A method and a system for enhancing Nitrogen removal in a GSBR and computer program product

Summary

Aerobic granular sequencing batch reactors (GSBR) have been successfully used for the treatment of municipal and industrial wastewater effluents.

To date most of the efforts were focused on understanding the behaviour of the GSBR, but not in finding the best practical strategy to be implemented with the aim to improve the N-removal.

To that end we developed a system for enhancing N-removal in a GSBR by controlling the dissolved oxygen (DO) by means of a closed loop based, comprising DO set point value automatic calculation (computer program) depending on ammonium concentration measurement at the end of the cycle.

N-removal efficiency after the activation of the control strategy increased from 48% to 75% during the first 36 hours and it remained stable during the next 36 hours (Figure 1).

We are looking for a company willing to acquire a competitive advantage via a license agreement.

State of development

Mathematical model describing the steady state operation of a GSBR treating diluted swine wastewater which was calibrated and validated with different sets of experimental data.

Assessment of the N-removal in the GSBR for five different scenarios which were simulated until steady state for practical DO concentrations and granule sizes.

Innovative aspects and applications

➢ N-removal higher than 70 % despite oscillations of the amonium in the effluent or any other disturbance in variables such as the granule size, influent C/N ratio or NLR.
➢ Reduced aeration costs. DO concentrations lower than 2 mg O_2 L^{-1}.
➢ Maintains the normal cycle of the GSBR
➢ Robust and long term operation control.
➢ Only DO set point is directly manipulated.
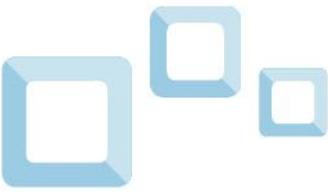➢ Automatic calculation of the DO concentration set-point value by computer program.
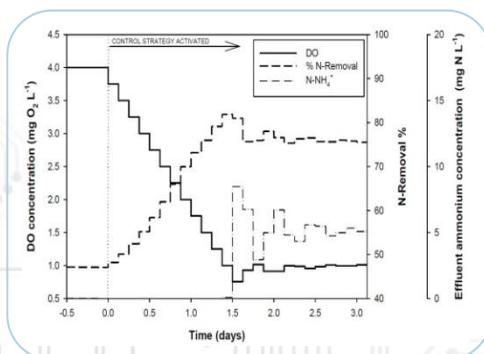
Figure 1: N-removal efficiencies before and after applying the proposed cascade control strategy in the GSBR (ammonium set-point 5 mg N L^{-1})
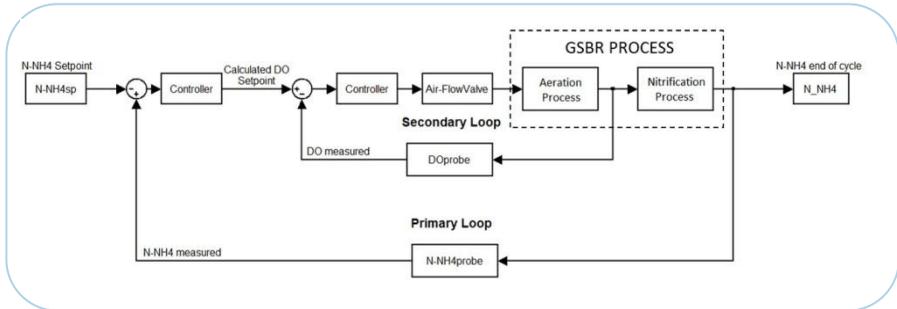
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Figure 2: Block-diagram of the cascade control strategy to enhance the N-removal

The Invention

Contrary to the known methods, the method comprises on-line measuring the ammonium concentration in the effluent of the GSBR during an operating cycle of the GSBR, preferably at the end thereof, and calculating by computer program the constant dissolved oxygen concentration set-point value for a consecutive operating cycle based on the result of the ammonium concentration measurement.

Two are the controllers used to implement the method:

1. For controlling the oxygen injection inside the GSBR.
2. Automatic $DO_{SET-POINT}$ calculation

Scientific References

http://www.sciencedirect.com/science/article/pii/S1385894713010383#

Facts

N-removal was enhanced when a small excess of ammonium was maintained in the effluent, i.e. at the end of the GSBR cycle (i.e. 5 mg $N-NH_4^+$ L^{-1}).

The required ammonium excess was easily achieved by imposing the adequate DO concentration in the reactor, to limit the nitrification step.

The search for the adequate DO concentration in the reactor can be easily automated by means of the novel cascade control strategy of the present invention protected by patent.

The control strategy will set the appropriate DO set-point at whatever values of granule size, influent C/N ratio or NLR. Therefore a high N-removal will be assured by the control strategy against disturbances in those variables, which are common during the reactor operation.

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