

Day 2 - Wednesday Nov. 3rd

Chat Conversation

Progress in Tech Research (Part 1)

Moderator: Arthur

Presenters:

Kai M. Udert

State of the art of urine treatment technologies

- **From Hilda Maingay:** Kai, any research papers that cover the best ways to stabilize urine on a household level and maybe also pasteurization. (alkaline process?)
 - **Response from Kai:** Hilda, most of the processes to stabilize urine on a Household Level aim to prevent urea hydrolysis. Acid dosage and base dosage (see Michel's talk) were used, but also electrolysis with the aim to destroy urease.
- **From Kimmerly Nace:** Thank you for such a complete overview - And very hopeful. Are there urine treatments being developed that you have heard of since 2019? What seems most promising? Are there specific research areas that need more focus?
 - Answered Live
- **From Greg Hostetler:** Why did you decide to stabilize the urine with CaOH_2 instead of using acidification?
 - Answered Live

Michel Riechmann

Field Testing the Blue Diversion Autarky Urine treatment

- **From Prithvi Simha:** What is the final form of the product you harvest from the dryer? And how do you envision it being emptied and used/sold?
 - Answered live
- **From Roland Missengue:** Michel, how long does the process take from stabilization to evaporation? What is the fertilizer production rate?
 - **Response from Michel:** The stabilization lasts less than 30 seconds. To assure a complete stabilization, the reactor is mixed hourly for three minutes, to make sure fresh urine gets in contact with the $\text{Ca}(\text{OH})_2$ in the depot at the bottom of the reactor. And to Rolands second question: The fertilizer production rate is around 4 kg that is harvested every month.
- **From Prithvi Simha:** Do you envision the BD autarky toilet with its current space footprint to be used in dense urban areas?
 - **Response from Michel:** The current footprint is still not optimized. However in dense applications nowadays you see a tendency to individual living. If you accordingly have a reduced number of users, the size of the module shrinks accordingly. Nevertheless we are also looking at other means of increasing the evaporation surface that are even more space efficient.
- **From Michel Riechmann:** For more information on the field testing of the Autarky urine treatment, also see our recent paper:
<https://www.sciencedirect.com/science/article/pii/S2589914721000372>

Abe Noe-Hays

Advancing the Design and Operating Conditions for Block Freeze Concentration of Urine-Derived Fertilizer

- **From Dyllon Randall:** Abe, while the NPK nutrient ratio stays the same, do the other key components in the urine change i.e. do you get precipitation occurring (things like CaCO_3) when the temperature drops since the solubility is really low for some compounds in urine? Also, what is the purity of the melted ice and how does this compare to drinking water standards in the US?
 - **Abe's response:** re. mineral precipitation and melt water purity: We expected, but did not

observe mineral precipitation in the freeze concentrator. The meltwater is 10x more dilute than urine, which means it still has about 600 mg/L nitrogen, to name one constituent. This is much higher than drinking water, so it would need to be treated before reuse for potable use (or most non-potable uses).

- **From Kai Udert:** Abe, what was the energy demand for the pasteurization step?
 - Abe answered live
- **From Karina:** Abe, what about using winter temps to passively freezing in cold climates?
 - **Abe's response:** passive freezing in winter: Yes, passive freezing in winter and melting in spring works in the Vermont climate, although you only get one freeze/thaw cycle per year.
- **From Lynn Broaddus:** Can you provide a link to paper? Thanks!
 - **From Ryan Homeyer:** Link to Freeze Concentration Paper:
<https://pubs.acs.org/doi/abs/10.1021/acsestengg.1c00271>

Sudeep Popat

Stabilization of source-separated urine using electrochemically synthesized hydrogen peroxide

- **From Kai Udert:** any issues with oxidation by-products? H₂O₂ can dissociate to hydroxyl radicals, which are very reactive.
 - **Sudeep's response:** We're working on real urine now. With this proof-of-concept study, no oxidation was observed, as we didn't have other organics other than acetate in the synthetic urine. But we'll definitely explore this more with real urine.
- **From Prithvi Simha:** have you performed follow-up trials with real urine (so very different than "synthetic urine"), and if so, what were the deviations?
 - **Sudeep's response:** We're working on this now. We expect to see some differences, but the peroxide concentrations we can produce are high and tunable, so we can address any scavenging of peroxide by increasing/decreasing the current applied.
- **From Sudeep Popat, Clemson:** Thanks everyone. I'll miss most of the remaining session, as I have to go teach in 15 minutes. But looking forward to watching videos of the remaining presentations. Happy to connect with anyone interested in the work we do, or for any synergies in projects you may be working on - please email me at spopat@clemson.edu.

Philipp Markus

Successful application of nitritation/anammox to undiluted source-separated urine

- **From Prithvi Simha:** do you foresee and will work on a decentralized PNA system for household applications at building or community-scale in the future?
 - Answered live