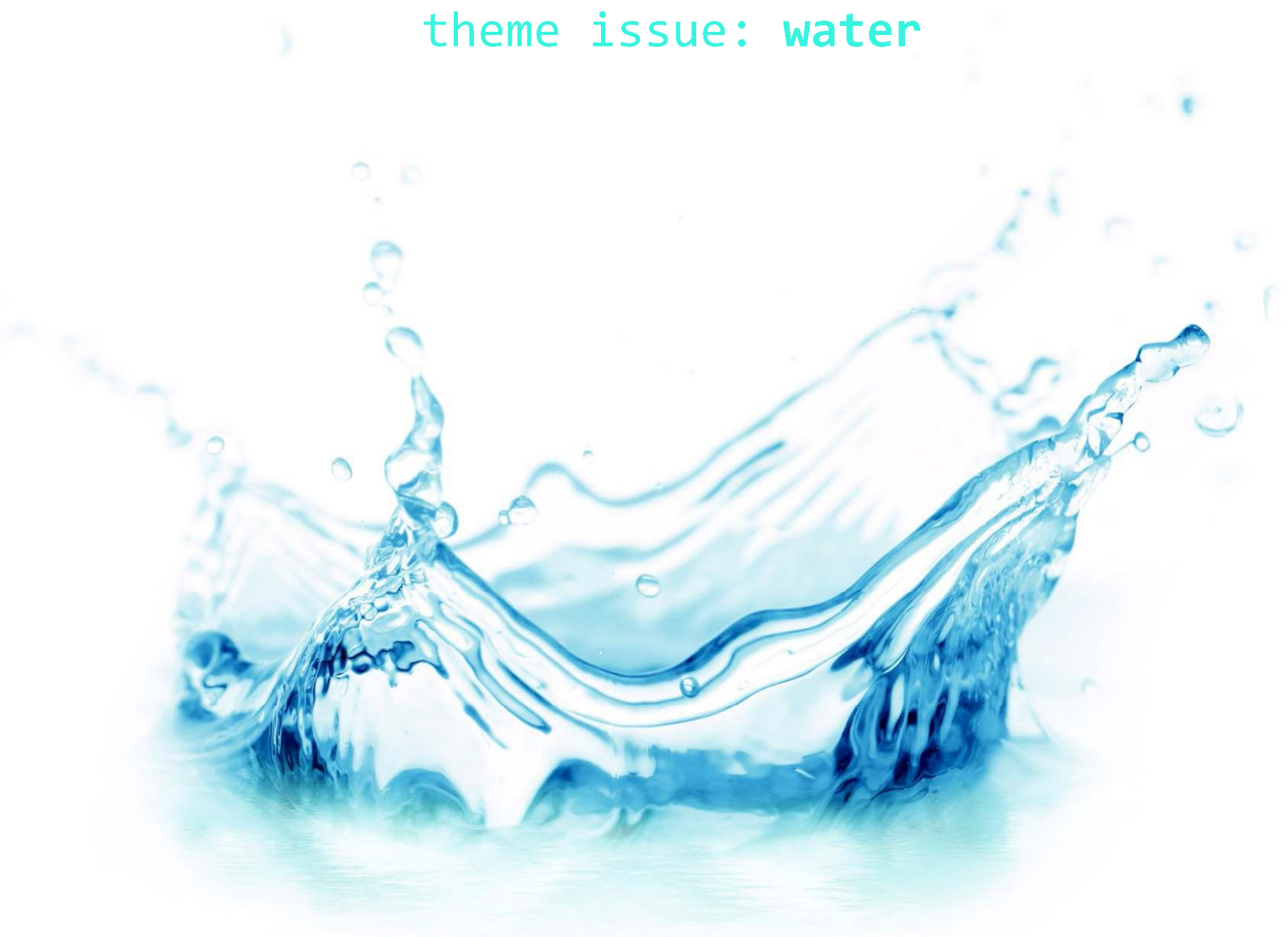


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# Wastewater sludge analysis with an on-line optical monitoring device (MOFI)

Terhi Suopajarvi<sup>a</sup>, Elisa Koivuranta<sup>a</sup>, Jani Tomperi<sup>b a</sup> Fibre and Particle Engineering, University of Oulu<sup>b</sup> Control Engineering, University of Oulu

The morphology analyzer MOFI has been developed in a MMEA - Measurement, Monitoring and Environmental Assessment Project, which is a SHOK program of Energy and Environment Cluster, CLEEN. (MOFI) is the on-line optical monitoring device, which has been used in the analysis of wastewater flocs morphology. MOFI has been used in the flocculation performances studies in the laboratory scale with different chemicals, wastewaters and sludges. With MOFI differences in floc morphologies with different chemicals have been compared and studied how different flocs are breaking during the pumping of the sample .

MOFI consists of an imaging unit, a sample handling unit and a control PC and electronics unit (Fig. 1). The imaging unit is equipped with a CCD camera,

LED light source and a cuvette. The cuvette is planar with the special design, which makes the flow of the sample laminar . The sample can be recirculated back to the sample handling unit, like in the case of floc strength tests or it can be led to disposal after imaging.

MOFI has been placed in the wastewater treatment plant (Viikinmäki, Helsinki) as *in situ* sludge floc analyzer at the end of May 2013 (Fig. 1), and since then image analysis from the flocs of the biosludge has been done approximately four times per day. The CCD camera was changed to one with better resolution at February 2014, which has improved the results of image analysis by giving more accurate data of the morphology of the flocs.

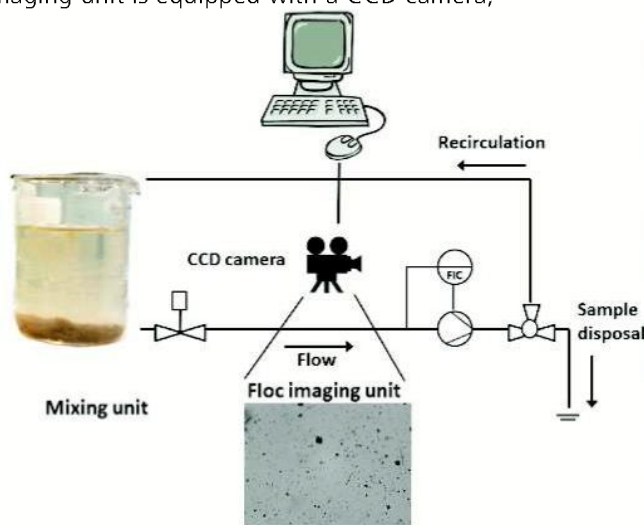
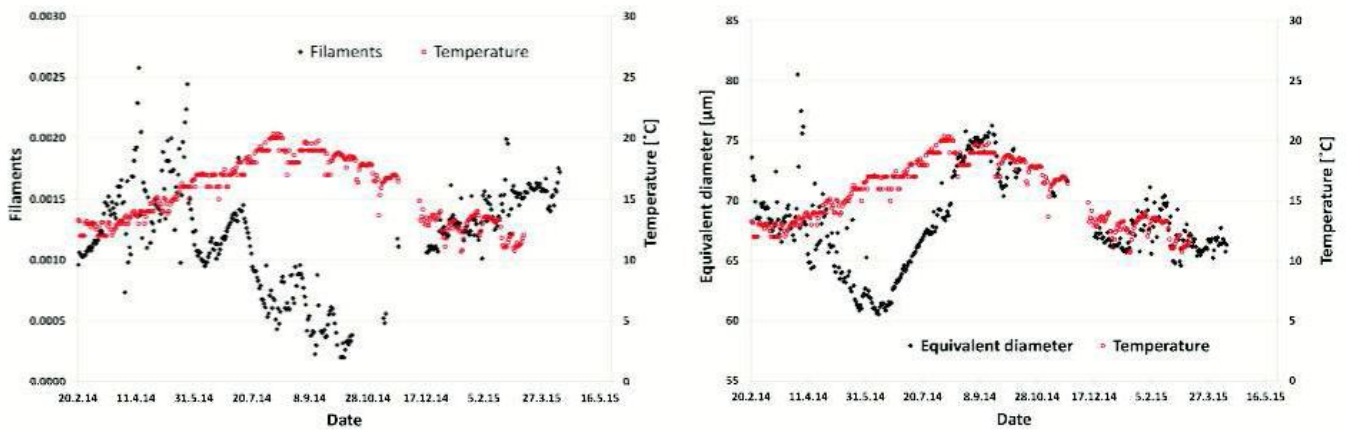


Fig. 1. Schematic illustration of floc measurement environment (MOFI) and MOFI at Viikinmäki waste water treatment plant.

The automated image analysis program is used to calculate the different size and shape parameters; equivalent diameter, amount of filaments, roundness, aspect ratio and the amount of small particles (< 25µm), which are not settling down easily, in each image. One image contains about 150 particles and the amount of images per analysis is around 1000, which makes the amount of analyzed particles

approximately 150 000 per sampling .

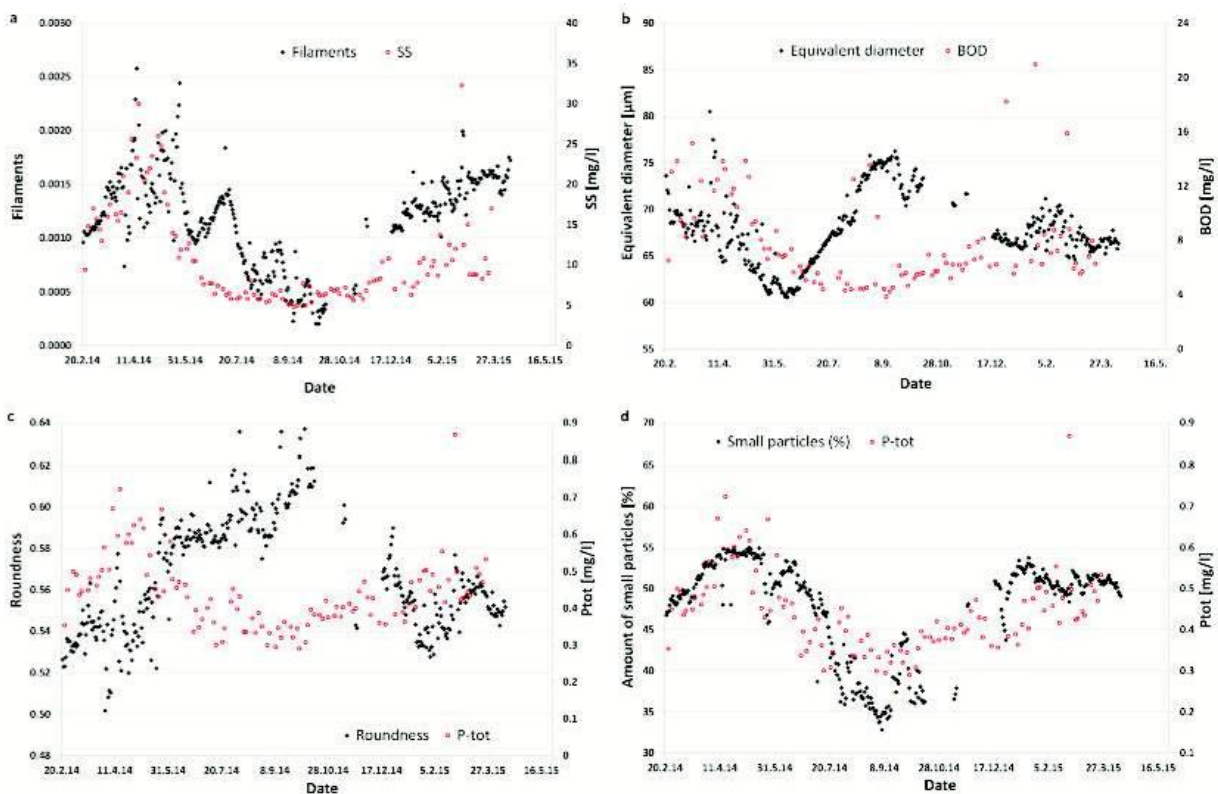
MOFI analyses have shown that mainly temperature of the wastewater effects in the growth of filaments and other morphological parameter (Fig. 2) and by that also to the purification results. Also sludge age and the amount of the sludge have effect on the growth of filaments.



**Fig. 2.** The effect of temperature on the growth of filaments and on the equivalent diameter of flocs.

It has been seen that extensive filaments growth affects the morphology of the flocs. High filament content decreases the roundness and the size of the flocs and increases the amount of small (<25 µm)

particles. On that account, the amount of suspended solid and nutrients increases in the purified water by decreasing the purification result (Fig. 3).



**Fig. 3.** The effect of floc morphology on the amount of suspended solids (SS) and nutrients on biologically treated wastewater. a) The content of filaments versus SS, b) the equivalent diameter of flocs versus biological oxygen demand (BOD), c) the roundness of flocs and d) the amount of small particles versus total phosphor content.

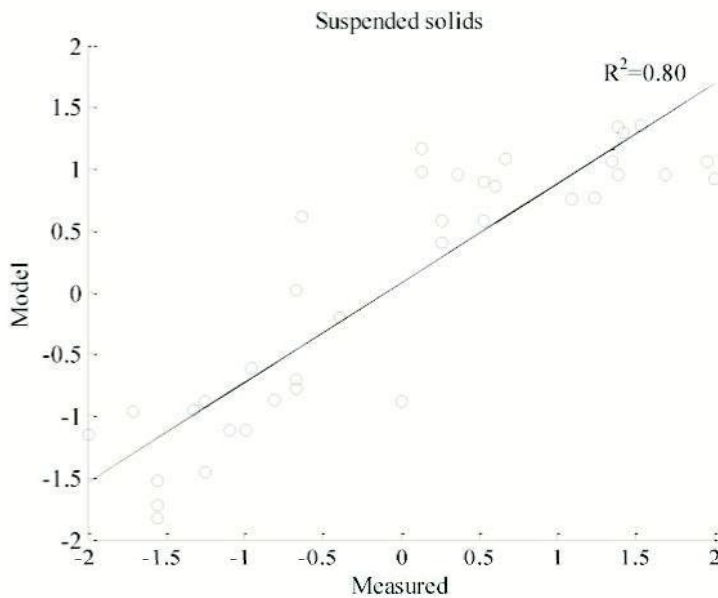
Analyzing the floc data from a long period of time has offered an opportunity to follow different parameters and their effect on purification result in different

situations and find correlations between floc parameters, online measurements and results from laboratory analysis.



Suspended solids content in biologically treated wastewater, which is one parameter to assess the treatment process efficiency, can be predicted with a simple model (Fig.4) developed using the on-line optical analysis parameters and process measurements from

the early stage of the process. Since the optical monitoring is performed in the aeration tank, proactive information about the quality of effluent is received over ten hours in advance.



**Fig. 4.** Modelled versus measured suspended solids content in biologically treated wastewater.

MOFI is a useful analyzer device in the laboratory scale as well as an on-line analyzer in a plant scale. It gives accurate information about flocs morphology and current situation in a purification performance in the aeration tank.

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