Superior FAME recovery from *Scenedesmus* sp. through pulsed electric field pre-treatment

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Focused Pulsed (FP) technology

The biomass is rapidly passed between electrodes that create a very high electric field (~ 30,000 V) that pulses rapidly (~ 2,000 Hz).

The high electric field interacts with the ionic groups on the cell membrane and cell wall to disrupt the biomass’s physical structure.
OpenCEL’s Focused Pulsed Technology for Large-Scale PEF

Full-scale application (Mesa, Arizona) demonstrated
- Biogas production increase of nearly 60%
- Reduced biosolids requiring disposal by 30%.
- Important improvements in the microbial community structure.

1. Main WAS Line
2. WAS Input
3. Grinder Pump
4. OpenCEL Unit
5. WAS Return
6. Control Unit
7. Cooling Water
8. 3-phase 480v
To enhance extractable lipid recovery from *Scenedesmus* after FP treatment.
Key parameters change after FP treatment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment intensity (Kwh/m³)</td>
<td>--</td>
<td>30.6</td>
</tr>
<tr>
<td>Temperature change</td>
<td>24°C</td>
<td>26-&gt;53°C</td>
</tr>
<tr>
<td>pH</td>
<td>7.42</td>
<td>6.97</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>4600±40</td>
<td>4440±30</td>
</tr>
<tr>
<td>VSS (mg/L)</td>
<td>4470±50</td>
<td>4300±30</td>
</tr>
<tr>
<td>TCOD (mg/L)</td>
<td>8000±30</td>
<td>8000±60</td>
</tr>
<tr>
<td>ssCOD (mg/L)</td>
<td>450±10</td>
<td>690±10</td>
</tr>
<tr>
<td>Increased ssCOD (% to control)</td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>
Flow Cytometer with SYTOX

Control
4% stained

FP
96% stained
FP treatment disrupts *Scenedesmus* ultra structure

FP treatment enhanced the accessibility to lipids and caused disruption of the lipid inclusions.
TEM field view confirms FP effect on *Scenedesmus*

Greater staining of white starch inclusions demonstrates improved permeability of the cell envelope.

Does all this help lipid extraction?
FP increased the recovery of FAME with different solvents

FAMEs to biomass ratio (%)

- B&D: 149%
- Folch: 87%
- Hexane: 310%
- Isopropanol: 60%
High FAME recovery with minimal Folch after FP treatment
Extraction kinetics improved after FP treatment (Folch)
Summary

• More accessible FAME due to FP treatment of *Scenedesmus*
  – faster kinetics and greater extent (+60% to 300%)

• Crude lipids/FAMEs increased with *small* Folch solvent amendment to isopropanol
  – Reduced toxic solvent usage up to **12-fold** for getting equal yields of lipid and FAMEs
  – Achieved this through **novel combination** of solvents, which is accentuated by FP.
    • FP (8.3% Folch) > Control (66% Folch) for *Scenedesmus*
Acknowledgement

– LightWorks, Arizona State University.
– Mr. David Lowry, TEM specialist
– Mr. Jared Alder, OpenCEL
SUPPORTING INFORMATION
Selective recovery of FAME by FP

FAMEs to crude lipids (%)

CTRL

FP

Folch (% in total 3 mL)

0.0 3.3 8.3 16.7 33.3 66.7 100.0

0 20 40 60 80 100 120
Particle size distribution measured by Multisizer

2_Pass FP

1_Pass FP

Control