MAPHEX
MAnure PHosphorus EXtraction System

Clinton D. Church\textsuperscript{1}, Alex N. Hristov\textsuperscript{2}, Ray B. Bryant\textsuperscript{1}, and Peter J. A. Kleinman\textsuperscript{1}
The Phosphorus Challenge

Phosphorus is a necessary and valuable nutrient.

Manure has been valued for thousands of years.

However:

To much manure P in areas of surfict cause it to be a pollutant.

P sorbing soil amendments and alternative application methods (injection, etc) are temporary solutions, at best.
But, what if manure P could be concentrated enough to be economically transported?

And, what if the liquid left behind had Negligible Phosphorus?
A Mobile Treatment System to Remove Phosphorus from Dairy Manures

Clinton D. Church\(^1\), Alex N. Hristov\(^2\), Ray B. Bryant\(^1\), and Peter J. A. Kleinman\(^1\)

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**Step 1: Initial Liquid/Solid Separation**

Manure Slurry

- **Solids:** 100%
- **Total P:** 100%

Auger Press

- **Solids:** 80%
- **Total P:** 15%
- **Stackable**

Centrifuge

- **Solids:** 10%
- **Total P:** 45%
- **Stackable**

*These low P solids are ideal for reuse as bedding material*

*These high P solids are easily transported to areas with low P*

**Step 2: Chemical Treatment**

Chemical Treatment Tank

- Fe sulfate with Polymer

*Chemically treated effluent*

**Step 3: Final Liquid/Solid Separation**

AutoVac® Filtration Unit

- **Solids:** 10%
- **Total P:** 40%
- **Stackable**

*These high P solids are easily transported to areas with low P*

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**Highlights**

- **Cost for a 1000 cow dairy**
  - Per day: $750
  - Per cow/yr: $180
  - Per kg P removed: $38
  - Per lb P removed: $17

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Step 1: Initial Liquid/Solid Separation

Manure Slurry

Dairy manure slurry

Auger Press

Dairy manure press effluent

Centrifuge

Dairy press effluent

Solids: 100%
Total P: 100%

Solids: 80%
Total P: 15%
Stackable

These low P solids are ideal for reuse as bedding material

Solids: 10%
Total P: 45%
Stackable

These high P solids are easily transported to areas with low P

Manure Slurry

Solids: 100%
Total P: 100%

Auger Press

Batch solids

Centrifuge

Medium sized solids
Step 2: Chemical Treatment

Fe sulfate with Polymer

Chemical Treatment Tank

Centrifuge effluent

Chemically treated effluent

Chemical Treatment Tank

Chemically treated effluent

Centrifuge effluent

Fe sulfate with Polymer
Step 3:
Final Liquid/Solid Separation

AutoVac® Filtration Unit

Chemically treated effluent

Fine sized solids

Solids: 10%
Total P: 40%
Stackable

These high P solids are easily transported to areas with low P

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- 96 – 99\% P removal efficiency
- 99\% solids removal efficiency
- All solids stackable (~70\% moisture)
- Most nitrogen is retained (N:P ~ 50:1)
- Ideal for fertigation of crops
- pH unchanged by process

Cost for a 1000 cow dairy

<table>
<thead>
<tr>
<th></th>
<th>Per day</th>
<th>per cow/yr</th>
<th>per kg P removed</th>
<th>per lb P removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated water</td>
<td>$750</td>
<td>$180</td>
<td>$38</td>
<td>$17</td>
</tr>
<tr>
<td>Returned to manure storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This was manure slurry 10 minutes ago.

Treated water is returned to manure storage.

Final Effluent

Solids: \leq 0.1 \%  
Total P: \approx 0.4 \%
Full-Scale MAPHEX System
Uses for Solids

1) Low P composted bedding from bulk solids

2) Sale of high P nutrient solids to organic farmers, mushroom growers, or retail

3) Feedstocks for energy generation

4) Innovative products (e.g. cowpots®)
Current Work

1) Testing of the Full-Scale Mobile Treatment System

2) Ongoing work to lower daily operating costs