How to produce fertilizer from urine: Struvite

Urine contains valuable nutrients; it is an excellent fertilizer if applied to crops. If urine cannot be applied directly because:
• storage space is not available
• transport is difficult
• its odour is unpleasant
You can produce struvite to benefit from the fertilizing properties of urine, because:
• volume and weight are reduced
• nutrients can be stored over time
• handling is more user-friendly in powder form

Further readings
• Etter, B. (2009): Struvite recovery from urine at community scale in Nepal – Project intermediate report. EPFL: Swiss Federal Institute of Technology, Lausanne, Switzerland

Internet resources
• www.novaquatis.ch
• www.sandec.ch
• www.ceep-phosphates.org

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Installation procedure
• assembly of reactor container (sheet metal tank with conical bottom) according to treatment volume (1 L reactor per 10 L of urine per day)
• construction of stirring mechanism & stand (welded metal bars and sheet); assure flow from storage to reactor to disposal.
• installation of fittings & filter (polypropylene fittings and nylon filter bag). Filter fabric: nylon fabric as used for shirts sewn to bag of 0.4 m² surface for 100 L reactor.
• set-up of reactor and storage tanks (plastic storage tanks with connections to reactor)

Dimensioning
• daily treatment capacity: 10 L urine / 1 L reactor
• 500 L urine yield approximately 1 kg struvite

Installation costs
• labour costs: 1 operator for a 500 L reactor

<table>
<thead>
<tr>
<th>Reactor set-up [NRs]</th>
<th>50 L</th>
<th>500 L</th>
</tr>
</thead>
<tbody>
<tr>
<td>steel tank for reactor</td>
<td>3'500</td>
<td>15’000</td>
</tr>
<tr>
<td>stirring system &amp; stand</td>
<td>2’000</td>
<td>10’000</td>
</tr>
<tr>
<td>urine storage tank</td>
<td>500</td>
<td>8’000</td>
</tr>
<tr>
<td>pipes &amp; fittings</td>
<td>500</td>
<td>2’000</td>
</tr>
<tr>
<td>effluent storage tank</td>
<td>500</td>
<td>8’000</td>
</tr>
<tr>
<td>total [NRs]</td>
<td>7’000</td>
<td>43’000</td>
</tr>
</tbody>
</table>

Further considerations
• small scale business approach
• commercialization of struvite as a fertilizer
• phosphorous prices are likely to increase further
• transportation of bittern from India to Nepal

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How does the STUN reactor work?

1. Fill reactor with urine
2. Add magnesium & stir
3. Open valve & filter struvite
4. Sundry struvite

STUN: Struvite recovery from urine in Nepal
The Struvite Harvesting Reactor

Stirring mechanism:
- metal crank
- metal rod shaft
- sheet metal blades

Stainless steel tank:
- crimped & riveted
- silicon sealed
- soldered at outlet

Reactor outlet:
- metal connector
- seal tape
- plastic ball valve

Filter module:
- plastic container
- nylon filter bag
- bottom outlet

How is struvite formed?

Urine contains phosphate (PO$_4$) and ammonium (NH$_4$); both are important nutrients. If magnesium (Mg) is added to urine, these substances will bind and form struvite (MgNH$_4$PO$_4$·6H$_2$O) powder, which can be filtered out.

Fertilizer comparison (N:P:K)
- Urea: 46:0:0
- DAP: 18:46:0
- Struvite: 6:29:0+10Mg

Struvite in practice – a valuable fertilizer
- slow-release – continuous nutrient flow
- bio-available – easy uptake by plants
- free of heavy metals and pharmaceuticals

Effluent reuse potential

Effluent characteristics – additional nutrients
- high nitrogen (N) content
- high potassium (K) content

Reuse potential – fertigation
- fertigation: fertilization by irrigation
- no clogging in drip irrigation

Magnesium (Mg) sources
- magnesium sulphate (MgSO$_4$): fertilizer powder
  magnesium content: 5 - 10%
- Bittern: waste product of salt production
  magnesium content: 3 - 10%

Magnesium (Mg) dosage
- determine phosphorus (P) content in urine
- Mg:P molar ratio 1:1.1

Process inputs

Urine harvesting
- from urine diverting toilets
- from urinals
- on markets
- in public buildings etc.

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