Finding Optimal Operation Condition in a Biological Nutrient Removal Process with Balancing Effluent Quality, Economic Cost and GHG Emissions

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Abstract : It is hard to maintain the effluent quality of the wastewater treatment plants (WWTPs) under with fixed types of operational control because of continuously changed influent flow rate and pollutant load. The aims of this study is development of multi-loop multi-objective control (ML-MOC) strategy in plant-wide scope targeting four objectives: 1) maximization of nutrient removal efficiency, 2) minimization of operational cost, 3) maximization of CH4 production in anaerobic digestion (AD) for CH4 reuse as a heat source and energy source, and 4) minimization of N2O gas emission to cope with global warming. First, benchmark simulation mode is modified to describe N2O dynamic in biological process, namely benchmark simulation model for greenhouse gases (BSM2G). Then, three types of single-loop proportional-integral (PI) controllers for DO controller, NO3 controller, and CH4 controller are implemented. Their optimal set-points of the controllers are found by using multi-objective genetic algorithm (MOGA). Finally, multi loop-MOC in BSM2G is implemented and evaluated in BSM2G. Compared with the reference case, the ML-MOC with the optimal set-points showed best control performances than references with improved performances of 34%, 5% and 79% of effluent quality, CH4 productivity, and N2O emission respectively, with the decrease of 65% in operational cost.

Keywords : Benchmark simulation model for greenhouse gas, multi-loop multi-objective controller, multi-objective genetic algorithm, wastewater treatment plant
Conference Title : ICMCE 2015 : International Conference on Mechanical and Control Engineering
Conference Location : Zurich, Switzerland
Conference Dates : July 29-30, 2015