally chemicals and filters have dominated the market. This implies that "something is substituted by nothing", or that chemistry has been (partly) replaced by physics, two core characteristics of The Blue Economy.

The First Cash Flow

The research team of ITRI quickly concluded that this technology finds a broad use in homes where the detrimental effect of (excessive) use of chlorine is well documented. The installation of this self-powered dechlorination device in combination with the generation of lights that indicate the temperature of the water through self-powered sensors offers a further bundling of innovations that render the home safer. And, when the water temperature increases, the efficiency of chlorine removal improves. These devices are low cost and since no additional wiring is required, it offers a platform for many eager entrepreneurs ready to enter the market.
The Opportunity
Whereas home use is an obvious first market entry, its application can be combined with numerous other innovations, like the vortex in the production of ice where the presence of chlorine requires more energy to freeze water, thus adding another energy saving element without requiring expensive apparatus. And, since the energy generation from the flow of water has been proven in high volume systems, only generating a minimal flow reduction while generating 50 Watts of electricity powering strong LED lamps, the system is ready for industrial size applications like the production of ultra-clean water for the food and drinks processing industries which today rely on expensive filters which need monthly and sometimes weekly replacements.

While it is impossible to hide a preference to eliminate the use of chlorine altogether, we cannot have the perfect stand in the way of the good and the better. Since the use of chlorine in drinking water is often regulated, the option offered by the self-powered dechlorination device permits us to operate in this world of transition. It also provides for a period to introduce substitutes, and going beyond the stigma of chlorine, permitting to remediate sources of pollution in a material and energy efficient way. This offers a platform for entrepreneurship that generates jobs, one of the priorities of The Blue Economy.

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