Settling Model Identification with an On-line Settlometer

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Final clarification is regarded as one of the most critical unit operations in an activated sludge wastewater treatment process. Settling of the bio-solids is to a large extent dependent on the amount and physical properties of the flocs. Population dynamics induced by wastewater changes and plant operation affect these physical properties and, consequently, settling characteristics are time-varying. Normally these characteristics are determined manually, but this is time-consuming and the measuring frequency is low. In our work an automated instrument was developed to obtain a higher information density on the basis of which alarms can be toggled or, as insights in the cause-effect relationships increase, control actions can be taken.

The central idea of the sensor is to monitor the movement of the sludge blanket in batch settling experiments performed in a down-scaled clarifier incorporated in the sensor and to deduce settling characteristics from the data.
The operating scheme is as follows. First, 10 litre of, possibly diluted, activated sludge is pumped into the decanter. Then, a settling curve is recorded using a moving scanner that monitors the sludge blanket as it descends. The sludge blanket can be readily detected from the light intensity curve obtained from the light scanner. After 40 minutes, the built-in decanter is drained, cleaning is performed and a new sludge sample is introduced.

Processing of the raw data readily produces the zone settling velocity (vs) and the (stirred) sludge volume ([S]SV). The latter can be combined with a sludge concentration measurement to determine SVI-values, and dSVI’s if a dilution step is included. These parameters are the traditional settling properties used in manual sedimentation monitoring. Parallel manual determinations showed the validity of the settlometer’s output.

A more profound interpretation of the data is based on the identification of mathematical models of the settling process on the basis of the experimental settling curves. Two models were evaluated and observed to perform equally well: The model of Takacs et al. (Wat. Res., 25, 1263-1271. 1991) and the more recent description of Cho et al. (Wat. Res., 27, 1237-1242. 1994). Although good fits were obtained between the mathematical model predictions and the experimental data, it was obvious from a detailed analysis of the estimation results that identifiability problems may arise due to the overparametrization of the models.
Hence, a number of parameters in the models must be estimated separately or more sophisticated "In-Sensor-Experiments" must be designed.

The device has been evaluated for two years on lab- and pilot-scale treatment plants and its robustness has been proven. Currently, full-scale trials are carried out and data will be reported.