BioSol Water Recycling LIFE project:
A new concept for wastewater treatment and reuse, and bioenergy production.

S. de La Rochebrochard[a], C. Narváez[b], J. Vázquez[c], C.A. Aragón[d]

[a]HELIO PUR TECHNOLOGIES, 139 rue Philippe de Girard, 84120 PERTUIS, France, s.delarochebrochard@heliopure.com
[b]COLDEP, route de Maguelone, 34250 Palavas Les Flots, France, cesar.narvaez@coldep.com
[c]FCC AQUALIA, EDAR Guillarei, Camino de la Veiga s/n, 36720 Guillarei (Tui) Spain, jvazquezp@fcc.es
[d]CENTA, Autovia Sevilla-Huelva km28, 41820 Carrión de los Céspedes, Spain, caragon@centa.es

INTRODUCTION

Water scarcity and drought is an increasingly frequent and widespread phenomenon in the European Union (EU). It was estimated that by 2007, at least 11% of Europe's population and 17% of its territory would have been affected by water scarcity, putting the cost of droughts in Europe over the past thirty years at EUR 100 billion (EC, 2012). Improving quantitative and qualitative water management as well as water treatment efficiency has become an increasing challenge in present times.

The BioSol Water Recycling LIFE project (**www.life-biosol.eu**) deals with this challenge by offering a cost-effective and efficient solution in closed systems (transparent tubular reactors) which will permit to save fresh water for reuse and prevent Green House Gases (GHG) releases. The project's objective is at least 80% of water recovery for reuse. BioSol Water Recycling project paves the way to a better water resources management in small and medium size communities where physico-chemical tertiary treatments such as reverse osmosis are not competitive.

4 entities are involved in this demonstrative action: HELIO PUR TECHNOLOGIES (France), FCC AQUALIA (Spain), COLDEP (France) and CENTA (Spain).

METHODS

The setup of the BioSol Water Recycling LIFE concept was planned in two demonstrating stages:

- **Demo 1**: Treatment capacity of 13 $m^3.d^{-1}$ (installed in the CENTA's R&D facilities)
- **Demo 2**: Treatment capacity of 50 $m^3.d^{-1}$

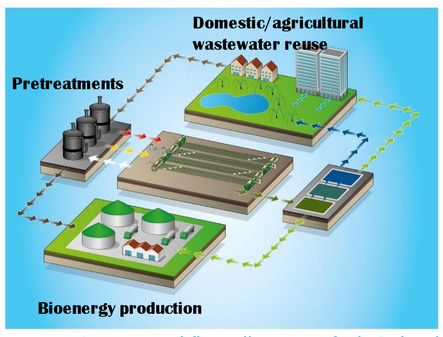

Figure 1 : Conceptual flow-diagram of BioSol units

Figure 2 : Recycling concept (BSP/VAL) view in Demo 1 site

The BSP units have been developed by HPT. They consist on 16 transparent treatment tubes (125 mm diameter, 65 m length each, 128 m^2), 4 feeding and collecting tanks connected to 2 Coldep® Vacuum Air-Lifts (VAL) columns for water circulation, O_2 stripping and CO_2 dissolution (1400/700 mm downward/upward column diameters, 6.2 m height) designed and provided by Coldep. The total system capacity is **37 m^3**.

Anaerobically pre-treated wastewater from Imhoff tank is treated by the BSP/VAL unit. After this process, water is conducted to a separation step ensured by a Coldep® VAL column (630/315 mm downward/upward column diameters, 4 m high) to obtain clarified water. The latter is reused for irrigation whereas the concentrated biomass (namely, algae) is released in a digestion unit provided by FCC AQUALIA. All the gathered information will be summarised in a Life Cycle Assessment (LCA), led by CENTA.

The results presented in this poster deal with :

- **Hydraulic** trials: optimal working range assessment for water circulation.
- **Individual batch treatment and separation trials** for process optimization. Treatment trials have been performed during 6 days at constant velocity (0,17±0,02 $m.s^{-1}$), volume and sunlight intensity (5 $kWh.m^{-2}.d^{-1}$) taking samples at 8 am and 8 pm every day.

RESULTS & DISCUSSION

1) Hydraulic trials

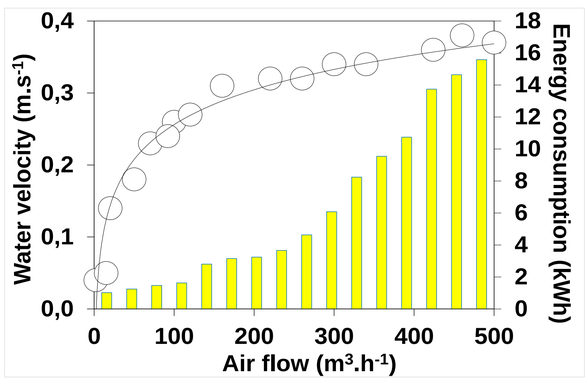

Figure 3 : Hydraulic performances : water velocity as a function of air flow rates in VAL columns

Water velocity ranges from **0.04 to 0.38 $m.s^{-1}$** inside each tube (Figure 3), thus overcoming the 0.25 $m.s^{-1}$ settling threshold according to Stokes law while allowing the transport of organic matter particles. A velocity ranging from 0.3 to 0.5 $m.s^{-1}$ was reported as ensuring enough turbulence so that microalgae cells frequently move to the better illuminated peripheral zone and thus not starved of light for extended periods (Molina et al, 2001).

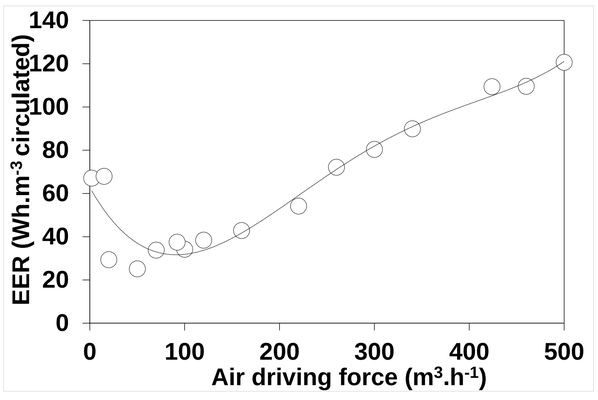

Figure 4 : Energy consumption for water circulation in VAL columns

Among the existing circulating techniques, in optimized conditions, VAL columns require the lowest energy consumption per m^3 circulated water (up to 3 Wh/m^3 whithout head losses), compared to axial pumps (10 Wh/m^3) and centrifugal pumps (200 Wh/m^3).

RESULTS & DISCUSSION

2) Treatment trials

First treatment trials have been performed in BSP/VAL unit on a batch mode in order to assess kinetics, using wastewater from Imhoff Tank (Table 1).

Table 1 : Imhoff Tank wastewater characteristics

Parameter	COD	COD_{sol}	BOD_5	$BOD_{5\ sol}$	TN	$N\text{-}NH_4$	$N\text{-}NO_3$	TP	$P\text{-}PO_4$
Concentration (mg/L)	437	213	260	115	68,2	57,2	<5	9	6

Organic matter is degraded by bacteria/microalgae microorganisms and N-NH4 is assimilated for protein production through photosynthetic phenomenon (Cai el al, 2013) (Figure 5).

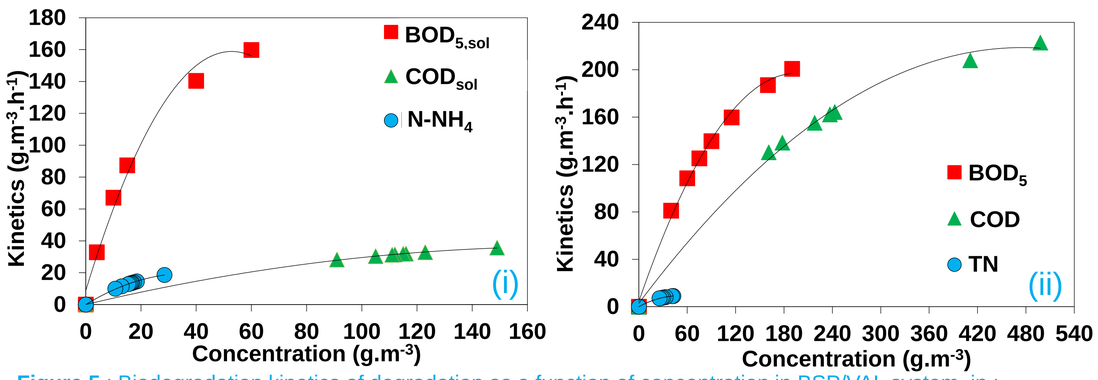

Figure 5 : Biodegradation kinetics of degradation as a function of concentration in BSP/VAL system in : (i) soluble ; (ii) total fractions

3) Separation trials

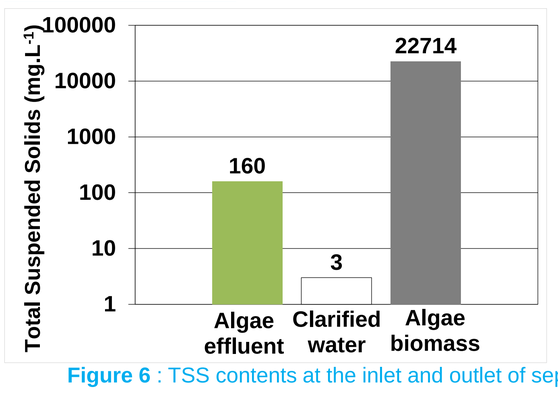

Figure 6 : TSS contents at the inlet and outlet of separation process

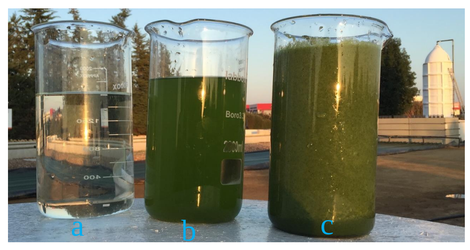

Figure 7 : Clarified water (a), algae effluent (b) and algae sludge (c)

The VAL harvesting column is able to concentrate algae biomass up to 2.2%. Total Solids content, prior to valorization for methane production by digestion, while TSS concentration can be reduced from 160 to 3 mg/L in wastewater (Figures 6 and 7).

CONCLUSIONS

➢ Hydraulic trials allowed determining sizing diagrams and optimal working range

➢ Treatment trials have shown degradation kinetics regarding targeted parameters for water treatment and will be followed by separation trials

Following studies are being conducted :

- Comparison of the effect of water velocity on BSP/VAL process performances
- BSP/VAL and VAL separation processes in continuous mode
- Treatment and reuse performances assessment for agricultural reuse
- Biomass valorization through methane and/or fertilizer production

➢ The final unit able to treat and reuse **50 $m^3.d^{-1}$ of wastewater** will be operated in the WWT plant of Almeria by the end of 2016.

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