Nitrogen Recovery from Source-Separated Urine

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BACKGROUND: Urine comprises 1% of waste water volume, if separated from feces in source-separating toilets it provides access to large quantities of nutrients

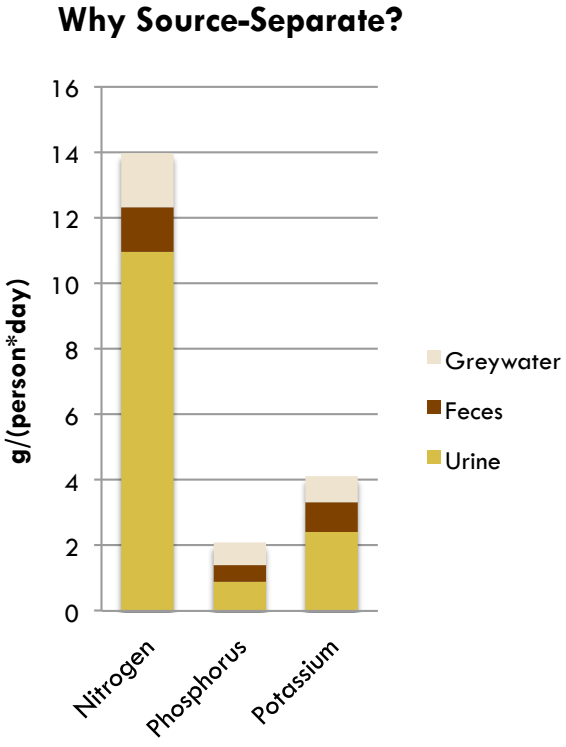


Figure 1. Benefits of source-separating urine

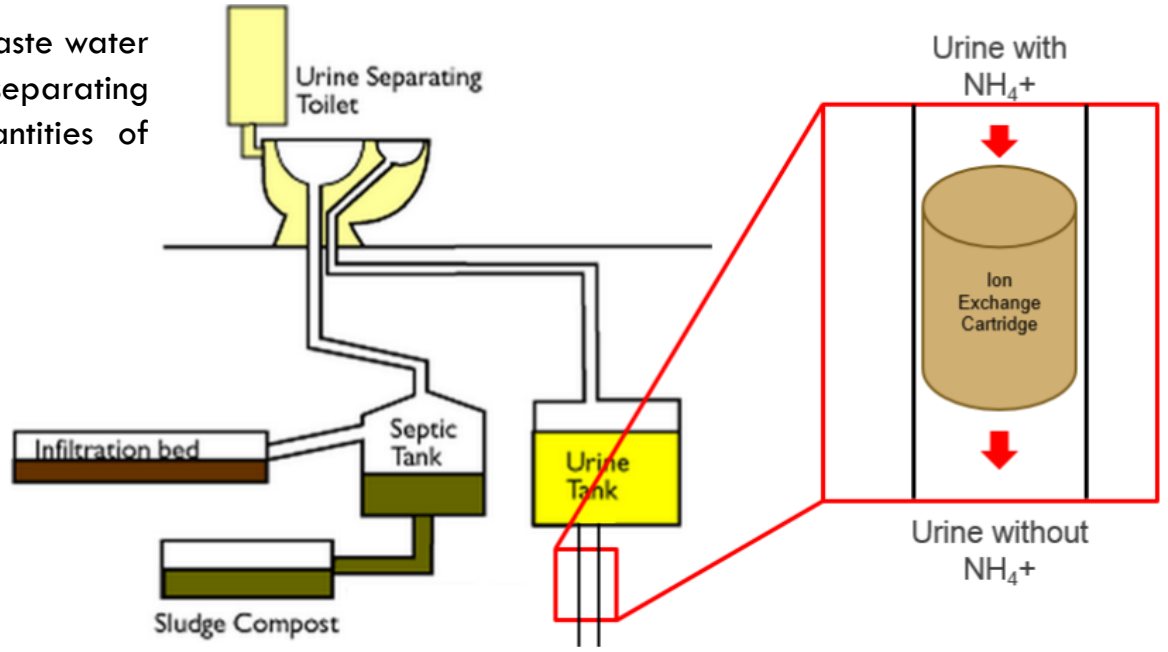


Figure 2. Visualization of the application and use of the ion exchange cartridge in a source-separating toilet

OBJECTIVES:

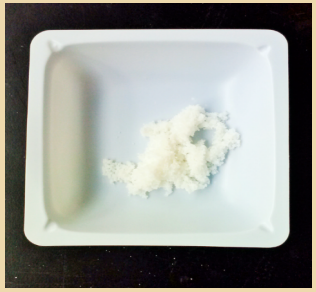
- Develop an ion exchange cartridge to recover nitrogen in the form of ammonium (NH_4^+) from source-separated urine to create fertilizers
  - Find a resin capable of adsorbing large quantities of NH_4^+
  - Determine how the uptake of NH_4^+ is affected with the presence of the other cations found in urine (K^+ & Na^+)

DESIGN APPROACH:

24 Hour Batch Experiments

Ammonium Chloride Batch Experiments

- Determined that Dowex Mac 3 was the cation exchange resin to use for the design of the ion exchange cartridge



Dowex Mac 3

Synthetic Urine Batch Experiments

- Derived a Competitive Adsorption Langmuir Model
  - Purpose: Understand the uptake of NH_4^+ in the presence of the additional cations found in urine (K^+ & Na^+)
  - Expect: NH_4^+ uptake will decrease because of competitive adsorption

Urine (Real) Batch Experiments

- *To be completed*-Derived data will be compared with synthetic urine Competitive Adsorption Langmuir Model

Competitive Adsorption Langmuir Model

$$q = K_{ads,i} q_{max} C_i / 1 + \Sigma K_{ads,j} C_j$$

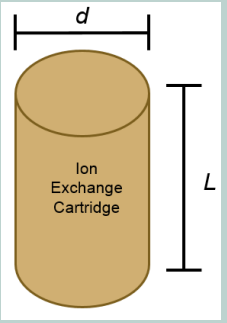
K_{ads} = *adsorption constant*
q_{max} = *maximum adsorption density*
C_x = *final concentration*
q = *adsorption density*

Continuous Experiments

- Derived dimensions for the ion exchange cartridge by using the derived expression on the right; type of toilet (gallons/flush) and pipe diameter were considered
- Continuous experiments: will see how the uptake of NH_4^+ is affected given a continuous flow of NH_4Cl solution, synthetic urine, or actual urine; Dowex Mac 3 and derived dimensions of cartridge will be used for experimental setup

$$\frac{L}{t} = \frac{QC_{in}}{q_{in}\rho_b \pi \left(\frac{d}{2}\right)^2}$$

L = *Length of cartridge*
t = *time*
q_{in} = *adsorption density*
d = *diameter of cartridge*
Q = *Flow rate*
C_{in} = *Concentration*
ρ_b = *bulk density*



Intermittent Experiments

- *Future work*