Edition 2019 Number 2
Bimonthly Newsletter

# S-team news

## The development of a new concept of water purification

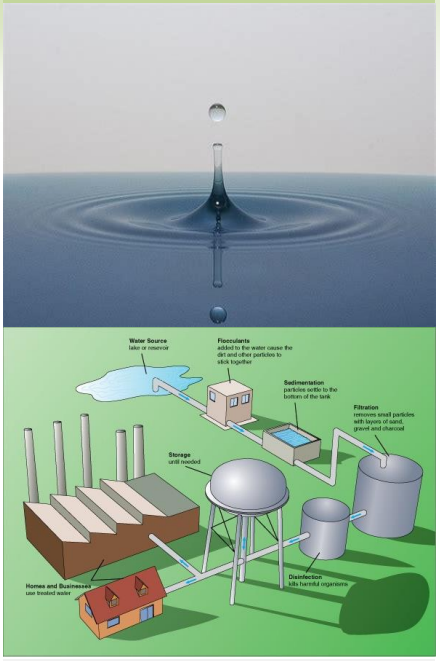
This concept is based on a heat treatment associated with physical treatment of wastewater rather than the currently used biological treatment that requires large costly facilities. This technology allows:

1. Reduce the production of greenhouse gases such as methane that emerges during the biological treatment of water;
2. Reduce the use of consumables (filters, flocculation agents) to limit the impact of water treatment on the environment;
3. Reduce investment needs. In fact, sewage treatment plants induce significant costs in construction and maintenance;
4. Recycle wastewater by separating water qualities from the source according to their dedicated use.

Wastewater treatment is an important source for the GHG emission (Campos J. L and. Al., 2016). In fact, biological treatment of wastewater produced three GHGs: carbon dioxide from the respiration of bacteria that degrade substances dissolved in water but above all methane resulting from the degradation of organic substances and whose Global warming potential is 25 times more potent than $CO_2$ and nitrous oxide ($N_2O$) associated with the denitrification process. The overall global warming potential of $N_2O$ is 298 times higher than that of $CO_2$. Even more than the abandonment of fossil energy, it is essential to find new water treatment processes that are treated for unsuitable uses in terms of demographic forecasts for the next decades in order to reduce the GHG emission. The thermal process promotes the removal of substances dissolved by precipitation rather than by biological treatment (which causes a methane emission). In addition, the use of cage molecules (cyclodextrins) to trap pollutants is much costlier (Nagy, ZM et. al., 2014).

Advantages of the LFree technologies are (1) The compactness to the installation required for individual use; (2) Robustness: Thanks to optical systems made of plastic (PMMA, solid and lightweight) rather than glass (heavy and brittle therefore difficult to carry); (3) The simplicity of assembly: which allows a transfer of technology to the developing countries without requiring costly investment; (4) Optimization of the capture of solar energy by a follow-up of the stroke of the sun on its two axes (which does not allow the LFR technique); (5) The benefits of a hybrid system that ensures the generation of electricity regardless of weather conditions; (6) The decentralization of electricity generation systems and its sharing via a smart-grid and (7) Decentralization of sewage treatment systems thus a significant reduction in investment that promotes the local economy by lowering the tax required to finance the maintenance and operation of infrastructure.

Its drawback remains that it uses fossil fuel in part for its operation but greatly reduces the consumption and the polluting emissions thanks to a modification made at the level of the internal combustion. In addition, it is planned in the medium term to carry out a module capable of recapturing the carbon dioxide emitted to produce the biofuel necessary for its operation. The goal is to obtain an almost zero carbon balance. For questions of patentability of the process, it cannot be described in this article, but a modeling of its functioning allows to compare its effectiveness based on 2 situations: a sunny day and a rainy day. However, electricity production depends on the possibility of converting natural (renewable) energy streams. However, technologies based on solar thermal energy have the disadvantage of requiring direct radiation but are more efficient in tropical zones while the technologies based on the photovoltaic effect can also work from diffuse radiation or reflected radiation (albedo) but are more effective when the ambient temperature is reduced (temperate countries). Consequently, hybridizing these 2 technologies brings advantages in reducing pollution and Green House Gaz Production.



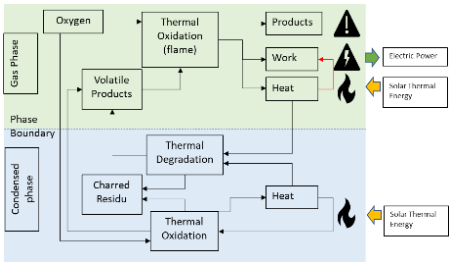

## Content

## A new Waste Water treatment plant technology to lower GHG emissions

The difference in electric generating systems is linked to the use of rotating machines (for solar thermal) or not (photovoltaic effect). The first advantage of rotating machines over photovoltaic technology is that it ensures a buffer zone safeguarding the balance between the energy demand and the supply available during the shutdown and start-up phases. The second advantage is Electric Power production efficiency that is clearly in favor of thermal engine converting mechanical energy into electric power.

By comparing modelled data for different weather situations that ensure the maintenance of electricity production (without however guaranteeing the same levels of production), it is understood that the use of fossil energy ensures half of the power generation. It can therefore be inferred that the system theoretically allows a fossil energy saving of 50% per sunny day and the modification of the internal combustion cycle associated with wastewater treatment could save more fossil energy and further reduce the emission of greenhouse gases induced by the biological treatment of wastewater and the production of methane (Fisgativa et al, 2017). On the other hand, if we compare the energy expenditure associated with sewage treatment plants and look at the biochemical oxygen demand for five days (BOD5), a parameter of water quality, we can see that the energy expenditure depends on the technology used. Thus, depending on whether an activated sludge station (less intensive with 3.2 kWh/kg bod5) or sequential biological reactors (SBR) or a membrane bioreactor (BRM) is used, the electricity expenditure varies for its operation. It was evaluated at 1,046 kWh/m$^3$ of water for a small sewage treatment plant (Singh et al., 2012).

The conversion into chemical energy by using the photovoltaic effect of solar radiation makes it possible to optimize the overall efficiency through the improvement of the internal combustion of the thermal engine. By the Association of Internal Combustion which supplies its lost heat to a micro-turbine which uses in main supply, the heat provided by the solar radiation for its operation and in secondary supply a chemical energy which modifies the Combustion parameters of the fossil energy used. This maximizes the yield by increasing it (15-20%), reducing the production of the unburned (by 60%) in the form of fine particulates and/or greenhouse gases. This also induces:

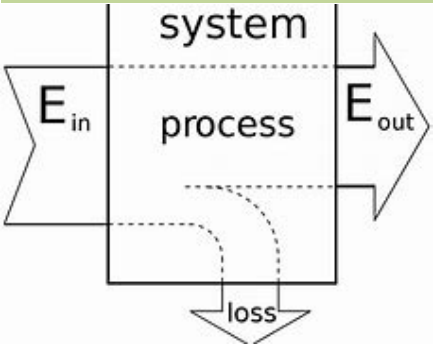



1) Optimization of lost heat recovery that promotes conversion to mechanical energy thus improves overall performance.
2) The optimization of the conversion of mechanical energy into electrical energy via a micro-turbine that exploits the transfer of energy in the boundary layer during the flow of a fluid (steam) in a smooth and rough mode thus improves the yield.

## The most burning news: Wastewater Management in the Wider Caribbean Region (WCR)

For decades, wastewater management has been a growing problem for the Wider Caribbean Region (WCR), a problem that regional governments have long understood as a threat to the economy, the environment, and to public health. In the Caribbean, most wastewater from cities, industry, and agriculture pours directly into surface water or into the sea completely untreated, degrading residents' quality of life, as well as the region's biodiversity, pristine blue waters, and reefs, which are the lifeblood of the vital tourism industry. Recent studies have shown that untreated sewage is one of the major threats to public health and the Region's rich biodiversity and is the result of rapidly expanding urban populations, poorly planned development, and inadequate or poorly designed and malfunctioning sewage treatment facilities. As a result, 85% of wastewater entering the Caribbean Sea remains untreated. 51.5% of households lack sewer connections and Only 17% of households are connected to acceptable collection and treatment systems (Source: Caribbean Regional Fund for Wastewater Management). This contamination is affecting ocean aquatic life (Méndez-Fernandez et al., 2018)

However, pesticides such as Chloredecone have been widely used in French west indies and contaminated the groundwater. Since the substance is classified as "carcinogenic, probably carcinogenic, or possibly carcinogenic to humans" and that it does not degrade over time. It is a major Public Health issue: It is fixed in soils and poorly soluble. Only percolating water can disperse it by dragging it to the groundwater and represent a long-term threat for human consumption of water and contaminated food (Multigner et al., 2015). Water treatment plant are unable to remove or degrade it although no thermodynamic reasons why chlordecone-respiring or -fermenting organisms should not exist (Dolfing et al, 2012). Both biological treatments and UV treatments remain quite ineffective and time consuming. A thermal degradation at 500°C for 1 second appears to be possible (Duvall et al, 1976) whereas *Methanosarcina thermophila* degrade the pesticide to 85% in 10 days (Jablonski et al, 1996).




## The LFree project: Adaptation of energy storage systems

Choosing the appropriate storage according to the type of energy produced in excess (thermal, chemical, mechanical, electrical) makes it possible not to have to resort to multiple conversions and conversion when one must capture energy flows of different nature. This helps to limit the loss of energy. Thus, the use of a flywheel allows to conserve the mechanical energy in its original form for medium-term use when the solar flux no longer allows to produce enough steam to operate the turbine. Moreover, the use without transformation of the direct current produced by the photovoltaic panel in alternating current makes it possible to optimize the production of mechanical energy and chemical energy.

The success of such a project depends heavily on the involvement of local actors such as local small and medium-sized enterprises that could benefit from technology transfer, with local authorities that should allow local regulation. The use of such technology to obtain drinking water and electricity and public subsidies from institutions such as the EU or UNESCO to recognize the usefulness of this new technology and to give it visibility. In addition, this project is fully in line with the implementation of the COP21 agreements providing for technology transfer to the countries of the south to reduce GHG emissions.

*Global warming isn't a prediction. It is happening.*

***James Hansen***

## Financing of the LFree project

The LFree project has been financed on private funds to obtain the proof of concept and make sure that such a technology could provide not only electric power but also safe drinking water while reducing the environmental impact.

Now the LFree project has to go further the proof of concept and study the economic viability. Indeed, poor countries mostly rely on old technologies (thermal power stations and Hydroelectric dams) that either pollute or damage the ecosystems. They necessitate huge investments. The goal is now to build an operating pilot and monitor it production of electric power ad safe drinking water. The feasibility of operating devices manufactured on site and able to work with each other to provide enough electric power and safe drinking water must be studied but necessitate European grants to finance the study.

European subsidies require at least equivalent private financing. As a consequence, Bio-S-Team is preparing to open its capital and to start a fundraising campaign by crowdfunding on Indiegogo soon.

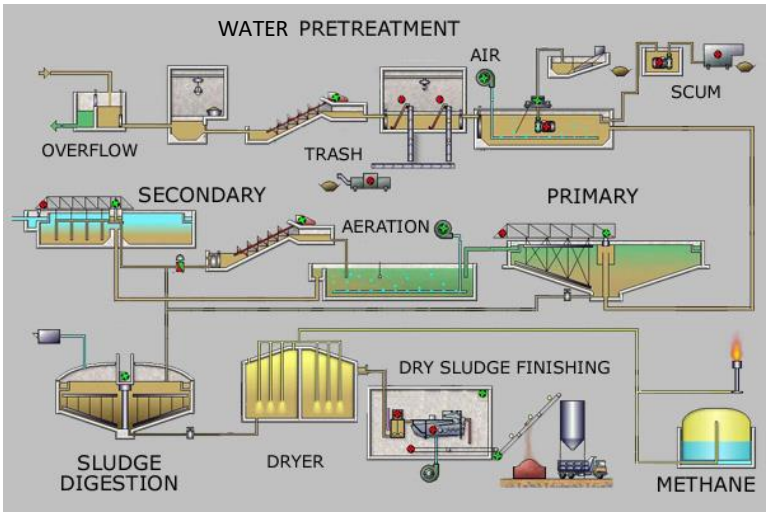
## The most burning news: breakthrough in steam generation, superheating technics and catalytic activities

The MIT recently published a new approach on steam generation from solar energy (Cooper et al., 2018). This technology provides the basis for new processes of sanitation or desalinization technologies by successfully generate steam with temperature up to 133°C under one sun illumination. The heat transfer process produce steam through a super heater constituted with a porous reticulated vitreous carbon foam, leading to superheated steam in a non-pressurized system. This technology might be improved since the Kyoto University researchers have designed a temperature-controllable, copper-based material for sieving or storing gases (Chu et al., 2019). Indeed, soft materials such as porous coordination polymer (PCP) can exhibit temperature-dependent flexible motions of their internal pores that can assist in gas separation and storage.

It opens a new field to drinking water production using nanoporous materials as heat recovery (solar energy, heat pump, air conditioning, cooling) is a key research focus toward reducing power consumption and encouraging sustainable development. Researchers from the Paris porous materials Institute (CNRS, ENS Paris, ESPCI Paris/ PSL University) and from the Charles Gerhardt Institute in Montpellier (Université Montpellier/CNRS/ ENSCM) have discovered a new hybrid porous material that is robust and synthetized through a "green chemistry" route (Wang et al., 2018).

On the other hand, a significant advance in the photocatalytic activity of conventional materials is demonstrated by a two-dimensional heterostructure comprising nanolayers of two semiconductors: black phosphorus and bismuth tungstate. As researchers have reported in the journal *Angewandte Chemie*, this catalyst harnesses the energy of visible light to split water and produce hydrogen, and to break down nitrogen monoxide in exhaust gas (Hu et al., 2019). This technology could potentially reduce atmospheric pollution.

These successful technological advances show the way to perform chemical processes, such as taking up a particular molecule ($CO_2$, $NO_2$ or $O_3$) from its surroundings, in response to an imposed change in the surrounding solution. Indeed, Scientists from the University of Liverpool have, for the first time, synthesized a new material that exhibits structural change and triggers chemical activity like a protein (Katsoulidis, et al., 2019).




*It doesn't make sense to argue about how much global warming is caused by man*

***Lisa Murkowski***

# A new environmentally friendly water treatment

Using water that has been treated for various purposes such as cleaning, toilets, gardening, is damaging the environment. Indeed, water treatment generates large quantities of greenhouse gas (GHG) and sewage sludges. One way to drastically reduce GHG emission is to separate water qualities according to its purpose at the source so it does not need to be undergo an anaerobic process and do not generate large quantities of GHG. However, water treatment producing GHG may be used to generate electric power (Lochet et al., 2012; Benali et al., 2019)

Furthermore, flocculants and coagulants may be sources of environmental and health concerns. For example, the use of Alun (Aluminum disulfate) for water treatment is questionable since a direct link between Alzheimer disease and aluminum is actually controversial (Inan-Eroglu et al., 2018).

The LFree project enables a water processing adapted to its end use. Indeed, using untreated water for gardening and toilets, disinfected water for showers and laundry and purified water for cooking and drinking allows to greatly reduce the production of GHG induced by the biological treatment of large quantities of water that are not necessary. It also lowers sludge that may contain pathogenic organisms or flocculating agents that can be harmful to the environment. The LFree technology also produces solid material after treatment (mainly composed of fulvic and humic acids precipitated by reaching their solubility product). However, this sludge is free of pathogenic bacteria (because of the thermic treatment).

## Bio-S-Team

info@bio-s-team.com

*Bio-S-Team, a company focused on biotechnology and sustainable development*

Find us on the Web : http://www.bio-s-team.com/

## Is photovoltaic technology really adapted to topical area?

Both the electrical efficiency and the power output of a photovoltaic (PV) module depend linearly on the operating temperature. The operating temperature plays a key role in the photovoltaic conversion process since solar cell performance decreases with increasing temperature (Dubey et al., 2013). On the other hand, the lifetime of photovoltaic modules depends on the thermomechanical stress in solar cells (Azeumo et al., 2019) as it is the case for concentrated solar power (CSP) technologies. However, CSP technologies does not have as poor biodegradability and environmental toxic substances as photovoltaic panels have. PV power plants have carbon footprints which, on a lifecycle basis can range from 12g $CO_2$ per kWh for a facility using First Solar's thin film modules, to as much as 24 g $CO_2$ per kWh – for one using multi-crystalline silicon panels. In one hand, Carbon Footprints of various PV-systems scenarios are greatly smaller than that of a diesel power station operation (Stylos et al., 2014). On the other hand, CSP systems have associated emissions that range between 14 and 32 g $CO_2$/kWh (IPCC, New York, 2013); Viebahn et al., 2008). All these data indicate that CSP are more efficient and environmentally friendly in tropical areas.

Follow us:

Subscribe to the Newsletter here