Algal biofilms: Use in wastewater treatment

Abstract

Preliminary studies have shown that algal biofilms grown using the rotating algal biofilm reactors (RABR) are effective in removing nutrients (nitrogen and phosphorus) from wastewater. However, unlike the established heterotrophic attached growth, implementation of algal based technology in wastewater treatment is still a challenge. There is very little information on:

1.Their performance in terms of nutrient removal and biomass productivity from bench to pilot scale operations

2. Factors that affect algal biofilm development and growth

3. Biofilm characterization

This project aimed at characterizing algal biofilms using microscopy techniques in order to understand their growth dynamics

Growth Studies

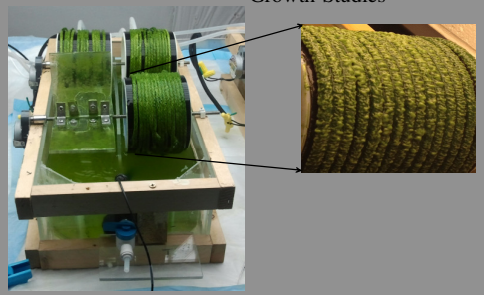


Figure 1: Lab scale RABR set up with algae from Logan city lagoons as inocula

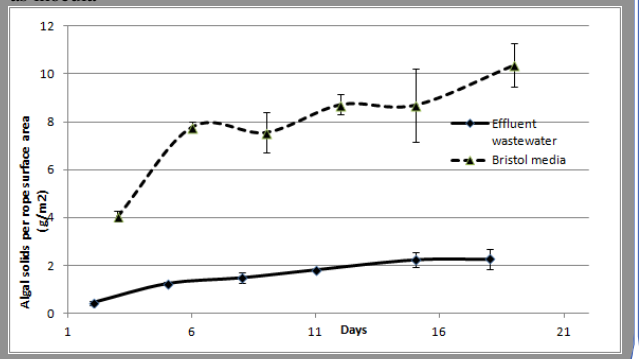


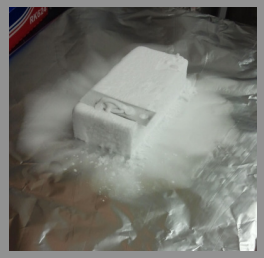
Figure 2: Biofilm growth under laboratory condition with effluent wastewater and Bristol media

Developing techniques for biofilm characterization

1. Direct imaging of algae cells using microscopy (confocal laser scanning microscopy, CLSM)
   This involved figuring out a way to sample, preserve, transport and analyze field biofilms from pilot scale RABR systems. A collaboration between the center for biofilm engineering (MSU), Bozeman –MT and USU is underway to develop a method for imaging biofilm samples on rope using single species RABR grown algal biofilms.

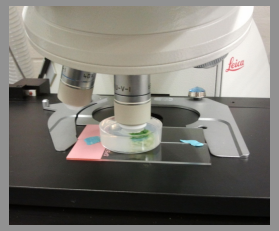
The objective was to find stains that would distinctively distinguish algal cells, the rope and other microorganisms like bacteria in the biofilm.

Figure 3: Different stain combination used on the biofilm samples.



It was easier to have clean cuts of rope (cross section) with samples frozen in embedding medium.

Figure 4: Preserving stained biofilm samples in embedding medium using dry ice.



Biofilm samples were embedded in agar and viewed as cross sections or top down sections on the CLSM. The agar prevented sample movement thus clear pictures

Figure 5: Biofilm sample embedded in agar on a CLSM

Results

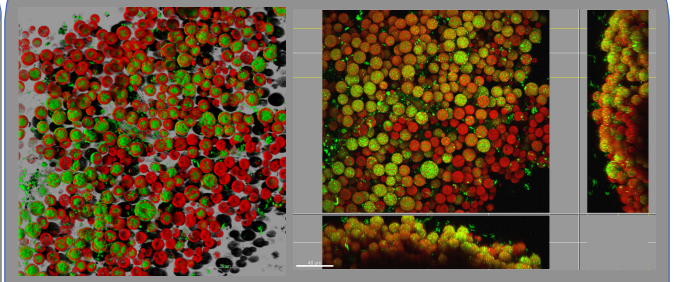


Figure 6: CLSM of suspended algae cells (left) and algal biofilm (right) of the same species

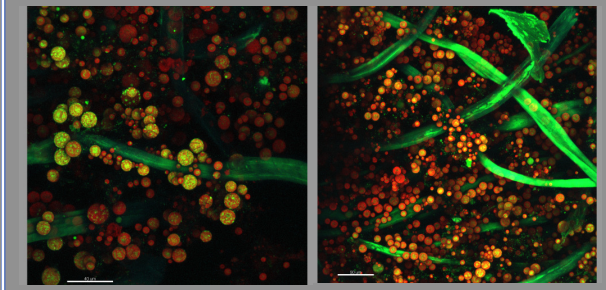


Figure 7: CLSM of algal biofilm showing cells around a rope with 63X (left) and 40 X (right) magnification

Conclusions

Single species RABR grown algal biofilms were successfully imaged using CLSM.

Further research is required for multi species mixed biofilms from pilot scale RABR

Acknowledgements

Karen Moll for the CLSM images and the entire CBE, Montana State University algal team.