Recovering Microalgae Using a Salsnes Filter

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Abstract : An existing commercial primary wastewater sieve technology in conjunction with a flocculator was modified and investigated for removal of microalgae grown either in wastewater or in pure medium for different micro-algal applications. Depending on the species > 90% of microalgae recovery from water was achieved. Scientific knowledge well known from the wastewater industry was used to integrate a flocculator and Salsnes filter. The project aims to: recover microalgae from wastewater or assist in clean-up of eutrophic water bodies for bioenergy, biofuels, other applications thus making wastewater an important nutrient resource and thus reduce the overall costs of harvesting microalgae.

Keywords: Microalgae; Nutrient resource; Wastewater

Introduction

This research project is a part of European Union framework program (FP7) for SMEs comprising of several small medium enterprises (SMEs), large enterprises, universities and research organisations within Europe. The goal of this research is to develop a universal algae harvesting technology by building on the experiences gained from removing particles from wastewater and by modifying the current wastewater technologies such as Salsnes filter to remove microalgae. Salsnes filter fine mesh sieves have been successful for primary treatment of municipal wastewater and for removal of suspended solids (SS) from industrial wastewater (Rusten and Ødegaard, 2006).

Microalgae can be a resource (biofuels, bioenergy, health products and animal feed) as well as a nuisance as seen in eutrophic water bodies. The efficiency of microalgae recovery is a significant issue because it relates to the economics of the separation technique (Bratby and Parker, 2009). Presently, algae recovery is expensive and energy intensive. The overall technology involves coupling of a flocculator to a Salsnes filter to achieve high microalgae recovery (> 95%) for different micro-algal applications. Two sites where algae are presently been grown have been investigated, one, where algae are currently grown on a large scale using municipal wastewater as a nutrient source, resulting in mixed cultures of wastewater and microalgae (Rogalla, et al., 2011) for biofuel applications in Spain and using pure cultures from commercial photobioreactors in Germany for cosmetic products.

Material and Methods

In this study, initially four different commercial microalgae species and one grown in waste-water were grown in open air tray photobioreactors using natural light in a green-house with artificial medium and investigated for removal from water (aka. harvesting). The microalgae species were investigated for their shape and size using a FlowCam device (Yarmouth, ME, USA) and for harvesting by direct filtration using a bench scale Salsnes filter (Rusten and Ødegaard, 2006). SS was used as a key parameter to determine the harvesting efficiency

from water. The different microalgae species were then investigated for flocculation using commercial dewatering polymers, chemicals or a combination using bench scale jar tests. Test procedures are similar to that in Rusten and Sahu, 2011. On optimisation of flocculator speeds, dosages and removal rates, G-values were used to scale up the bench scale results to pilot scale flocculation. One litre of flocculated microalgae each was filtered through different mesh sizes (500μm –11μm) to determine high microalgae recovery. The tests were conducted both at bench scale (1 L) and pilot scale (25 L) for all the five species.

Results and Conclusions

Based on the microalgae size (Table 1.1) direct filtration did not yield significant results. Polymer and chemical dosages were optimised to get a higher floc size (Table 1). High removal of microalgae observed on filtering flocculated microalgae (Table 1.2). Rapid mixing of 300 rpm for 10-20s and slow mixing at 30-50 rpm for 5-10s was used. G values were scaled up for pilot scale using a commercial stirrer for flocculation. The challenges of integration of flocculator + Salsnes filter and other pilot data will be presented at the meeting.

Table 1.1 Microalgae characteristics and optimised dosages in mg polymer/g SS algae in water phase

Species	**Shape**	**Media**	**Average particle size[1]**	**# of particle analysed**	**Area Based Diameter range**	**Optimised dosage**	**Area Based Diameter for flocs range**
			μm		μm		μm
Chlorella vulgaris	Spherical	FW	5.07	3838	3.99±1.26	18	72.46±14.24
Dunaliella salina	Irregular	M	7.26	646	4.84±3.7	51.6[2]	41.91±9.85
Nanochloropsis oculata	Spherical	M	4.8	3805	11.49±6.92	3.5	35.29±8.66
Scenedesmus sp	Rod	FW	20.01	440	14.7±6.61	2.3	40.73±12.38
Wild type	Oval	WW	50.43	54	14.8±7.83	32	52.28±14.49

1- Based on length; FW-fresh water; M-Marine; WW-Wastewater; 2-polymer + PAX XL 60; Typical starting concentration of microalgae ranged from 1000-2500 mg/L.

Table 1.2 Percentage recovery of microalgae from respective medium using jar test flocculator (bench scale) and 25 L flocculator (pilot scale flocculator)

	Bench scale flocculation		**Pilot scale flocculation**	
Microalgae species	**% removal wrt SS**	**Best sieves** μm	**% removal wrt SS**	**Best sieves** μm
Chlorella vulgaris	93	33	40	158, 74
Dunaliella salina	70	74	31	11
Nanochloropsis oculata	76	74	92	18
Scenedesmus sp.	96	250	94	158
Wild Type algae	80	250	84	18

References

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