Algal Remediation of Landfill Permeate:
BioEnergy Summer School 2011

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Introduction

- Over 3,500 Municipal Solid Waste landfills in the U.S.
- Leachate: aqueous landfill effluent resulting from water percolation and biochemical processes in waste.
  - Groundwater pollution (ammonia & dissolved solids)
  - Treatment and management required
- Treatment Methods
  - Transport to water treatment facility
  - On-site chemical/physical processes
  - Constructed wetland

Alachua County Southwest Landfill

- 27-acre lined cell opened in 1988 receiving about 300 tons/day and closed in 1998
- Approximately 5 million gallons of leachate need to be treated…
- Currently experimenting with a 2-phase Reverse Osmosis system for leachate treatment

Problem definition

- Landfill leachate is a highly contaminated liquid
  - Reverse osmosis (RO) is a novel treatment for leachate
  - RO is inefficient at removing ammonia
- Ammonia levels in RO permeate do not meet Groundwater Cleanup Target Levels (FL DEP).

Algal Remediation

- Growing algae as a water treatment method
  - Algae uptake nutrients such as ammonia
  - Typically associated with sewage treatment
  - Landfill permeate has potential as a growth medium due to high nitrogen content

- Benefits of Algal Remediation
  - Biomass production that can be used for fertilizer, animal feed and biofuel

Hypothesis

- Native microalgae can grow on landfill leachate pretreated with reverse osmosis.
- The algae can remediate the ammonia present in the reverse osmosis treated leachate.

Objectives

- Determine optimal cultivation system
  - Mixing strategies
    - Aerated culture
    - Impeller mixed culture

- Evaluate the impact of the cultivation system on ammonia remediation.

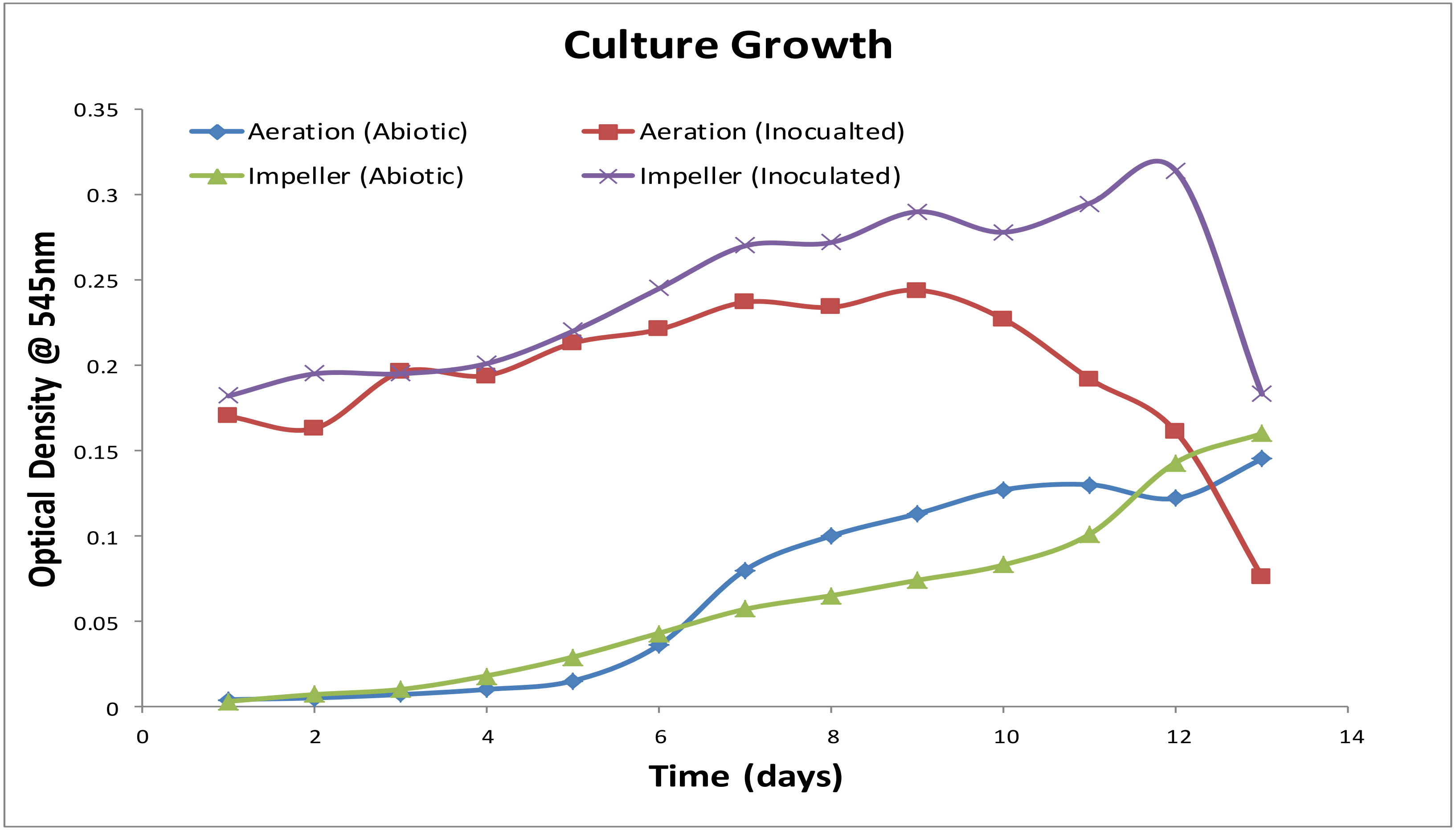
Methodology

- Experimental set-up
  - 4 cultivation chambers and one fiber glass column were used as containment vessels
  - 2 chambers served as abiotic controls (filled with 790 liters of permeate)
- Two chambers were filled with 50% permeate and 50% algal inoculum (790 liters total)
- The fiber glass column was also filled with 50% permeate and 50% algal inoculum (80 liters total)

Methodology

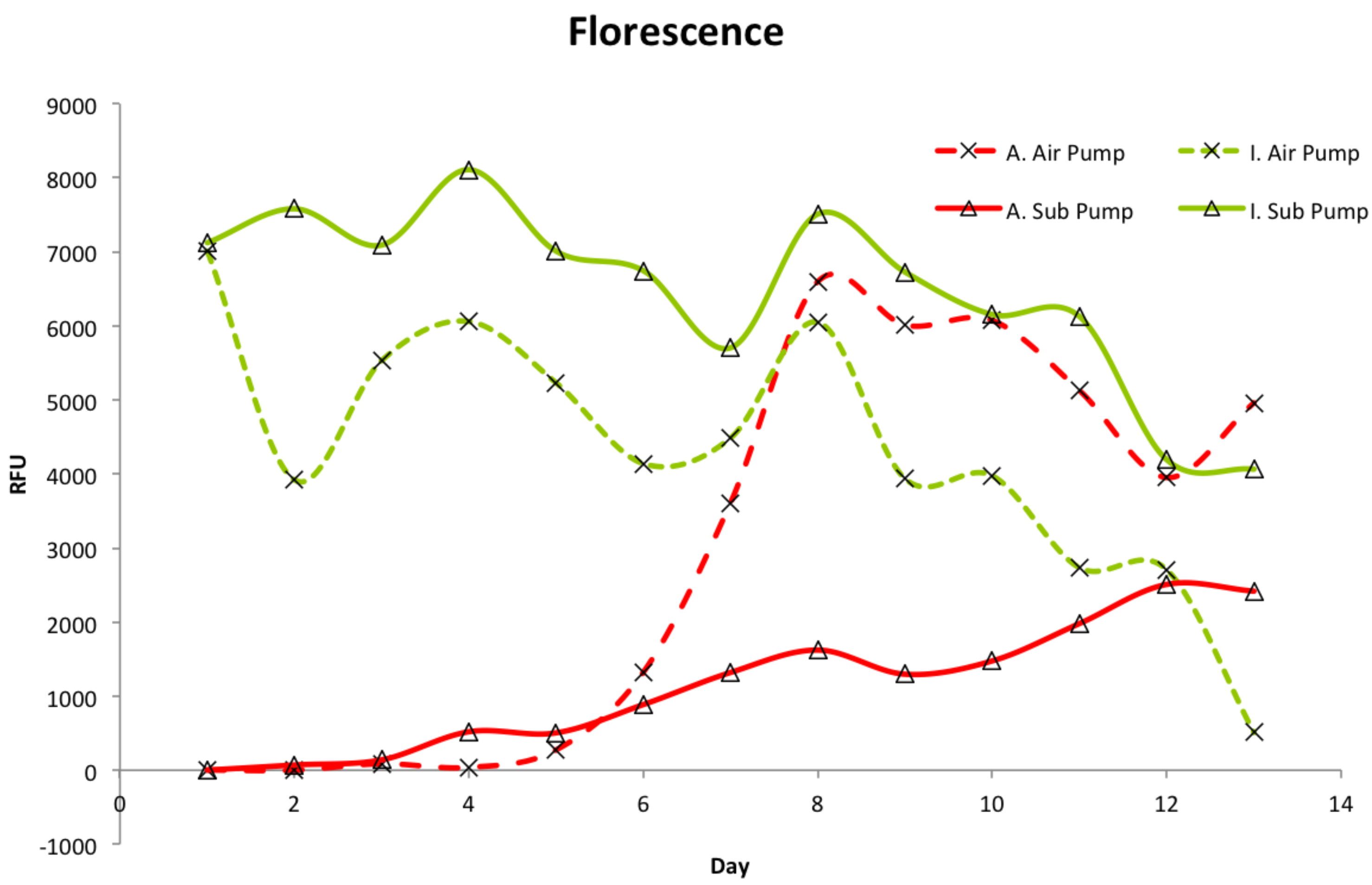
- Cultures were sampled daily and measurements were taken following Standard Methods (APHA 1998):
  - Ammonia
  - pH
  - Optical density (at 545 & 680 nm)
  - Electrical conductivity
  - Fluorescence
  - Total & volatile solids

Results

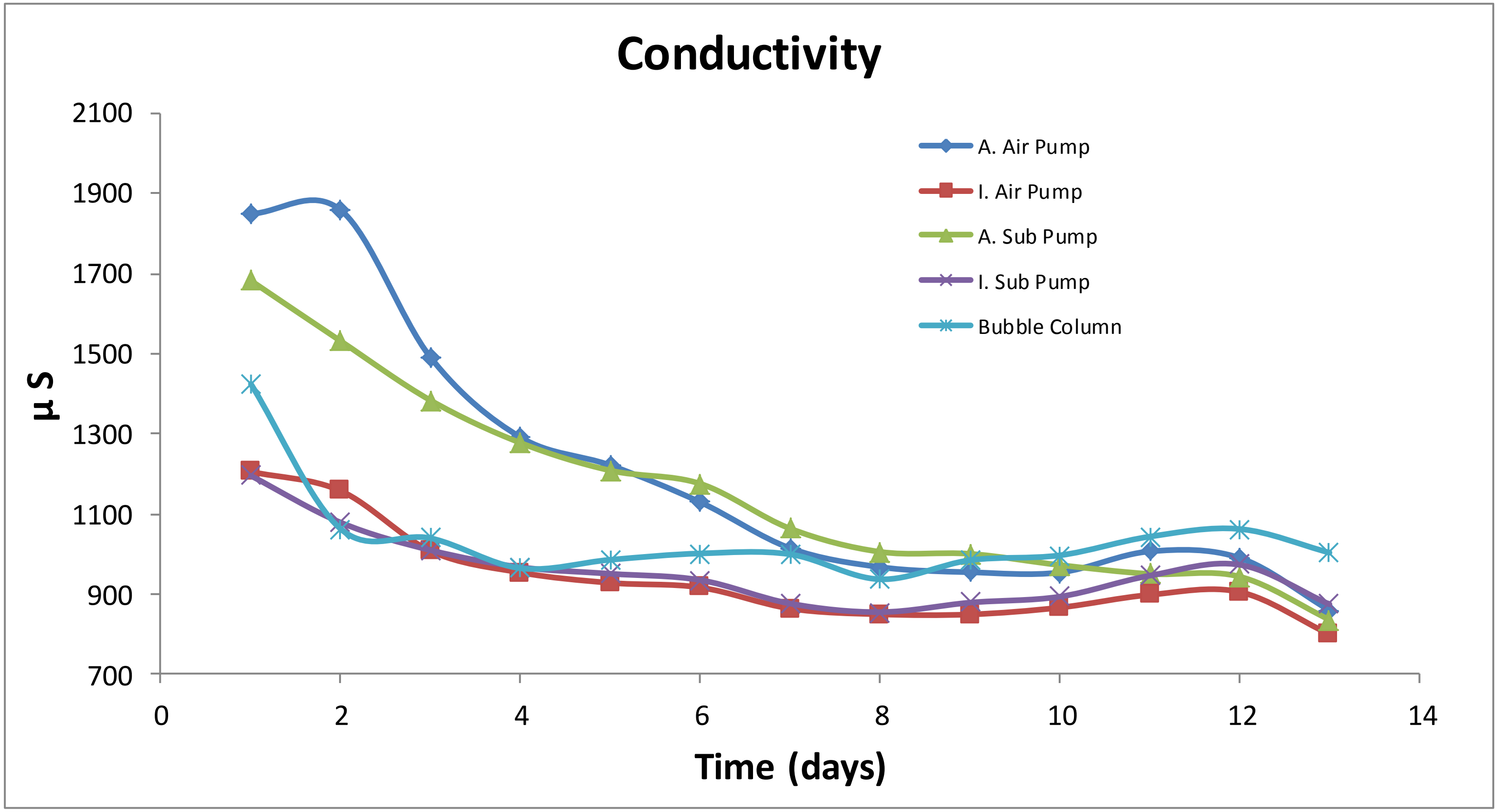


Inoculated chamber with impeller pump showed higher overall growth

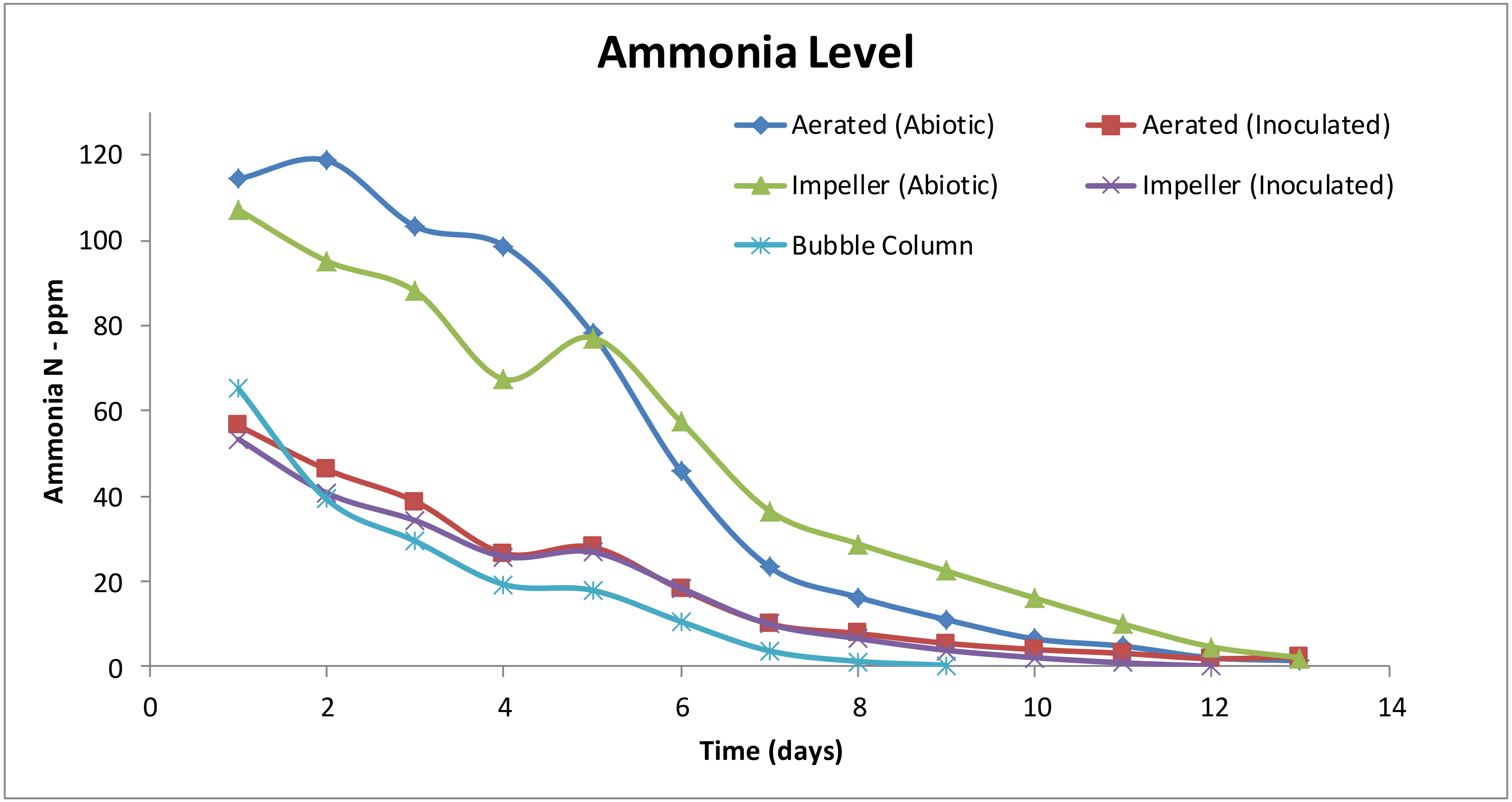
- All four chambers reached peak growth around day 10



Florescence
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
RFU
0
2
4
6
8
10
12
14
Day
A. Air Pump
I. Air Pump
A. Sub Pump
I. Sub Pump



Conductivity reduces with time because of ammonia volatilization as well as uptake of other ionic nutrients. (i.e. K^+, Mg^{2+})



All systems reduced ammonia levels below Groundwater Cleanup Target Levels of 2.8 ppm (FL DEP) in 12 days

Conclusions

- Algae are capable of growing in landfill leachate treated with reverse osmosis.
- Algal cultivation remediated ammonia levels in RO permeate to below Groundwater Cleanup Target Levels (2.8 ppm).
- Impeller mixed cultures reached a higher density than aerated cultures.
- Both mixing strategies remediated ammonia concentrations to approximately the same level.