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Global sensitivity analysis in modeling of high-rate activated sludge system for energy production

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In a worldwide level, the need for environmental protection is recognized and demands new methods to exploit the renewable energy sources and products that can be reused. This tendency in recent years has a major influence on wastewater treatment methods, as it is directed from methods aimed at removing wastewater to methods that aim to exploit them for energy production. One of these systems is the High-rate Activated Sludge system (HRAS), and specifically the A-stage of an AB (Adsorption / Bio-oxidation) process. The purpose of the A-stage of an AB process is for the carbon oxidation to be minimized and to foster the carbon sorption with biological flocculation and intracellular storage of soluble substrate. In other words, the idea is to remove organics through adsorption in order to produce large amounts of waste sludge that can be converted to biogas by anaerobic digestion (Schulze-Rettmer and Zuckut, 1998). The general characteristics of a HRAS system are the low solids retention time (SRT), low hydraulic residence time (HRT) and low dissolved oxygen (DO) levels, which results in relatively small reactor volumes at potentially lower costs (Jimenez et al., 2013). According to Thomas Nogaj (2015) the mathematical model which will be used is referred to as the A-stage high-rate activated sludge (HRAS) - Dual Substrate Model. The Dual Substrate approach indicates that the fast biodegradable soluble substrate (SBf) and slow biodegradable soluble substrate (SBs) are metabolized simultaneously. Moreover, the Dual Substrate model calibrates slightly better than the Diauxic Model (Nogaj, 2015). In this study a comprehensive sensitivity analysis based on Monte Carlo method was conducted. The mathematical model takes into account the random fluctuation of model's parameters by creating a range of possible values for each one of them and a corresponding probability distribution. Thus values selection is taking place in a pseudo-random way through a specific probability distribution (normal, lognormal, uniform, etc.). According to the results the most important stoichiometric and kinetic parameters that affects model's results are highlighted.