Module:	Process Engineering
Lead:	Prof. Dr. E. Morgenroth
Title:	**Optimize total nitrogen removal and N_2O emissions of densified sludge systems.**
Description:	The main priority for wastewater treatment plants (WWTPs) is to remove pollutants to achieve high effluent quality, with total nitrogen (TN) being one of the main pollutants. However, WWTPs must also meet the target of net-zero emissions by 2050. Recent results show that the potent greenhouse gas and ozone depleting substance N_2O (265 kg CO2-eq) dominates the greenhouse gas emissions from WWTPs. N_2O is a by-product of nitrification and an intermediate of denitrification. Minimising N_2O emissions from WWTPs, while maximising TN removal, is therefore of crucial interest. Densified Activated Sludge (DAS) and Aerobic Granular Sludge (AGS) rely on the use of dense and large (a few hundred microns) bio-aggregates called granules. DAS and AGS systems can operate at high biomass concentrations due to the improved sludge settleability, which increases treatment capacity and thus represent a major advance over conventional activated sludge systems. Mass-transfer in granules is limited by diffusion, resulting in the formation of concentration gradients over their radius. During the aerated phase, an oxygen gradient develops, where the outer layer is aerobic and the inner core is anoxic or anaerobic. The formation of different redox conditions within the granules allows simultaneous nitrification and denitrification (SND). However, practical experience indicates that SND is limited during the treatment of municipal wastewater with AGS systems, while model predictions suggest that TN removal could be maximised by adjusting the aeration strategy. Yet, it is not clear how the aeration strategy influences the fate of organic substrates (hydrolysis, fermentation, storage) during denitrification, their utilisation by different microbial communities and thus total TN removal. Ultimately, it is not clear to what extent TN removal can be increased while simultaneously minimising N_2O emissions. Tasks: - Data Treatment: develop an R-script to automatically import and treat data from the experiments (Ammonia-Uptake Rate, Nitrate Uptake Rate, TN effluent quality, N_2O emission factor, etc.). - Conduct experiments to understand to what extent denitrification occurs preferentially in the flocs (when a low dissolved oxygen concentration is applied) as opposed to within the granules. A 24 L or 8 m3 reactor (already in operation) can be used. - Conduct experiment with different aeration strategies (constant aeration, 2-dissolved-oxygen set-point, increasing oxygen concentration) to evaluate to what extent SND and ultimately TN removal can be maximised, while minimising the N_2O emissions. - Define the basis for the development of an aeration controller based on on-line measurements of ammonium, nitrate and N_2O concentrations, with the aim of maximising TN removal and minimising N_2O emissions.
Grading:	Report = 60 % Presentation = 20 % Practical work = 20 %
Other:	Organization: Work will be performed at Eawag. Prerequisites: Interests in technologies for biological wastewater treatment / data treatment, experimental work Project period: 14 weeks / 50% Language: English Contact: Mengqi Zhu (mengqi.zhu@eawag.ch) and Laurence Strubbe (Laurence.strubbe@eawag.ch)