Applying Real-time Pollution Control To Reduce The Consumption Of Chemicals And Energy Of DAF

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Introduction

Dissolved air flotation (DAF) has been applied successfully as pre-treatment for surface water and wastewater. The operational costs for DAF depend mainly on the consumption of chemicals and energy. However, these costs can be reduced when making use of online measurements in wastewater. Nijhuis Industries and Qsenz have been successfully developing automatic cleaning system to ensure a robust UV-vis based COD measurement sensor (NI-SENS). This enables a feedforward chemical dosing control to the wastewater based on real-time COD values, integrated in the i-DOSE product.

Figure 1: Product design i-DOSE

This way the consumption of chemicals can be decreased compared to the application of a fixed chemical dosage. Additionally, the online measurements can be utilized to decrease the energy requirement of DAF by adjusting the aeration pressure according the solids concentration of the influent. The aim of this study was to incorporate the real-time pollution control in the 'Intelligent DAF' and to determine the obtained reduction of chemicals. Additionally, the possible energy savings of DAF was investigated.

Methodology

The DAF treating 900 m^3/day of wastewater from red meat slaughterhouse was equipped with i-DOSE. By using a real-time feedforward dosing control, the consumption of coagulant ($FeCL_3$, 40%), neutralizer (NaOH, 30%) and polymer were optimized based on the COD load. The possibilities for the energy reduction were investigated in the 'Intelligent DAF' system which was filled with tap water to investigate the bubble formation. The energy usage of the recirculation and aeration was calculated for all different tests. The bubble size was calculated by Stokes law (bubbles up to 100 µm rise as rigid spheres under laminar flow conditions [Edzwald 1995]) using the measured rise velocity, the density of water and air and the dynamic viscosity of water at 20°C.

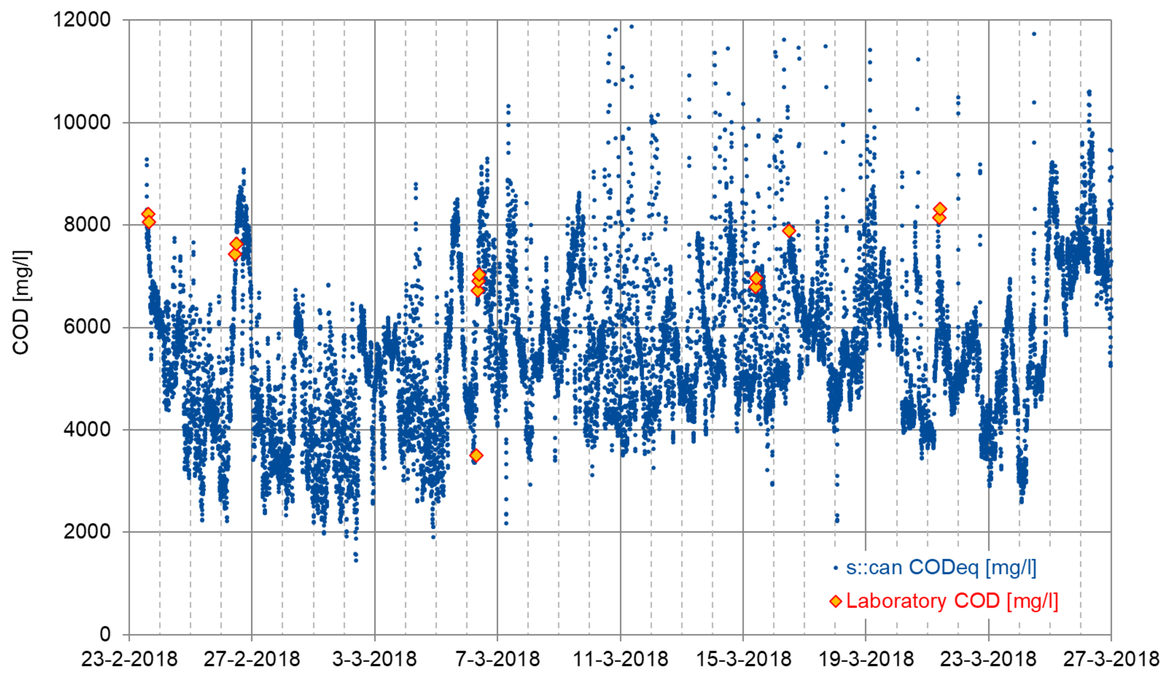

Figure 2: Online COD analysis result with NI-SENS sensor compared to laboratory analysis result.

Results & Discussion

Figure 3 shows the results of the real-time COD control on the dosing of chemicals using wastewater of a red meat slaughterhouse. The amount of chemicals dosed using the pollution control was lower during the start-up of production and during the cleaning at the end of the production day compared the original fixed dosage of $FeCl_3$ and NaOH. Thus, by determining the real-time COD load of the influent, the chemical dosage can be optimized.

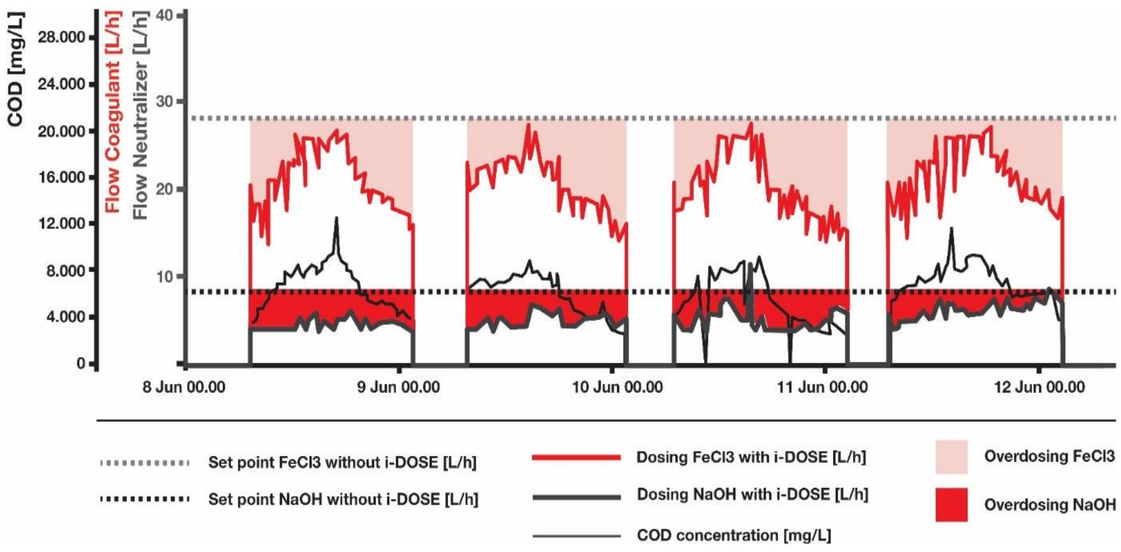

Figure 3. COD concentration, coagulant ($FeCl_3$) dosage and neutralizer (NaOH) dosage over time compared to the previous fixed $FeCl_3$ and NaOH dosage.

Figure 4 depicts the rise velocity and corresponding bubble size at different energy reductions of the recirculation and aeration obtained with the 'Intelligent DAF'. The air bubble size increased from 43 µm until 53 µm with increasing energy reduction up to 29%. It can be observed that while the energy reduction leads to an increase in velocity and bubble size, the desired bubble size was still obtained up to an energy reduction between 22-28%. This implies that up to almost 30% energy can be saved while still attaining a good performance.

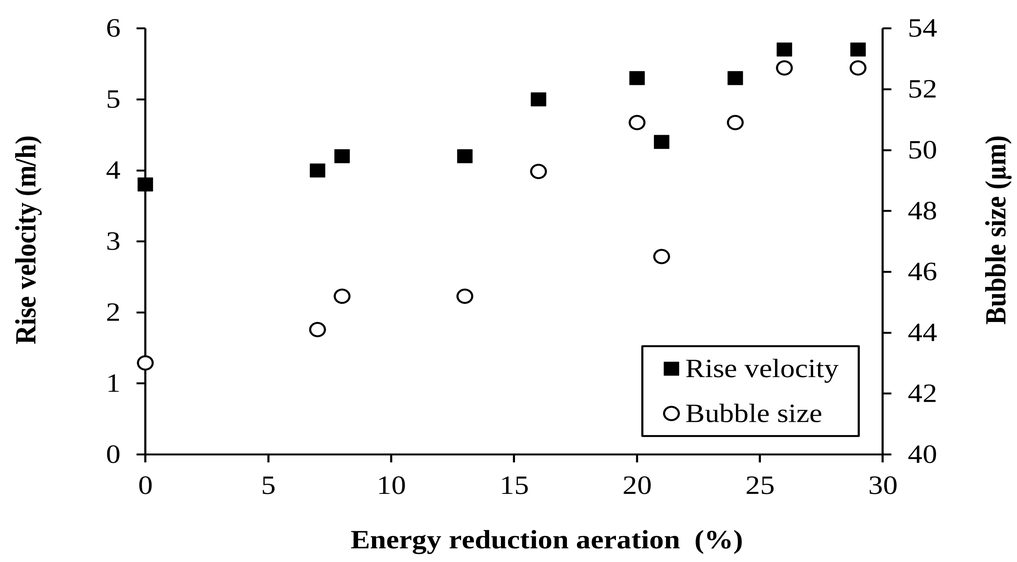

Figure 4. The measured rise velocity of the air bubbles and the corresponding bubble size at different energy reductions

Conclusions

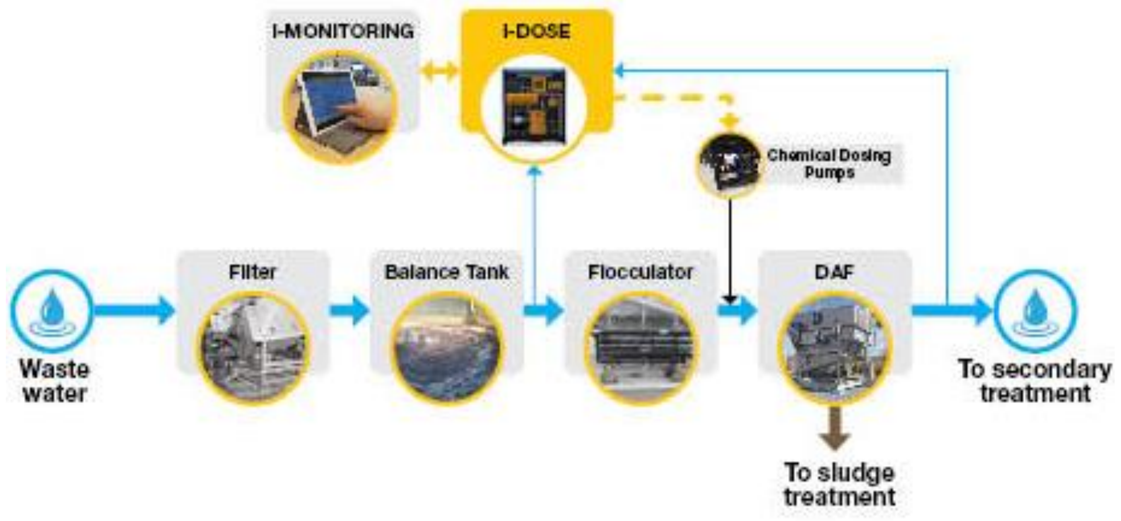

Figure 5. Implementation of i-DOSE in physical-chemical primary treatment system

- The chemical dosage in a red meat processing plant can be reduced by approximately 25% ($FeCl_3$ and NaOH reduction), depending on the COD fluctuations in the influent.
- Overdosing of metal salts will result in an increased inorganic content and volume of the produced sludge, 3% in this specific case.
- 50% reduction of operator attendance (in daily operational inspections, adjustments)
- Another advantage for real-time chemical dosage that the volume of balance tanks can be reduced, since the system can deal efficiently with fluctuations in pollution load. This will only be applied at green field installations.
- With 'Intelligent DAF', up to 30% energy can be saved while attaining good performance with the optimal bubble size
- ROI of 1 – 2 years can be achieved, depending mostly on the total wastewater volume treated.

SOLID SOLUTIONS IN A FLUID WORLD