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STUDY OF CHEMICAL OXYGEN DEMAND AND AMMONIA REMOVAL EFFICIENCIES BY IMAGE ANALYSIS AND MULTIVARIATE STATISTICS TOOLS

António Luís Pereira do Amaral[1]; Daniela Mesquita[2]; Eugénio Campos Ferreira[2]

[1]*Instituto Politécnico de Coimbra – Instituto Superior de Engenharia de Coimbra*
[2]*Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, Universidade do Minho*

Activated sludge systems are frequently used in wastewater treatment for chemical oxygen demand (COD) and ammonia removal. However, several problems can affect the operation of these systems leading to abnormal conditions such as filamentous bulking, viscous bulking and pinpoint flocs, among others. These occurrences, which may lead to the decrease of COD and ammonia removal efficiencies, are linked to biomass morphological and physiological changes and can be studied by microscopic evaluation. However, traditional microscopic inspection by a human operator, and correspondent manual assessment, is a subjective and labor intensive procedure. Automated image processing and analysis presents considerable convenience in such cases.

For this study, a lab-scale activated sludge reactor was operated for 100 days and monitored through microscopic staining and image analysis. The operational parameters were modified inducing the above mentioned abnormal conditions, apart from the normal operation. Biomass morphology was obtained by bright field microscopy combined with grayscale image processing. Biomass physiology was also studied by employing epifluorescence combined with color image processing. The LIVE/DEAD® BacLight™ Bacterial Viability Kit was employed to determine the biomass viability, and the LIVE BacLight™ Bacterial Gram Stain Kit for the biomass Gram status. Two ad-hoc Matlab specially developed programs were employed.

COD and ammonia removal efficiencies were studied by clustering the data points in two large clusters: "95% or above" and "below 95%" for the COD, and "90% or above" and "below 90%" for ammonia. These clusters were selected based on the behavior of these two parameters throughout the experiment time. The results showed that the COD removal efficiency was well predicted by the best 10 physiological parameters with an overall accuracy of 94.1%, for the ensemble of the tested conditions. Relatively high accuracies of 90.6% and 91.2% were also obtained for the ammonia removal efficiency regarding the best 9 physiological and morphological parameters, respectively. Thus, for the ammonia removal efficiency both types of parameters are equally useful, leading to 95.3% accuracy when the best 3 physiological and 6 morphological parameters were used.

References:

Mesquita, D.P., Amaral, A.L., Ferreira, E.C. 2011. Identifying different types of bulking in an activated sludge system through quantitative image analysis. Chemosphere 85, 643-652.