Application of batch oscillatory baffled bioreactor to produce biobutanol using *Clostridium* GBL 1082

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ABE fermentation

Acetone-butanol-ethanol fermentation

- Demand for acetone during World War
- Demand for butanol from automobile industry

So, why we’re looking at it again?
  - Interest in renewable energy

Industrial exploitation started: 1916

Glorious term until: 1950s

Demised in late 1950s
Our objectives are:

- to develop autoclaveable laboratory-scale OBBs for biobutanol production
- to produce biobutanol in OBBs at a yield of 0.30
- compare the yields and productivity with other conventional bioreactor (stirred tank and agitated Schott bottle)
Advantages of using OBB

- Straightforward scale-up
- Reproducible yields and productivity
- Compact design
- Reductions in residence time

Stonestreet, 2006
Batch oscillatory baffled bioreactor (BOBB)

- OBB features
  - Autoclaveable size
  - On-line growth monitoring
  - Various sampling ports
  - Stainless steel bellows: ensure sterility

Fluid mechanical condition:
- $Re$: Mixing intensity
- $St$: effective eddy propagation
- $Re_n$
OBB flow pattern
Fermentation method

Bacteria
(Clostridium GBL1082)

Synthetic Molases

Products
- Acetate
- Butyrate
- Acetone
- Butanol
- Ethanol

Fermentation condition:
- Anaerobic
- Temp. : 32°C
- pH₀ : 6.5

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Results

Yields and productivity in OBB at various $Re_o$

- **Yields (g ABE/g glucose)**
- **Productivity (g/L h)**

<table>
<thead>
<tr>
<th>$Re_o$</th>
<th>Yields</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>0.28</td>
<td>0.32</td>
</tr>
<tr>
<td>938</td>
<td>0.32</td>
<td>0.36</td>
</tr>
<tr>
<td>470</td>
<td>0.40</td>
<td>0.44</td>
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</tbody>
</table>

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**OBBs**

**Experiments**

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Results

ABE and acid production in various bioreactors

<table>
<thead>
<tr>
<th>Bioreactors</th>
<th>ABE (g/L)</th>
<th>Acid (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBB</td>
<td>13.5</td>
<td>Low</td>
</tr>
<tr>
<td>STR</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Bottle</td>
<td>9.6</td>
<td></td>
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</tbody>
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OBB:
6% greater yields
29% higher yield

Yields and productivity in various bioreactors

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<th>Productivity (g/L h)</th>
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<tr>
<td>OBB</td>
<td>0.34</td>
<td>0.17</td>
</tr>
<tr>
<td>STR</td>
<td>0.29</td>
<td>0.10</td>
</tr>
<tr>
<td>Bottle</td>
<td>0.32</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Conclusion

- OBBs are advantageous reactor technology for biobutanol production: higher yield and productivity, reproducible at larger scale

- OBBs have lower peak acid – acid crashes are less likely

- Mixing independent over the range investigated so far – good yield at $Re_0 470$; productivity at $Re_0 938$
Thank you

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