Supplementary material for

Anaerobic Fluidized-bed Membrane Bioreactor for Treatment of Liquid Fraction of Sludge Digestate: Performance and Agricultural Reuse Analysis

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1. Recovery of nitrogen in nutrient recovery units

1.1 Effect of pH and time on the recovery of nitrogen by purging

As shown in Fig. 1a, the removal of NH_4^+-N increases as the blowdown time increases and the blowdown pH increases. This is due to the fact that the blow-off is mainly related to the dissociation of NH_4^+-N. The longer the blow-off time, the more NH_3 is naturally taken out of the solution and the higher the removal rate of NH_4^+-N from the solution. pH is higher, the easier it is for NH_4^+-N in the solution to proceed in the direction of generating free NH_3, and the easier it is for the NH_3 to be taken out of the gas.

1.2 Effect of temperature on the recovery of nitrogen by purging

The relationship between the purge temperature and the removal of NH_4^+-N at a purge time of 2 hours and a pH of 11 is shown in Fig. 1b. As the blowdown temperature increased, the removal rate of NH_3 increased. This is because the increase in temperature intensifies the Brownian motion, making it easier for NH_3 in the aqueous solution to escape. In addition, the higher the temperature, the higher the degree of dissociation of water, the more favorable the dissociation of NH_4^+-N, and the higher the rate of dissociation, resulting in higher NH_4^+-N removal.

2. Recovery of phosphorus in nutrient recovery units

2.1 Effect of pH on phosphorus recovery by precipitation

The effect of different pH values on the removal of PO_4^{3-}-P is shown in Fig. 2a. The formation of $MgNH_4PO_4$ is most favored at a pH of 9. When the pH is too high or too low, the removal of phosphate ions is not favored. This is due to the fact that when the pH <9, the NH_4^+-N solution in solution produces NH_3 that binds to water, which is detrimental to the formation of $MgNH_4PO_4$ When the pH >9, OH^- in the solution competes with the PO_4^{3-}-P and NH_4^+-N to produce $Mg(OH)_2$, resulting in a decrease in Mg^{2+} content of the solution, which is not conducive to the formation of $MgNH_4PO_4$. Therefore, the pH of the solution is too high or too low for the formation of $MgNH_4PO_4$.

2.2 Effect of P/N ratio on phosphorus recovery by precipitation

The removal rates of phosphate for different P/N ratios are shown in Fig. 2b. The removal rate of PO_4^{3-}-P increased as the NH_4^+-N dosage was increased. When the P:N ratio exceeds 1:1.2, the increase in PO_4^{3-}-P removal decreases. Although there is still a large amount of NH_4^+-N in the solution, it is difficult to form $MgNH_4PO_4$ at this point due to the limitations of PO_4^{3-}-P and Mg^{2+} content. Therefore, increasing the amount of NH_4^+-N added is beneficial to improve the removal rate of PO_4^{3-}-P, but beyond a certain percentage, there is no substantial increase in the generation of $MgNH_4PO_4$.

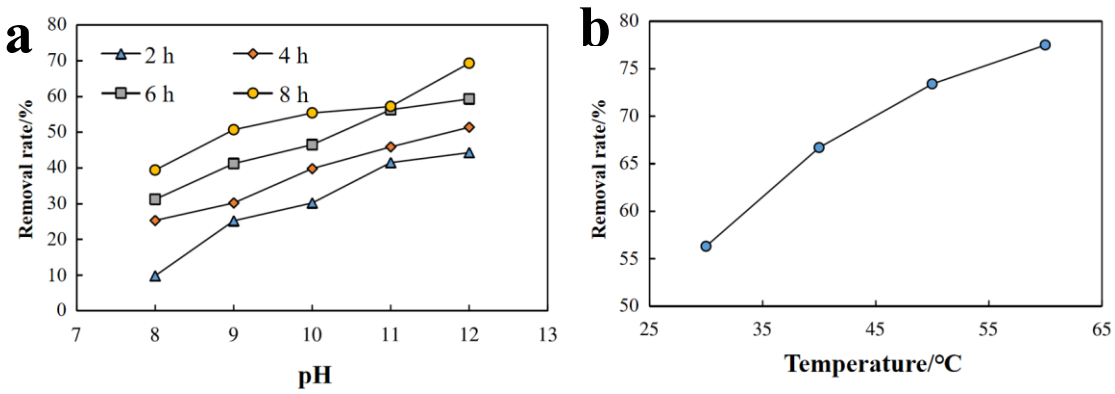

Fig. S1 Effect of different blow-off conditions on NH_4^+-N removal.

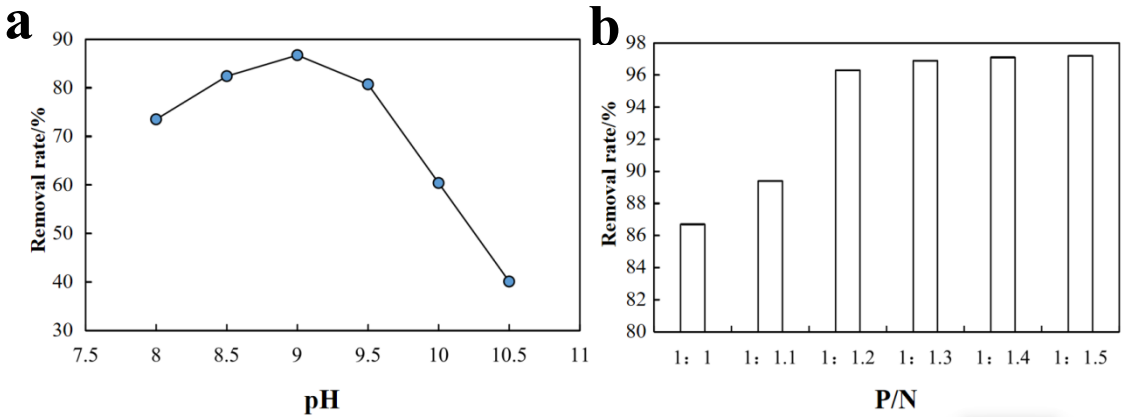

Fig. S2 Effect of different blow-off conditions on PO_4^{3-}-P removal (**a:** Mg:N:P =1:1:1**; b:** Mg:P =1:1).