



Multi-objective optimization of cascade controller in combined biological nitrogen and phosphorus removal wastewater treatment plant

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ABSTRACT

The multi-objective genetic algorithm (MOGA), aiming at determining the optimal set points for controllers existed in the supervisory control layer, is developed to enhance the treatment performance of a combined biological nitrogen and phosphorus removal wastewater treatment process (i.e. an anaerobic-anoxic-oxic process). Firstly, a cascade ammonia controller that consists of a primary proportional-integral (PI) controller and a secondary PI controller is set up and tuned using the internal model control tuning rule. The primary controller is used to control the ammonia concentration in the effluent and the secondary controller is used to control the dissolved oxygen concentration in the last reactor. This cascade controller could lead to better set point tracking and disturbance rejection control performance. Then, the multi-objective optimization (MOO) of the effluent ammonia controller set point and the nitrate controller set point in the fourth reactor is performed using the MOGA. The two conflicting optimization objectives are (1) effluent quality index which is a function of various main effluent loads and (2) energy consumption which is the sum of aeration energy consumption and pumping energy consumption. The MOO results indicate that the optimal set points for the effluent ammonia concentration and the nitrate concentration in the fourth reactor are both about 1.1 gN/m^3 . The cascade controller with the optimal set points has the capability of enhancing the effluent quality and the energy-saving performance simultaneously.

Keywords: Multi-objective optimization; Genetic algorithm; Cascade control; Anaerobic-anoxic-oxic process

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