Challenges and Strategies for Implementing New Technology

2015 VWEA Education Seminar
Richmond, VA

JB Neethling
30 April 2015
Outline

- Challenges
- Putting into practice
- Opportunities
Challenges

What is limiting the ability to implement new technologies?
Challenges

- Information overload
- It cannot be done
  - Not theoretically possible
  - It will never work
- It’s not cost effective
- It’s too risky
Information Overload

Water and Wastewater Treatment Patents (1976-2013)
Information Overload

Water & Wastewater Treatment Patents (US), 1976-2013

Cumulative Water and Wastewater Treatment Patents


Everything that can be invented has been invented

Charles H. Duell, Commissioner of US Patent Office, 1899… or Punch Magazine 1899
The main challenge with literature reviews is that only successful applications are reported!
It cannot be done (aka it’s theoretically impossible)

Maurits Cornelis Escher – Perpetual Motion
Is it Biological or Chemical Phosphorus Removal?

- 1970’s biological phosphorus removal reported at full scale (PhoStrip, 5-stage Bardenpho, PhoRedox, AO, etc)
- Biological vs. Chemical removal mechanism debated
- Settled in 1980’s in favor of biological
- Increased understanding continues

Baviaanspoort, Pretoria (1978)
Chemical Phosphorus Removal is Theoretically Limited

FePO₄ Solubility

OrthoP residual vs Fe/P dose
It cannot be done (aka it’s theoretically impossible)

OP detection limit changed from 0.05 to 0.01 mg/L

Takacz et al. (2004)
Chemical Phosphorus Removal … Surface Complexation Model explains Performance

No Solids Inventory

With Solids Inventory

Loss of Alum feed

Scott Smith
Wilfrid Laurier University
Zero Sludge Production Possible?

- Cell lysis and cryptic growth
- Uncoupled metabolism
- Endogenous metabolism/increase decay
- Microbial predation
- Increase biodegradability in “inert solids”
- Hydrothermal oxidation
- Microbial population selection

Some Liquid Stream Sludge Reduction Mechanisms
BioAugmentation for Wastewater Treatment

Bioaugmentation Solutions

- Enhance BOD
- Nutrient removal
- Odor control
- Digestion
- Bioremediation
- Grease/FOG
- Ammonia reduction
- Etc…
Deammonification: Sidestream -> Mainstream?

Sidestream Deammonification

BOD removal

RAS

WAS

RAS

NDN/Anammox

ANX

AER

SCL

WAS

Cyclone

AD

Centrifuge

Anammox

Cyclone

Mainstream Deammonification

Emerging

Cumulative Capacity, lb N/d

Sum N load, lb N/d

0

40,000

80,000

120,000

160,000


Sidestream Deammonification

0

40,000

80,000

120,000

160,000


Mainstream Deammonification

Emerging
It’s not Cost Effective: Phosphorus removal via Struvite Formation (HDR, 2000)

Features
- Eliminate phosphorus dewatering recycle
- Eliminate struvite nuisance precipitation
- Partial removal of ammonia
- Reduce energy for nitrification
- Reduce ferric/alum for P removal
- Reduce alkalinity required for nitrification
- More reliable biological P removal
- Reduce Operation & Maintenance
- Reduce equipment replacement

Struvite Recovery Reactor (HDR, 2000)

Business case failed to produce short payback
It’s Too Risky

**Type of Risks/Fears**

- Serial number 001
- Meeting performance expectation
- Unknown secondary impacts
- Unreliable performance
- Operational uncertainty

- Sunk investment
- Cost of failure
# It’s too Risky

The Comparison of Four Alternatives: Cost

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<th>Criteria</th>
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<th>Conv_2</th>
<th>Innov_1</th>
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<td>Comparison</td>
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<td>3</td>
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It’s too Risky
Comparison of Four Alternatives: Non-Cost

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<tr>
<th>Criteria</th>
<th>Conv_1</th>
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<td>Meet Permit Limits</td>
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<td>EDCs Removal</td>
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<td>Biosolids/UV Compatibility</td>
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<td>Ease of Operation</td>
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<td>3</td>
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<td>GHG Emissions</td>
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<td>9</td>
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<td>Level of Confidence/Proven</td>
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<td>Piloting Recommended *</td>
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<td>Ease of Implementation</td>
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<td>Good Neighbor (Odor)</td>
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<td>Minimize Chemicals</td>
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<td>Ability to Meet Lower Limits</td>
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<td><strong>Total</strong></td>
<td><strong>109</strong></td>
<td><strong>90</strong></td>
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Toyota Prius and Sidestream Deammonification Growth

- Number of units in service
- Sidestream Deammonification vs Prius
- Growth about equally fast
- Last two years incomplete?
Put into Practice/Implementation
Put into Practice/Implementation

First Reaction – Business Case
- The Blink Test
- Sound Science?
- Trusted Sources
- Business Case?
  - Yes
  - No

Investigate – Technical
- Investigate Existing
- Pilot/Full Scale Study
- Technically Sound?
  - Yes
  - No

Implement – Limit Risk
- Unintended Consequences
- Backstop Plan
- Risk OK?
  - Yes
  - No
First Reaction – Build the Case

- Use Malcolm Gladwell’s “Blink” test!
  - If it sounds too good to be true, it probably is!
- Check the science
  - But remember it is evolving
- Check past experiences from trusted sources
- Is the business case favorable
Investigate the Technical Performance

- Investigate existing installations
  - Phone, in person,
  - Question the operators & owners
- Pilot test and/or Full scale tests
  - Determine site specific conditions
  - Operations assessment
- Evaluate technology performance

Coeur d’Alene Tertiary Microfiltration Nitrification and Phosphorus Removal Process

Credit: HDR Inc. 2014
Implement – Limit the Risk

- Unintended consequences
- Develop Risk Mitigation Plan for Implementation
- Backstop option

Reduced Sludge Production Process
  Operate as Aerobic Digester

Contact Clarifier – Filter converted to Direct Filtration
Opportunities

New developments allow for innovation
Change the Paradigm: Struvite Part II

- Generate a marketable product to tip the scale

May 2009
Change the Paradigm: C.C. Meyer – Bridge and Road Builder: The McArthur Maze Rebuilt

- Tanker Truck Crashed into Column, Fire damage close ramp
- Bid of $876,075
- Reopened the evening of Thursday, May 24, 2007
- Finish a month early
  - 26 days after accident
- Received $5 million bonus
- State estimate:
  - $6 million per day economic impact
  - Including $491,000/d Bay Bridge Tolls loss

A WIN-WIN solution is always the best outcome
Win-Win to Achieve NDN in a BOD Basin
OCSD California Case

Primary Effluent

RAS

1a 1b 2 3 4 - 6

Anoxic Selector

Step Feed

AS in Flow
Effluent NH4
Progressive Improvements/Trial and Error

- Kirby Ferguson
  - Everything is a Remix

- Tom Wujec
  - Take an iterative approach
New Tools – to Assess Technology

Molecular Tools
(Winkler, 2012)

Process Simulators/Models

CFD Modeling

Online Instrumentation / Dynamics
Conclusion
Conclusion

There is no lack of ideas...

Trust, but Verify

Create a Win-Win Solution

Rome was not built in a day
Even the Best of the Best make mistakes…

"About 20 percent of Einstein's papers contain various mistakes of various degrees"
(Mario Livio Brilliant Blunders)

....but it does help to be right most of the time !!!
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