Electronic Supplementary Material (ESI) for Environmental Science: Water Research & Technology. This journal is © The Royal Society of Chemistry 2016

## Hypoaeration of Activated Sludge to Reduce Energy Requirements at Distributed Reclaimed Water Plants: Studies at Bench and Pilot Scales

Dotti F. Ramey, Junko Munakata-Marr, Tzahi Y. Cath\*

Colorado School of Mines, Golden, CO, USA

\*Corresponding author: email: tcath@mines.edu

**Supplementary Information** 

| Phase            | Fill |       | React | Settle | Decant |         |
|------------------|------|-------|-------|--------|--------|---------|
| Blower           | OFF  | ON    | OFF   | OFF    |        |         |
| Mixer            |      |       | ON    | OFF    |        |         |
| Cycle time (min) | 0-20 | 20-60 | 60-75 | 75-90  | 90-110 | 110-120 |

**Fig. SI-1.** Typical schedule of phases and sub-phases during the bench-scale SBR testing. The total aeration time "ON" during the HDO-B test was 50 minutes and 55 minutes during the LDO-B test. The phase length and aeration sub-phase lengths were controlled by the LabVIEW program.

|                  | Bioreactor 1 | l     |       |    |            |       |     |    |  |  |  |  |
|------------------|--------------|-------|-------|----|------------|-------|-----|----|--|--|--|--|
| Phase            | React/Fill   | React |       |    | React/Draw |       |     |    |  |  |  |  |
| Blower           | OFF          | ON    | OFF   | ON | OFF        | ON    | OFF |    |  |  |  |  |
| Mixer            | ON           |       |       |    |            |       |     |    |  |  |  |  |
|                  | Bioreactor 2 |       |       |    |            |       |     |    |  |  |  |  |
| Phase            |              | React | /Draw |    | React/Fill | React |     |    |  |  |  |  |
| Blower           | OFF          | ON    | OFF   |    | OFF        | ON    | OFF | ON |  |  |  |  |
| Mixer            | ON           |       |       |    |            |       |     |    |  |  |  |  |
| Cycle time (min) |              | 0-6   | 60    |    | 60-120     |       |     |    |  |  |  |  |

**Fig. SI-2.** Treatment phases and sub-phases in each bioreactor during a treatment cycle in pilot-scale testing. The length of the aeration and non-aeration sub-phases within the 'react', and 'react/draw' phases can be adjusted to meet treatment goals. Adapted from <sup>37</sup>.



**Fig. SI-3.** Effluent concentration for (a) standard conditions (HDO-B) and (b) hypoaerobic conditions (LDO-B). Steady state was achieved when the effluent concentration of ammonium was equal to or less than 5 mg/L-N, and COD less than 40 mg/L. Steady-state conditions were established on day 14 of HDO-B testing and day 15 of LDO-B testing.



**Fig. SI-4.** Comparison of DO profiles for the bench-scale HDO-B and LDO-B tests. DO concentration control set points were 1.8 and 2.1 mg/L for HDO-B and 0.7 and 0.8 mg/L for LDO-B tests. The profiles show that the DO concentration was successfully controlled for each test condition.



**Fig. SI-5.** Pilot-scale effluent ammonium, TN, and COD concentrations under (a) standard conditions (HDO-55) and (b) hypoaerobic conditions (LDO-55). Data show that COD steady state was achieved from the first day of each test condition and that effluent concentrations were less than half of the target concentration. During the LDO-55 testing, all effluent concentrations were below target levels from day 2, demonstrating that no acclimation period was required for nitrification under hypoaerobic conditions.



**Fig. SI-6.** Evaluation of  $NO_2/NO_3$  ratio and nitrite accumulation under hypoaerobic conditions. The very low  $NO_2/NO_3$  ratio in the effluent shows that nitrite did not accumulate under hypoaerobic conditions and SND was not a mechanism of TN removal in the pilot-scale hypoaerobic system.