Transitioning Transformative Technologies from Laboratory to Field Testing to a Commercial Product

JEFF PIASCIK  jeffp@biomasscontrols.com
Motivation

• To further develop TT transitions from lab to field to potential products (stress-testing, mean-time-to-failure, etc)
• Develop modified “Deming Model” for TT “productization”
• Test for ISO (30500) compliance / KPI Development
• Evaluation and data comparison of multiple usage scenarios
• Technology acceptance from user data
Implement (plan-do-check-adjust) for control and continuous technology improvement

1). Prototyping
2). Manufacturing
3). Product / Commercialization

During PDCA cycles potential partners critical to engage earlier for technology:
- Sourcing
- Development
- Transition
As technologies ready for system level testing – this transition step transfers from laboratory to stress-tests at test facilities.

(1) Plan – technology enters testing phase
(2) Do – testing (lab / stress-test)
(3) Check – verify system level readiness
(4) Adjust – allow time for system evaluation and re-engineering if necessary.
1). Prototyping

(1) Plan – technology enters reliability phase with eye on manufacturing

(2) Check – verify system level for manufacturing readiness

(3) Do – MTTF / DFMEA

(4) Adjust – allow time for system evaluation and re-engineering for subsystem sourcing
Modified Deming Model

1). Prototyping

(1) Plan – manufacturing – develop approach (commodity or competitive driven)?

(2) Do – supply-chain management (supplier sourcing, development, transition)

(3) Check – quality control, maintenance level planning

(4) Adjust – processes for effective product release.

2). Manufacturing
1). Prototyping

2). Manufacturing

3). Product / Commercialization

Technology

Partnership for local productization / commercialization of technology
- Supply-chain management in place for deployment and maintenance
- Becomes commercial partner-led project/venture
RT Technology

- separate urine and feces
- dry and burn feces
- remove suspended solids
- electrochemically generate chlorine from NaCl in urine
- recycle disinfected liquid

FSMS | FEBRUARY 2019
Lab / Field Results

- Electrochemical (EC) treatment effectively kills pathogens in concentrated blackwater, but this process alone is energy-intensive (65-100 kJ/L).
- Field studies indicated that merely disinfecting liquid is insufficient—we have to improve color, odor, and turbidity!
- EC can also be used to reduce COD, color, and turbidity (“polishing”) in blackwater but this requires up to 10x as much energy as disinfection!
The hybridized approach (EC + GAC) enables treatment to both **hygienic** and **user acceptable** levels with significant reduction in the energy required by EC treatment alone.

...odor and color acceptable!
## Modified Liquid Treatment

**FOCUS:**
- Suspended solids: Aug 2016 – Jan 2017
- Dissolved COD: Feb 2017 - now
- Polishing: now - near future

**TARGETS**

<table>
<thead>
<tr>
<th>APPROACH:</th>
<th>EC process optimization</th>
<th>settling tank redesign</th>
<th>pre-process GAC</th>
<th>post-process GAC</th>
<th>as low as possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy (kJ/L)</td>
<td>76</td>
<td>65</td>
<td>42</td>
<td>TBD</td>
<td>as low as possible</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>3755</td>
<td>2791</td>
<td>1062</td>
<td>747*</td>
<td>&lt; 250</td>
</tr>
<tr>
<td>turbidity (NTU)</td>
<td>980</td>
<td>314</td>
<td>153</td>
<td>179*</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>color (PCU)</td>
<td>&gt; 1500</td>
<td>&gt; 1500</td>
<td>235</td>
<td>25*</td>
<td>&lt; 300</td>
</tr>
</tbody>
</table>
Lab / Field Results

Duke Toilet in Coimbatore Status Update

**STeP**

- Plant application tube line to sewer so liquid system can be run 24/5
- PPT GAC backwashed 1:10 after 316 hours of operation since last backwash
- NA
- Install injection well buffer tanks in late January
- Holding pump replaced and working properly
- Buffer tanks received at VKSM from O&M on 1/22, to be replaced just before Reclaimer is installed

Next:
- ISO Spiking test tentative
- Run reactor and GAC to failure
- Decommission, Empower, Install Reclaimer end of Feb

Note: Prateek to return week of Feb 4th

Tested to ISO standard

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inlet</th>
<th>Outlet</th>
<th>% Removal</th>
<th>ISO Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (mg/l)</td>
<td>689</td>
<td>16</td>
<td>98%</td>
<td>10/30</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>914</td>
<td>64</td>
<td>93%</td>
<td>50/150</td>
</tr>
<tr>
<td>TN (mg/l)</td>
<td>169</td>
<td>53</td>
<td>69%</td>
<td>70% reduction</td>
</tr>
<tr>
<td>pH</td>
<td>7.7</td>
<td>7.7</td>
<td>-</td>
<td>6-9</td>
</tr>
</tbody>
</table>

*Phosphorus <20 ppm in both influent and effluent

Biological Liquid Treatment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inlet</th>
<th>Outlet</th>
<th>ISO Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. Coli (n=12)</td>
<td>&gt;1600</td>
<td>&lt;20/L</td>
<td>100/L</td>
</tr>
<tr>
<td>Helminth egg   (#/L) (n=5)</td>
<td>44</td>
<td>&lt;1</td>
<td>&lt;1/L</td>
</tr>
</tbody>
</table>

*FSM5 Poster – Testing of an Integrated Waste Treatment System for a Single Stall in a Women’s Toilet in India
Lab / Field Results

- Feces were thermally dried (pathogen-free).
- Un-reliable ignition with feces
- Fuel metering for continuous combustion – inconsistent
- Non-ideal insulated system and leaks creates large thermal losses
- Odor – (400-700 odor units – (no *E. coli* in bioaerosols)
Lab / Field Results

- Field Process reporting and KPI Development

**Process Run Time**

**Drying Temp Profile**

**Sensor Analysis**
RT Technology

Granulated Activated Carbon Filtration System

Baffles

Solid / Liquid Separator

Drying Belt

Electro-Chemical Process

Storage

Macerator / Accumulator

Combustor
Deployed Field Testing Units

Lab Testing

Solid Models

Field Testing Platform
S.H.E. (MHM)

Lab testing has led to an re-engineering phase for field deployment testing.
Conclusions

• Invaluable data has / is still being acquired:
  1. Multiple testing platforms accelerates development / reengineering phases
  2. Different testing environments pose their own challenges
• ISO compliance is priority for product development
• Developing key off-shore partnership for prototyping (potential commercial partnership)
• Value engineering / supply chain identification will be essential for success
Partnerships

STeP Sanitation Technology Platform

G K Controls Private Limited

UNIVERSITY OF KWAZULU-NATAL

INYUVEI YAKWAZULU-NATALI

Khanyisa Projects

TRIANGLE ENVIRONMENTAL HEALTH INITIATIVE

ENERGY INSTITUTE Colorado State University

UWE Bristol University of the West of England

SEWA Self Employed Women’s Association

CASCADE DESIGNS

L&T Technology Services

Parryware

Biocare Diagnostics

NATIONAL INSTITUTE OF DESIGN

PHHI FOUNDATION OF INDIA

KOHLER

Cranfield University
Thank you!

Contact: jeffp@biomasscontrols.com