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

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BIOMASS CONTROLS

Center for WaSH-AID
WATER, SANITATION, HYGIENE AND INFECTIOUS DISEASE

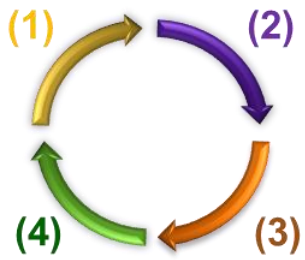
AfricaSan5 FSM5

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

Modified Deming Model

Implement (plan-do-check-adjust) for control and continuous technology improvement



Technology

1). Prototyping

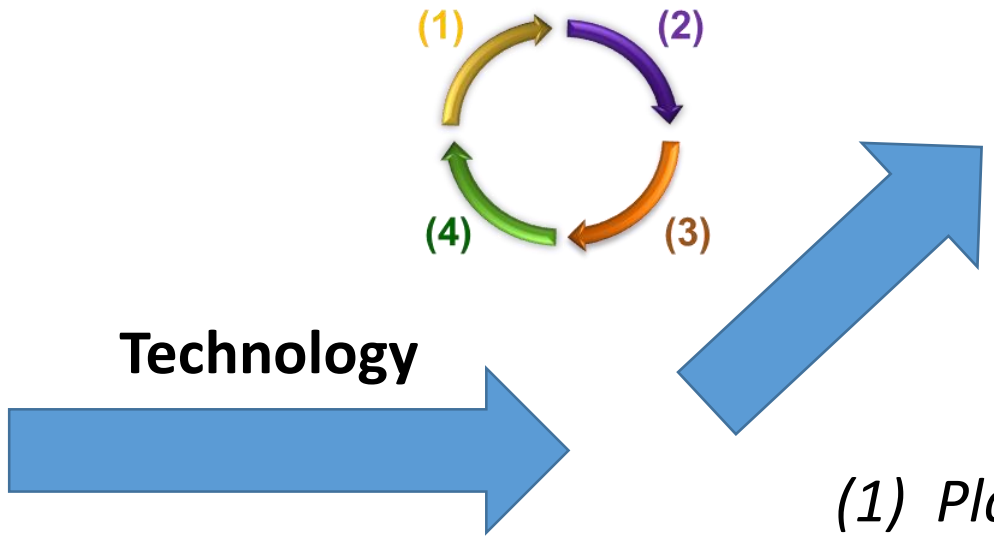
2). Manufacturing

3). Product / Commercialization

During PDCA cycles potential partners critical to engage earlier for technology:

- Sourcing
- Development
- Transition

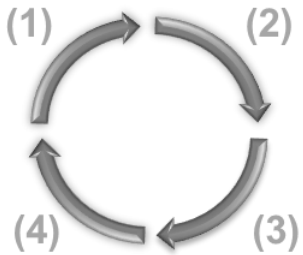
Modified Deming Model



As technologies ready for system level testing – this transition step transfers from laboratory to stress-tests at test facilities.

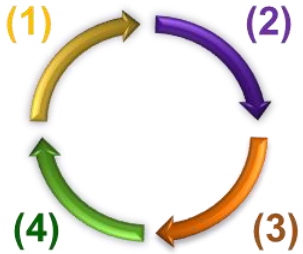
(1) Plan – technology enters testing phase
(2) Do – testing (lab / stress-test)
(3) Check – verify system level readiness
(4) Adjust – allow time for system evaluation and re-engineering if necessary.

Modified Deming Model



Technology

1). Prototyping



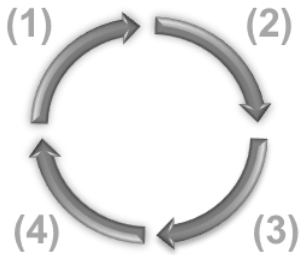
(1) Plan – technology enters reliability phase with eye on manufacturing

(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



Technology

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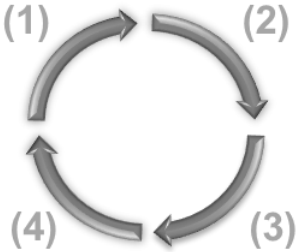
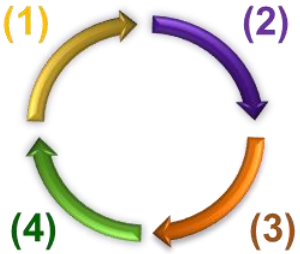


2). Manufacturing



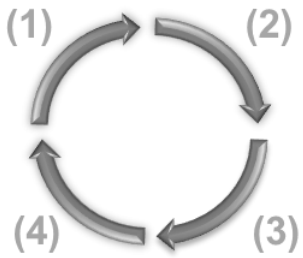
(1) Plan – manufacturing – develop approach (commodity or competitive driven)?

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

(3) Check – quality control, maintenance level planning

(4) Adjust – processes for effective product release.

Modified Deming Model



Technology

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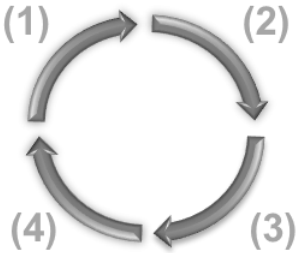

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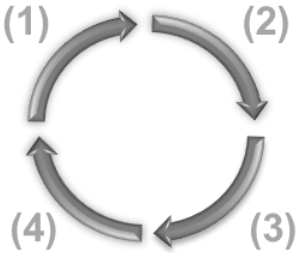


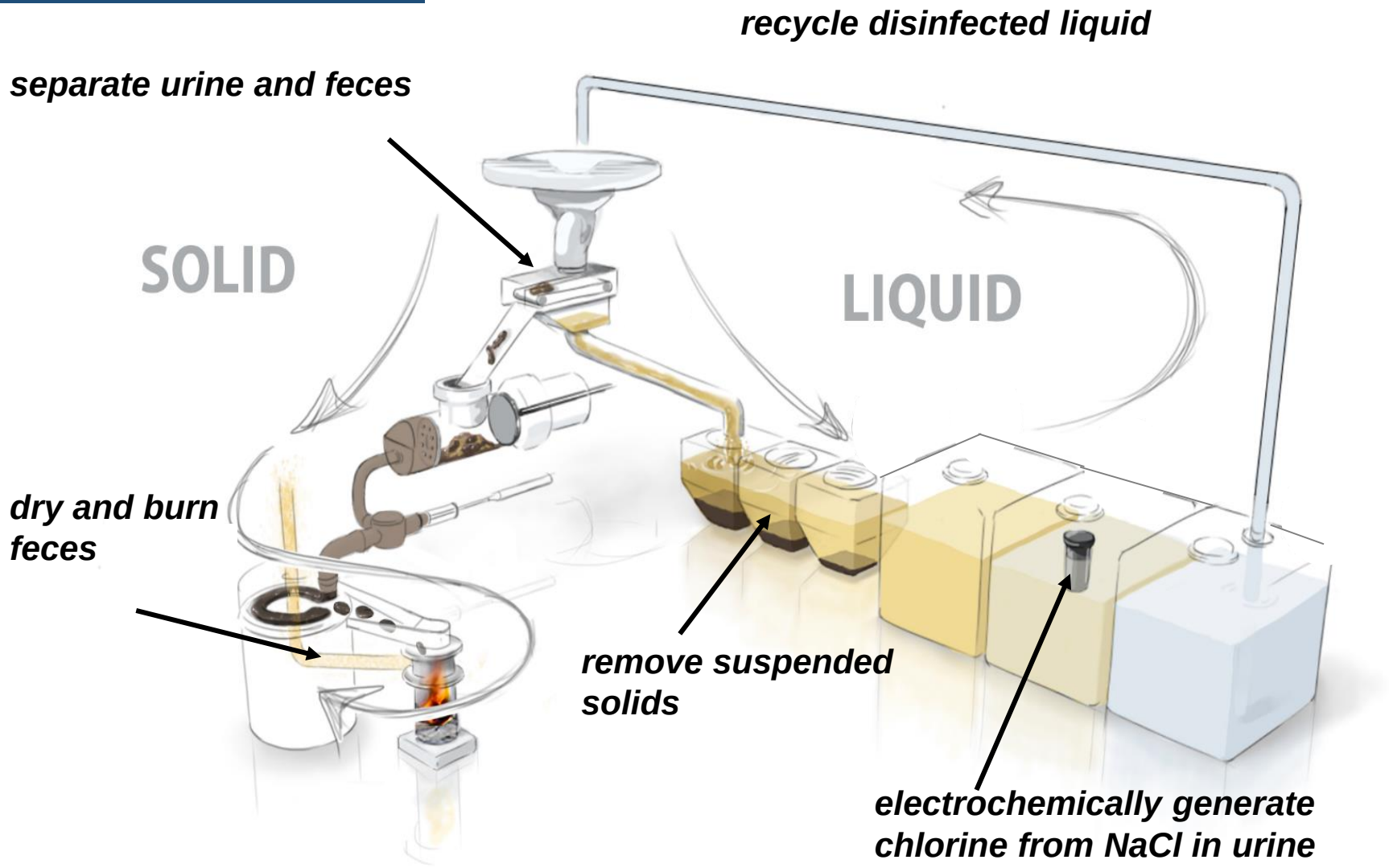
3). Product / Commercialization

Partnership for local productization / commercialization of technology

- Supply-chain management in place for deployment and maintenance
- Becomes commercial partner-led project/venture

Testing Facilities

RT Technology



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!

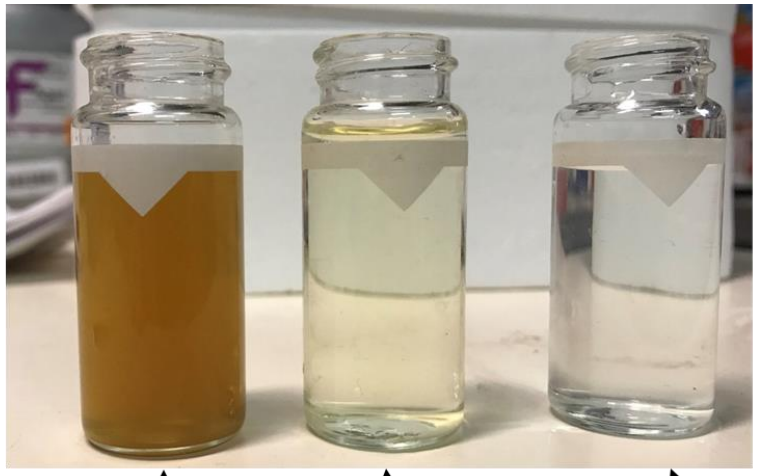
Pathogen Free Effluent

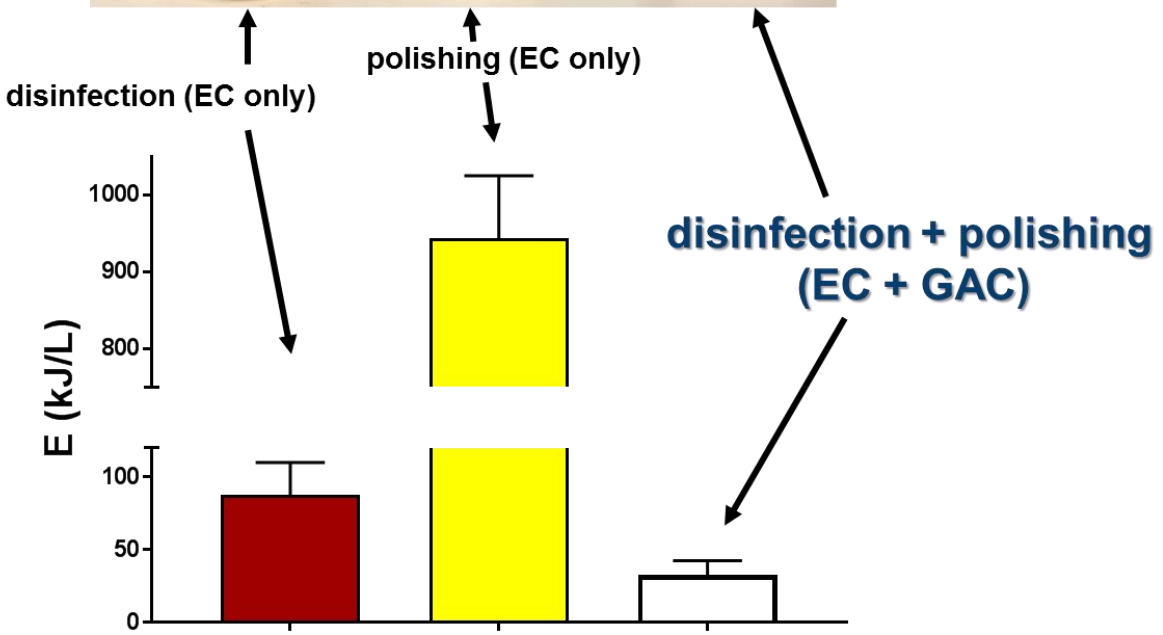
Polished Pathogen Free Effluent

Lab / Field Results

- 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!

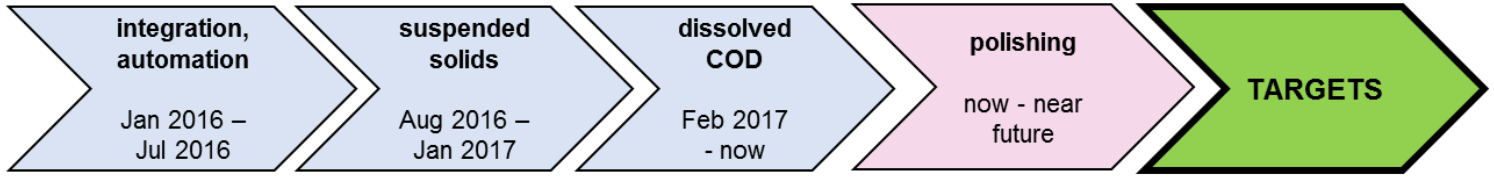




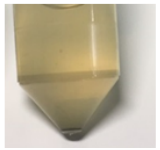
Lab / Field Results

Modified Liquid Treatment

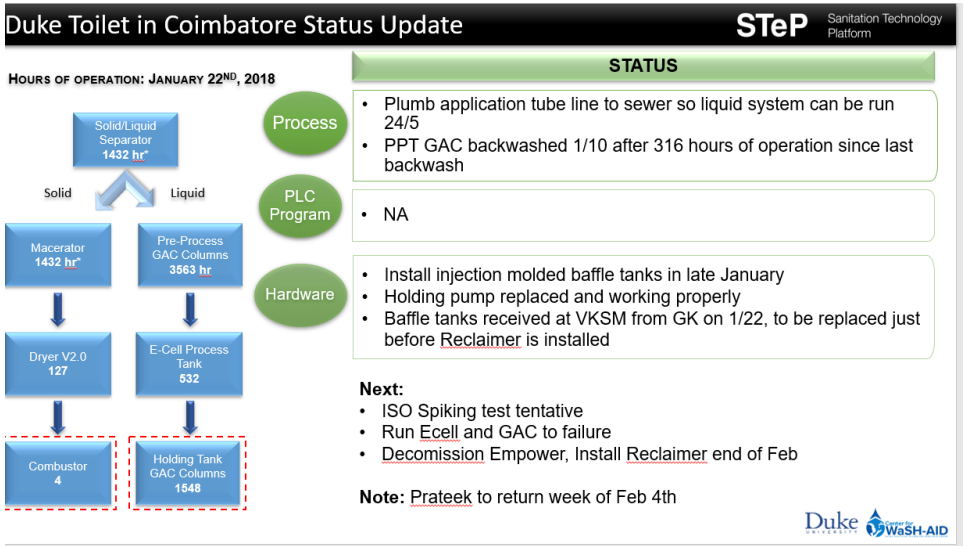
FOCUS:

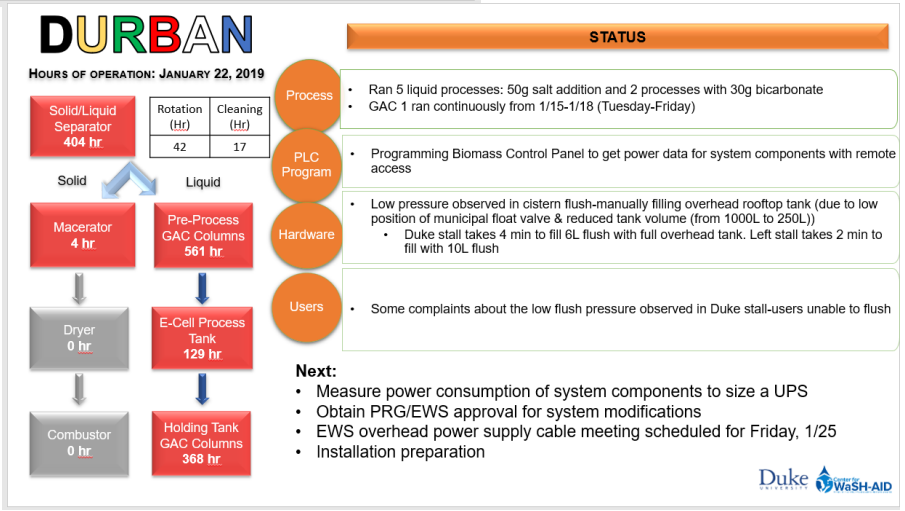


APPROACH:	**EC process optimization**	**settling tank redesign**	**pre-process GAC**	**post-process GAC**	
energy (kJ/L)	**76**	**65**	**42**	TBD	**as low as possible**
COD (mg/L)	**3755**	**2791**	**1062**	747*	**< 250**
turbidity (NTU)	**980**	**314**	**153**	179*	**< 2**
color (PCU)	**> 1500**	**> 1500**	**235**	25*	**< 300**



Lab / Field Results





Tested to ISO standard

Parameter*	Inlet	Outlet	% Removal	ISO Target	
TSS (mg/l)	689	16	98%	10/30	✓
COD (mg/l)	914	64	93%	50/150	✓
TN (mg/l)	169	53	69%	70% reduction	✓
pH	7.7	7.7	-	6-9	✓

*Phosphorus <20 ppm in both influent and effluent

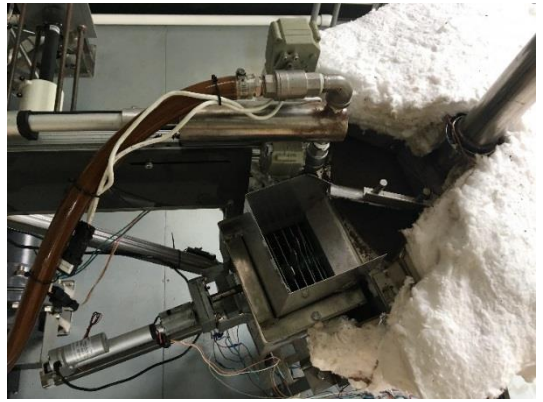
Biological Liquid Treatment

Parameter	Inlet	Outlet	ISO Target	
E. Coli (n=12)	>1600	<20/L	100/L	✓
Helminth egg (#/L) (n=5)	44	<1	<1/L	✓

*FSM5 Poster – Testing of an Integrated Waste Treatment System for a Single Stall in a Women's Toilet in India

Lab / Field Results

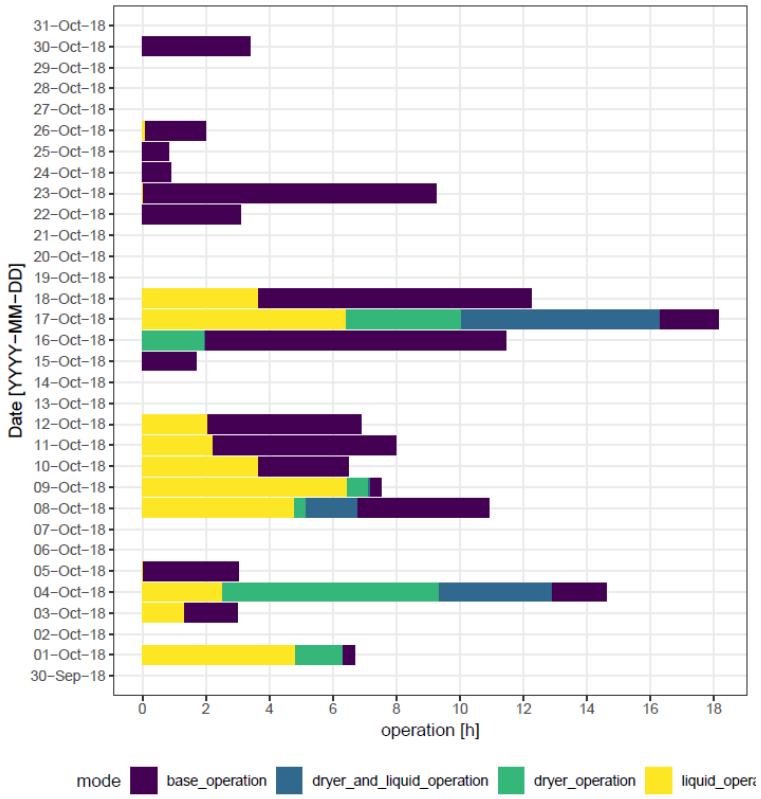
- Feces were thermally dried (pathogen-free).
- Un-reliable ignition with feces
- Fuel metering for continuous combustion – inconsistent
- Non-ideal insulated system and leaks creates large thermal losses
- Odor – (400-700 odor units – (no *E. coli* in bioaerosols)



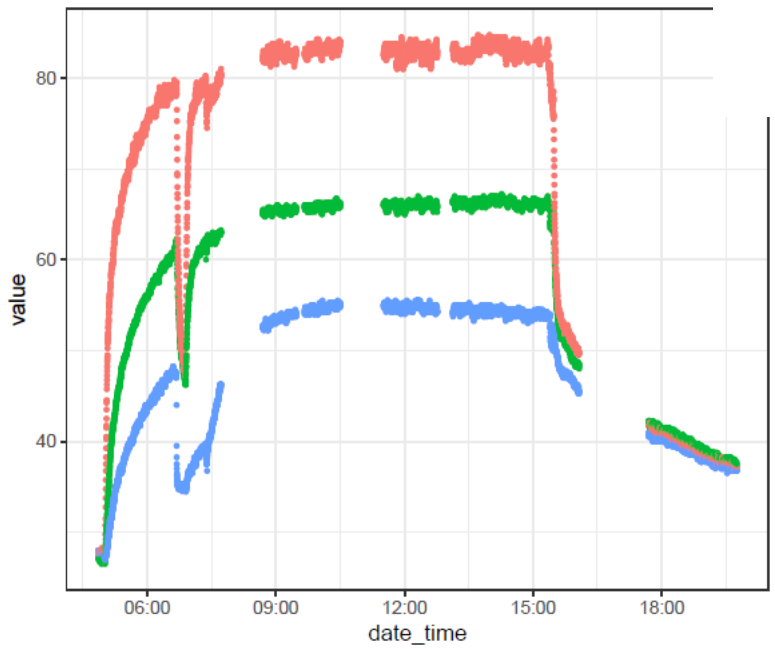
Lab / Field Results

- Field Process reporting and KPI Development

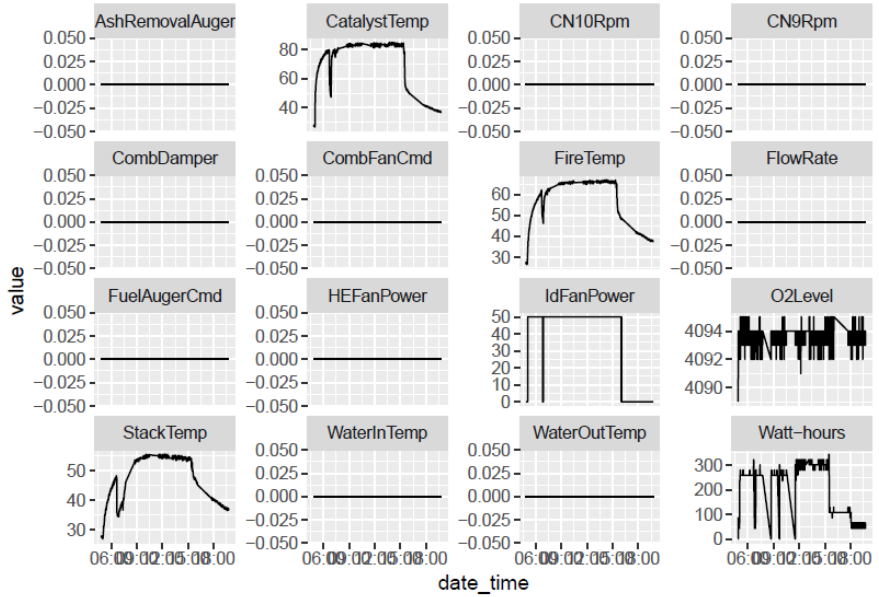
Process Run Time



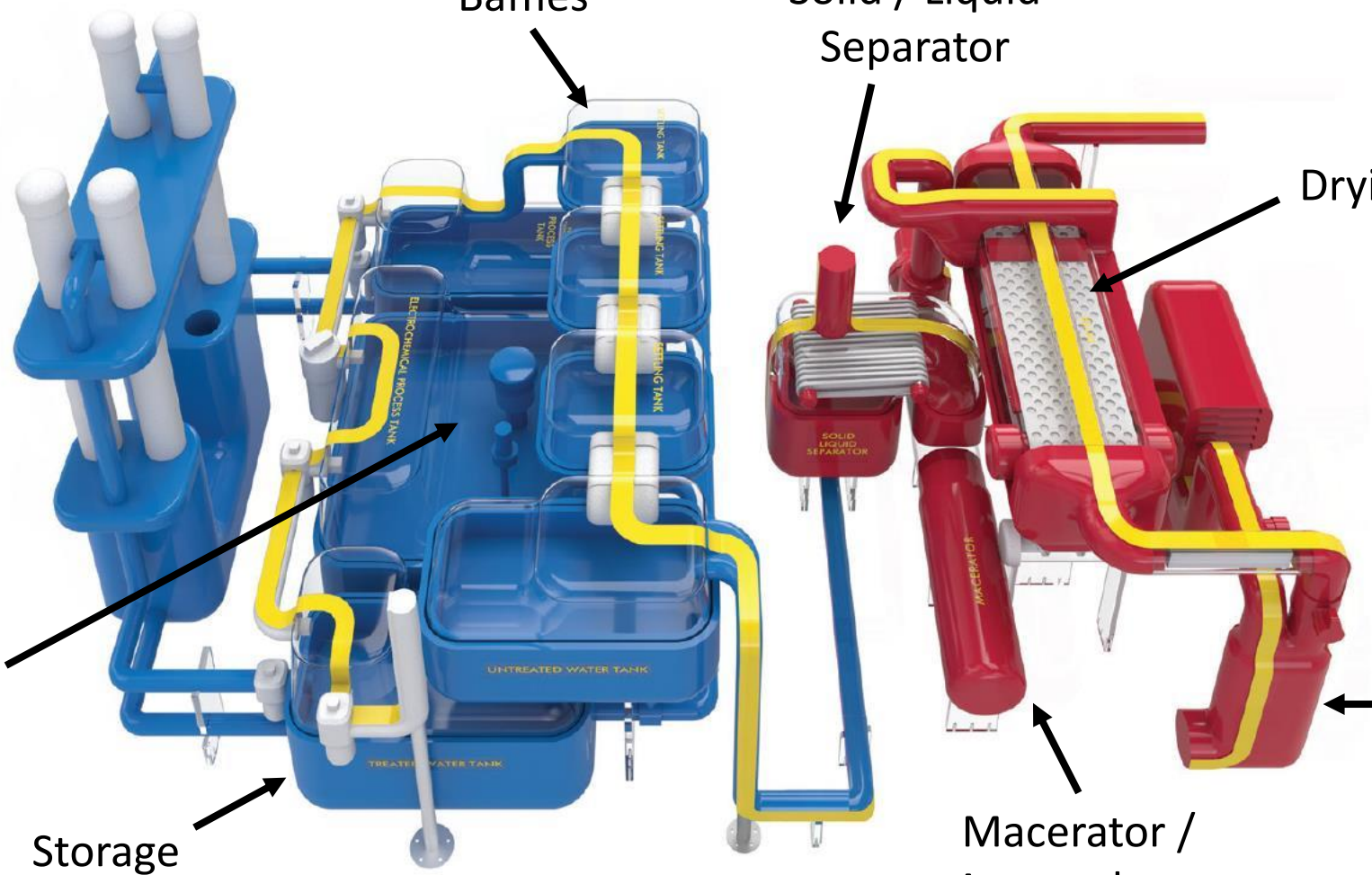
Drying Temp Profile



Sensor Analysis



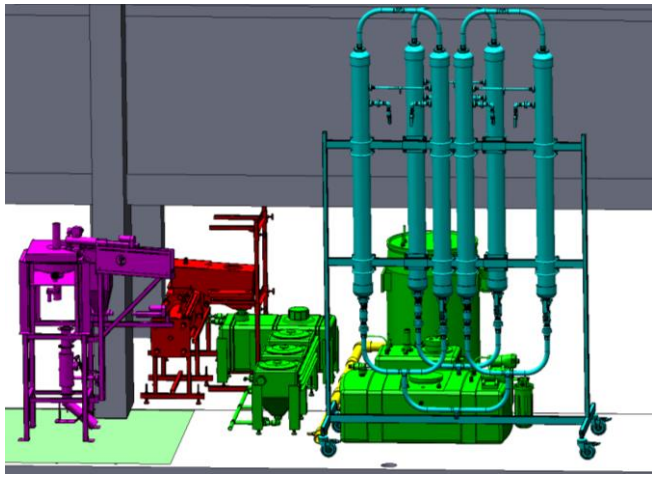
RT Technology

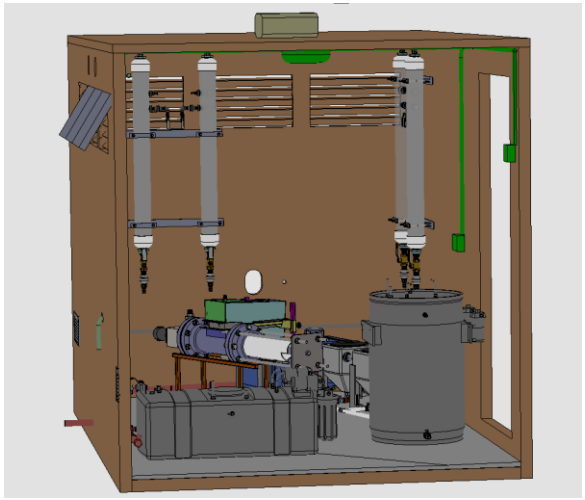


Deployed Field Testing Units

Lab Testing

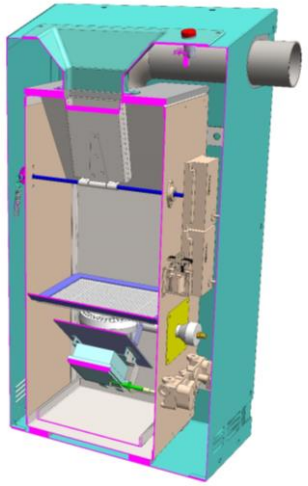
Solid Models

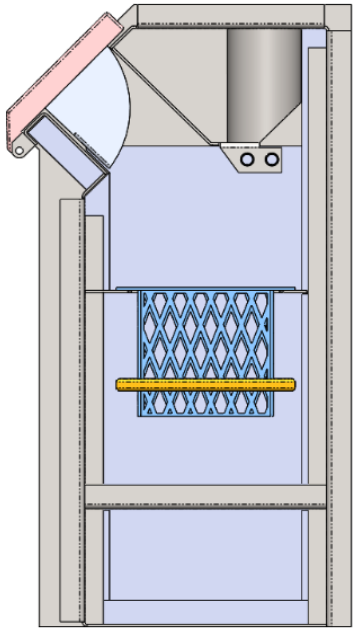


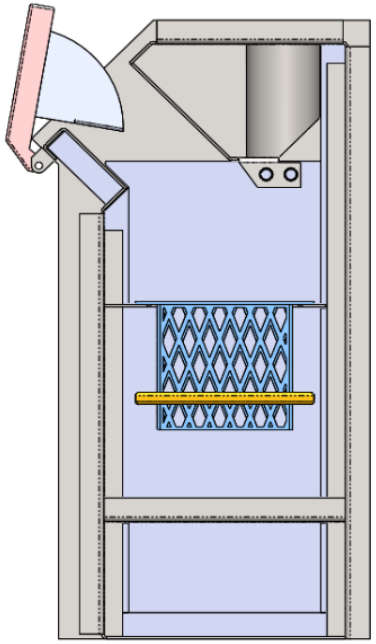


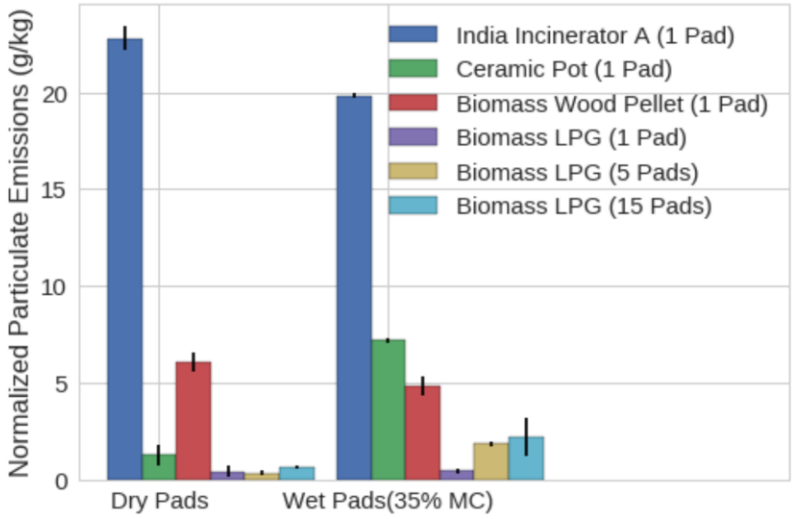
Field Testing Platform

S.H.E. (MHM)









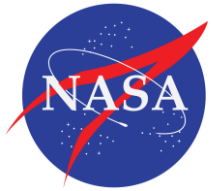
Lab testing has led to an re-engineering phase for field deployment testing

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

G K Controls Private Limited



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