# Electrochemical system for selective

## 2 oxidation of organics over ammonia in

### 3 urine

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#### 10 Declarations of interest: none

#### 11 Supplementary information

#### 12 S1. List of runs

- 13 Runs were named in order of execution and are listed in Table 1. Runs irrelevant to the research
- 14 question of this article, as well as runs that failed due to leakages or other technical problems are not
- 15 included in this list. 30 runs were included in this study.
- 16 Table S1 Runs

Run	Feed	рН	Duration, h	Gas TAN Analysis
B15	Simulated	Neutral	72	No gas capture
B17	Simulated	5	95	Gas Wash Bottle
B20	Simulated	Neutral	72	Gas Wash Bottle
B22	Simulated	Neutral	95	Gas Wash Bottle
B23	Simulated	5	74	Gas Wash Bottle
B25	Simulated	3	96	Gas Wash Bottle
B27	Simulated	3	95	Gas Bag
B28	Simulated	2	95	Gas Bag
B29	Simulated	3	72	Gas Bag
B30	Simulated	2	72	Gas Bag
B31	Simulated	1.5	94	Gas Bag
B32	Simulated	Neutral	94	Gas Bag
B33	Simulated	1.5	71	No gas capture
B34	Simulated	2	71	No gas capture
B41	Simulated	3	71	No gas capture
B42	Simulated	2	71	No gas capture
B43	Simulated	3	95	Gas Bag

B44	Simulated	2	95	Gas Bag
B47	Simulated	1.5	43	Gas Bag
B36	Real Urine	Neutral	94	Gas Bag
B38	Real Urine	Neutral	72	No gas capture
B40	Real Urine	2	93	Gas Bag
B45	Real Urine	5	76	No gas capture
B46	Real Urine	2	76	No gas capture
B48	Real Urine	2	43	Gas Bag
B49	Real Urine	2	71	No gas capture
B55	Real Urine + KCl	3	113	No gas capture
B56	Real Urine + KCl	Neutral	113	No gas capture
B57	Real Urine + KCl	5	76	No gas capture
B58	Real Urine + KCl	Neutral	52	No gas capture

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#### 18 S2. Measured pH in anodic and cathodic compartments

pH in anodic and cathodic compartments in all runs are presented overlaid in Figure S1. The pH in the neutral runs (Figure S1a) remained similar in anodic and cathodic compartments until 48h, after which a separation in anodic and cathodic pH's was detected, indicating a loss of buffering capacity. The explanations for the observed overall drop in reactor pH were not identified. Anodic pH measurements in runs at pH 5 and pH 3 are noisy as these pH's are in a rapidly changing region. The anodic pH rise in b) at ~60h is due to a temporary pump failure. Anodic pH rise in c) at 0-12h is due to pH probe bypass error.



- 26
- Figure S1 pH in the anodic and cathodic compartment during experiments with simulated urine in a) neutral runs, b) in pH 5 and c) in pH's 3, 2 and 1.5.
- 29 The initial pH drop is presented in more detail in Figure S2. A buffering effect in the anodic loop is
- 30 clearly visible at pH 6.5-7 for the first 75min after which a rapid drop to pH 2 is observed. In pH 3 runs,
- 31 this drop is cut by pH relay regulated pump.



Figure S2 pH in the anodic and cathodic compartment during experiments with simulated urine in pH
3 and below during the first 2h.

#### 35 S3. Anodic compartment TAN and chloride concentrations

36 Anodic compartment TAN and chloride concentration are presented in Figure S3. In neutral pH (Figure 37 S3a), the concentrations are identical to full reactor concentrations, as the system is fully mixed. In pH 38 5 and pH  $\leq$ 3, TAN concentration rapidly drops to a relative concentration level between 0.2-0.25 C/C<sub>0</sub> 39 and remains stable. Chloride concentration is presented in parallel with the average full reactor 40 concentration and a more rapid drop in chloride concentration is visible in pH  $\leq$ 3 compared at the 41 anode compared to full reactor results (see Figure S3c).



Figure S3 TAN and chloride concentrations in the anodic compartment and the chloride trend in the whole reactor in a)
 neutral pH, b) pH 5 and c) pH 3 and below.

45 S4. NOx by-products

46 Measured nitrate and nitrite concentrations are presented in Figure S4, presented as fractions to 47 initial TAN ( $C/C_0$ ). In neutral pH (Figure S4a), both nitrate and nitrite are detected in the system and 48 both species are removed within the timeframe of the experiment. In experiments with  $pH \le 5$ , 49 formation of nitrate is visible in the anodic chamber (Figure S4b) during the first 24h, after which 50 nitrate is removed. Nitrite is detected almost entirely in the cathodic compartment, during first 36h 51 when nitrate concentration is the highest.



Figure S4 Relative nitrate and nitrate concentrations in simulated urine relative to initial TAN (C/C<sub>0</sub>) in a) neutral pH in the whole reactor, and in the b) anodic compartment of runs with pH  $\leq$ 5 and c) cathodic compartment of runs with pH  $\leq$ 5.

#### 55 S5. Real urine measurements

56 Chlorine mass balance in real urine is presented in Figure S5. In real urine (Figure S5a), chloride is 57 converted to perchlorate within the first 24h. Chlorate is detected as an intermediate product. When 58 surplus chloride is added as potassium chloride (Figure S5b), only a small fraction of lost chloride is 59 detected as perchlorate. This is at least partly due to precipitation as potassium perchlorate which 60 was collected and analysed on the membrane at the cathodic chamber in these runs. Rate of chloride 61 removal at neutral pH, pH 5 and pH 3 was clearly different in these three regions, indicating a change

62 in chloride oxidation pathway on the anode.



Figure S5 Relative amounts of chloride, chlorate and perchlorate compared to initial reactor amount of chloride in a) real urine and b) chloride supplemented urine.

66 Nitrate and nitrite concentrations are presented in Figure S6. Only small amounts of nitrate and67 negligible amounts of nitrite were detected in real urine, corresponding to the observation that very

- 68 little nitrogen was oxidized. In surplus chloride, higher nitrate and nitrite were detected, similar to
- 69 levels observed in synthetic urine.



71 Figure S6 Relative nitrate and nitrate concentrations relative to initial TAN ( $C/C_0$ ) in a) real urine and b) chloride 72 supplemented urine.

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#### 74 S6. Minteq parameters

75 Table S2 Utilized Minteq parameters.

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Parameter	Value		
Alkalinity is specified in this problem	Yes		
Option of alkalinity claclulation	Normal		
Terminate if charge imbalance exceeds 30 %?	No		
Choose the number of iterations:	2000		
Method for activity correction	Davies, b=0.3		
Oversaturated solids	Are not allowed to precipitate		
Minimum concentration of species	1E-300		
Minimum value of saturation index for solids	-500		
Maximum value of saturation index for solids	500		
Model parameter set	HFO (Dzombak & Morel)		
Interface model	2-pK DLM		
Specific surface area m2/g	600		
Site density, no1	2.25581		
Site density no2	0.05639		

77 S7. Examples of measured potentiostatic data



79 Figure S7 Example of recorded cell voltage and anodic potentials in different pH values.