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Monitoring filamentous bulking and pin-point flocs in a lab-scale activated sludge system using image analysis

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Activated sludge processes are the most frequently used techniques regarding biological wastewater treatment. However, depending on the process operation conditions, several malfunctions could take place, in which filamentous bulking and deflocculation processes, such as pin-point flocs, are the most common problems, causing the sludge settling ability decrease and effluent quality deterioration. Bright field Image analysis is nowadays considered a powerful tool to quantitatively characterize aggregated and filamentous bacteria. Furthermore, the use of epifluorescent staining techniques, coupled to image analysis, presents a promising method to determine bacteria gram nature and viability.

Encouraged by the success of image analysis procedures over the last years, the present work studied a lab-scale activated sludge system, under operation conditions causing filamentous bulking and pin-point flocs phenomena. Sludge settling ability and turbidity values were measured verifying the nature of the settling problem. COD contents, as well as nitrogen contents, in terms of $N\text{-}NH4^{+}$, $N\text{-}NO3^{-}$ and $N\text{-}NO2^{-}$, were surveyed in the feeding effluent, reactor bulk and settler. Regarding the biomass characterization, four major morphological descriptors groups were studied, covering free filamentous bacteria contents, aggregates contents, aggregates size and aggregates morphology. With respect to the aggregates characterization, these were divided in 3 classes (large, intermediate and small aggregates) according to their size. Percentages of gram-positive bacteria, gram-negative bacteria, viable and damaged bacteria were also evaluated based on fluorescent image analysis. Finally, the raw resulting data was fed into a multivariate statistical analysis, in order to enlighten the relationships between the obtained image analysis information and operational parameters.

An improvement of the sludge morphological characterisation was found by combining fluorescent and bright field image analysis procedures. Furthermore, the results obtained during the monitoring period indicate that automated image analysis can help clarifying the nature of the events within the aeration tank, when the system is submitted to disturbances.

Keywords: activated sludge, image analysis, filamentous bulking, pin-point flocs