Utilizing on-line optical monitoring to predict the effluent quality in the activated sludge process

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As the limitations to effluent discharges defined by the authorities are stringent and operating costs are constantly rising, more attention must be focused on the optimal operating of the wastewater treatment process. In an activated sludge process, where flocculation is in a critical role, the on-line characterization of floc morphology combined to predictive modelling is a potential tool for assessing the quality of treated wastewater and to be used as assistance in optimizing the process control and to avoid the environmental risks.

On-line optical monitoring device

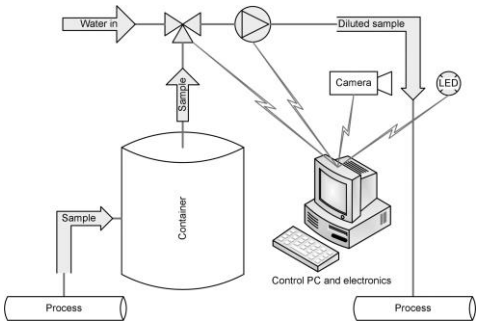

Figure 1. The on-line optical monitoring device.

The on-line optical monitoring device was developed especially for in-situ use and tested at a full-scale municipal wastewater treatment plant over one year period. Wastewater samples were imaged with a charge-couple device camera and automated image analysis program was used to analyze the morphological parameters of flocs.

The on-line optical monitoring device consists of the imaging unit, the sample handling unit and the control PC and electronics unit. The imaging unit includes an industrial camera, LED light source and a cuvette. The sensor of CCD camera is 5.5 mm × 3.7 mm (1392 × 1040 pixels) with a pixel size of 3.6 µm × 3.6 µm. The wastewater samples are pumped from the aeration tank into the container, diluted and pumped to the imaging unit cuvette. The control PC and electronics unit controls the pump and valves synchronized with image acquisition.

Modelling the effluent quality

The measured optical monitoring variables were used together with the process measurements to develop predictive models for the traditional quality variables of treated wastewater. Five variable selection methods (correlation, stepwise, forward, genetic algorithm, successive projections algorithm + GA) were used to find the optimal subsets of input variables for the models. Multivariable linear regression (MLR) was used to predict the output variable and the fitness of the model was evaluated using cross-validation.

Table 1. Examples of the modelling results.

	SS		BOD		COD		N		P	
	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE
Genetic algorithm	0.79	0.47	0.55	0.64	0.55	0.64	0.63	0.61	0.69	0.52

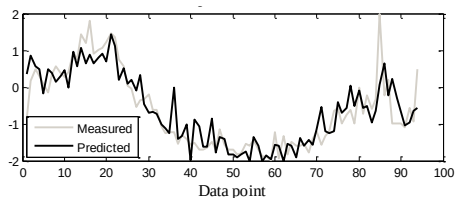

Figure 2. Measured and predicted suspended solids as scaled values in biologically treated wastewater.

Conclusions

The optical monitoring device is a valuable tool for monitoring the changes in floc morphology.

- The on-line optical monitoring results have clear dependencies on some process variables and the purification result.
- Objective, continuous and fast method includes several morphological characterization variables and enables observing the changes at an early stage before they show as problems in the treated water quality and sludge.
- Combined to predictive modelling it has potential to be utilized in controlling the process, keeping the process in stable operating conditions and avoiding environmental risks.

References

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