

Day 2 - Wednesday Nov. 3rd

Chat Conversation

Progress in Tech Research (Part 2)

Moderator: Abe

Presenters:

Dyllon Randall

Recovering urea crystals from stabilized human urine

- **From Rebecca Nelson:** Dyllon, For the passive dosing with calcium hydroxide, how can you know whether the solid material in your toilet is the $\text{Ca}(\text{OH})_2$ or the calcium phosphate precipitate?
 - **Response from Dyllon:** Hi Rebecca, it would be a mixture of residual calcium hydroxide, calcium phosphate, magnesium hydroxide and calcium carbonate. More about it here: <https://www.sciencedirect.com/science/article/pii/S2213343718306043>
- **From Michele Heeb:** at what scale are you currently using/testing the method you presented?
 - **Response from Dyllon:** We have only tested the method at lab scale as a proof of concept
- **From Abe Noe-Hays:** Can you describe the process you referenced that evaporates water at 30 Wh/L.
 - **Response from Dyllon:** I think they used a simple tray system to remove the water by evaporation. The details would be in the publication I referenced.

Stephanie McCartney

Advancing Membrane Technologies for Phosphorus and Nitrogen Recovery from Human Urine

- **From Kai:** Stephanie, how would you stabilize the fresh urine and how will this influence the phosphate transport?
 - **Stephanie's response:** That is a great question and something I will need to consider. I would love to hear your thoughts.
 - **Response from Kai:** Stephanie, stabilizing with $\text{Ca}(\text{OH})_2$ will not be a good option for the reasons Prithvi mentioned. Additionally, the remaining phosphate will be present as PO_4^{3-} . If you stabilize with acid, the much of your phosphate might be in the form of H_3PO_4 , depending on the pH you will achieve. If you keep the pH above 4, nearly all phosphate will be H_2PO_4^- . this might be ideal for your process.
 - **From Stephanie:** Thanks, Kai! We are looking at pH manipulation in our next study, but not in the context of stabilization. But that may be something to add to the work!
- **From Prithvi Simha:** Stephanie, can you please motivate why phosphorus selectivity is so important? Why focus on just one or two nutrients, when we can recover and recycle all using other methods that Kai presented before? Also, Do you also aim to combine both of your membrane-based processes? Because I didn't understand how you'd recover ammonia and phosphorus as you need hydrolysed urine for the first and fresh urine for the second.
 - **Stephanie's response:** Hi Prithvi, we do aim to put both in sequence. First, is P recovery from fresh urine using the Donnan dialysis technique and the second step is once urine hydrolyzes we apply membrane distillation to capture ammonia
 - **From Prithvi:** Thanks Stephanie, it would be really difficult to use both membrane processes, without prior stabilisation of urine as Kai also mentioned. And most stabilisation processes would increase pH and precipitate phosphorus anyway. Something to consider :)

Caitlin Courtney

Concentrating stabilized human urine using reverse osmosis to produce fertilizers

- **From Michel Riechmann:** Caitlin, Did you reach a stable flux in your experiments or did you stop the experiments before?

- **Response from Caitlin:** our setup uses a small flat sheet membrane (only 140cm²). Because of this we need to continuously recycle the brine. As the brine concentration increases the permeate flux will also decrease so its not possible to see stability. We do plan on doing longer run tests where we recycle the permeate back to the tank with the brine (keeping the feed concentration the same). Doing this we'll be able to monitor stability.
- **From Kai Udert:** Caitlin, what was the rejection rate for the different nutrient compounds?
 - **Caitlin's response:** the rejection (for real urine) for urea was 83%, potassium was 98% and the phosphorus was precipitated in the Ca(OH)₂ stabilization step.
- **From Asfak Patel:** Caitlin, Have you checked the membrane life cycle? How many liters of urine can we treat for one time use of membrane?
 - **Caitlin's response:** this will be tested in our pilot plant during long term operation.

Dr. Lei Guo

Inhibition of Urea Hydrolysis in Human Urine by Pharmaceuticals and their Metabolites

- **From Abe Noe-Hays:** Lei Guo, How do the levels of pharmaceuticals necessary for urease inhibition compare to the levels typically found in urine? What is a typical ug/L concentration of a pharmaceutical at inhibitory levels?
 - **Response from Lei:** Great question! We are working on pushing the limit of the concentration of pharmaceuticals to see how low levels we will need for the drug molecules.
- **From Kai Udert:** Lei, How will you remove the pharmaceuticals later?
 - Answered Live
- **From Michele Heeb:** Lei, but isn't then the end product contaminated with the pharmaceuticals?
 - **Response from Lei:** Thanks for the question! We are currently investigating two possible directions: (1) As urine already contains relatively high concentration of pharmaceuticals itself, we are studying if the level of concentration can inhibit urease; (2) We are also studying if we can incorporate the other treatment technologies (e.g., membrane, aop) to remove the pharmaceuticals by the end of the treatment. I hope this answers your question.
- **From Dyllon Randall:** Lei, what happens if people did not take these specific pharmaceuticals - the urea in urine would not be stabilized?
 - Answered Live

Taylor Zehren & Thor Retzlaff

Introducing waste*development, for portable sustainable sanitation

- **From Michael Snow:** Thor, do you have a price point you expect these to sell for (ie to port a potty companies)?
 - Answered Live
- **From Michèle Heeb:** Hi Thor, nice design! Maybe I missed it but how (and who) is going to treat and collect the waste from the toilets?
- **From Michel Riechmann:** Thor, for the separation mechanism, did you partner up with EOOS to integrate their urine trap or did you develop your own system?
 - Answered Live
- **From Lynn Broaddus:** Thor, Do you have any of your prototypes available for use in other places?
 - Answered Live
- **From Hilda Maingay:** Thor, what kind of UD toilet shape did you use to avoid user mistakes, like putting paper in the wrong place and plug up the urine pipe
 - Answered Live
- **From Carol McCreary:** What sort of clients are you looking for? (Maybe the Olympic Discovery Trail, which is accessible by road?)
 - Answered Live
- **From Hilda:** Thor, do you have a diagram of your UD toilet? We live with UD toilet at home without

problems, but often in public UD toilet has problems because of user mistakes of where they put the paper and other particles that can come from clothes (leaves, dirt) and the body (hair) and TAre you using the little schematic drawing on your 'napkin'? Is there a higher risk of cross contamination?

- [Response from Thor](#): Our technology was born from a napkin sketch. We have developed it to limit cross contamination and maximize user interface.
- [From Thor Retzlaff](#) | waste*development: Please reach out thor@waste-d.com