SEVENTH FRAMEWORK PROGRAMME

Research for the benefit of specific groups
Research for SMEs

Operation SWAT

Algae Harvesting Technology

The initial stages of bench-scale sieve tests show that flocculation processes may be required to achieve acceptable harvesting efficiency and capacity. This is, however, very dependent on the type of algae, and extensive pilot scale harvesting experiments is still to be done. The development of the new technology is yet at a very early but promising stage, with the goal of 95% algae recovery at 40% lower costs than the best state of the art technology within reach.

Microalgae has been researched and cultivated commercially for human and animal nutrition, for cosmetics and pharmaceutical applications, for biofuels and biomass production, for wastewater treatment and to some extent for greenhouse gas abatement. The production for the microalgal biomass market today alone generates a turnover of 1.25 billion US$ per year (0.94 billion €/yr) while the total algal world market is about 7-7.5 billion US$ per year (5.2-5.7 billion €/yr) and is growing, with European Union being home to 30% of this world's algae market activity.

The most critical challenge faced by all algae growers is harvesting. Harvesting is expensive and energy intensive. A group of European SMEs (Salsnes, Asio and Inwatec) has decided to work together to capture a part of the global algae harvesting equipment market. The objective is to develop a universal algae harvesting technology by building on their experiences gained from removing particles from wastewater and by modifying wastewater treatment technologies to harvest algae. **Salsnes Water to Algae Treatment (SWAT) technology** will use a flocculator followed by a Salsnes Filter to harvest algae. Two RTDs (Aquateam and HERI) will carry out research and development to achieve the objective. Two test sites have been chosen (IGV in Germany and Aqualia in Spain) to test the SWAT technology.

The goal of the SWAT technology is 95% algae recovery, 40% lower costs than the best state of the art technologies (Centrifuge and Dissolved Air Flotation) and energy consumption < 0.08 kWh/m^3 of algae. The consortium will explore the SWAT technology in the growing biofuel market (which has a projection of 1.6 billion US$ or 1.2 billion Euros by 2015) and then in other algae markets.

To date the project has identified algae species of commercial interest for biofuel production, animal feed, food, cosmetics and pharmaceuticals. Seven selected algae species have been grown in the lab. Size analysis showed that fine mesh sieves with very small pore sizes will be needed to harvest microalgae without prior flocculation. Bench-scale sieve tests, without prior flocculation showed that sieve cloths with the smallest pores blocked easily, indicating low hydraulic capacity, while larger pore sizes resulted in higher hydraulic capacities but lower removal efficiencies. The highest

harvesting efficiency achieved with non-flocculated algae was 85 %, while several algae species had significantly lower harvesting efficiency.

These direct filtration results clearly showed that the tested algae species need to be flocculated in to larger particles in order to achieve the goal of more than 90 % recovery when harvested on a filter mesh sieve. This will require the addition of a flocculation aid.

A literature review of polymers and chemicals suitable for flocculation of algae, as well as different types of flocculators, has been conducted. The possible risks associated with flocculent usage for food, animal feed, fish feed, pharmaceuticals and cosmetics were also addressed.

A lot of jar-tests have been performed, to find what chemicals or polymers that work for flocculation of different algae, and what are the optimum chemical or polymer doses. Flocculation efficiencies up to 100 % have been achieved. Particle size analysis showed the flocs to be a lot larger than the single algae, with floc sizes up to 1000 microns.

The results showed that the optimum flocculant and optimum dose is very dependent on the type of algae. Very good flocculation could be achieved with all the tested algae species, but for some species it may not be achieved at an economically acceptable chemical dose.

Many bench-scale flocculation tests have been done, as well as bench-scale Salsnes Filter harvesting work of flocculated algae. This includes finding the proper pore size for the filter mesh sieve cloths, as well as the initial procedures for cleaning of the sieve cloths. This work will continue, and has not been reported.

The design of a pilot-scale flocculator and the integration of this flocculator and a pilot-scale Salsnes Filter will be finalized very soon.

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