**Optimization of wastewater treatment processes using a rheological approach**

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**1. Introduction**

Biological processes such as classical activated sludge treatment or membrane bioreactors (MBR) are the process the most used for the treatment of wastewater within the last decades. In recent years however, we are witness to an increase of global inflows entering wastewater treatment plants (WWTP), whereas authorized levels of pollutants in the outflows get more and more reduced. To face this context, WWTP new units have to become more and more efficient and a great attention is now paid to the optimization of treatment processes of both wastewater and excess wastewater sludge. In the present work, rheological approach is investigated to optimize wastewater treatment plan using a bench test device specially developed for the purpose of this work.

**2. Methods**

The rheological bench used consists in a bioreactor equipped with a double helical ribbon impeller fixed on a motor (HRI system) and a recirculation loop in which the sludge flows in pipes (pipe system) of 2 different diameters used to measure the "in situ" rheological behavior of activated sludge. The pipe system is equipped with two differential pressure transmitters and a flow meter to measure the pressure drop and the volumetric flow rate. This permit to draw the rheograms of sludge in pipes. For each solid concentration (TSS) studied, the parameters (τ0, K and n) of the Herschel-Bulkley model are determined based on the reference rheograms measured by the Couette rheometer (AR550). These rheograms are then compared to the one obtained with the different in situ configurations (HRI and pipes).

**3. Results and discussion**

HRI rheograms always show a good agreement with the reference one. On the contrary, pipes rheograms do not always match the reference. Wall slips phenomena are observed for each TSS concentrations, notably depending on the pipe diameter. At low concentration, slip is only observed for the pipe with the smaller diameter whereas at high concentration slip is present with both pipe configurations. Slip phenomena have been taken into account using slip correction calculations. Plotting the slip velocity curves as a function of the wall shear stress, we can distinguished two types of phenomena responsible for wall slip: the static depletion and the particle migration. The occurrence of each mechanism is dependent on interparticles interactions via the TSS concentration.

**References**

1. Ohanessian – 2016 - Développement d'un outil de caractérisation in situ d'écoulements de boues de station d'épuration
2. Seyssiecq et Al. - 2015 - In Situ Rheological Characterisation of Wastewater.
3. Seyssiecq et Al. - 2003 - State-of-the-art: Rheological characterisation of wastewater treatment sludge
4. Mori, M.; Isaac, J.; Seyssiecq, I.; Roche, N. Effect of Measuring Geometries and of Exocellular Polymeric Substances on the Rheological Behaviour of Sewage Sludge. Chem. Eng. Res. Des. 2008, 86 (6), 554–559. https://doi.org/10.1016/j.cherd.2007.10.013.
5. Wang, H.-F.; Hu, H.; Yang, H.-Y.; Zeng, R. J. Characterization of Anaerobic Granular Sludge Using a Rheological Approach. Water Res. 2016, 106, 116–125. https://doi.org/10.1016/j.watres.2016.09.045.
6. TIXIER, N. Approche des propriétés rhéologiques de suspensions biologiques floculées. 160.
7. AL-DAWERY, S. K.; REDDY, S. S. AN EXPERIMENTAL STUDY ON THE RHEOLOGICAL PROPERTIES OF CONDITIONED MUNICIPAL ACTIVATED SLUDGE. 2017, 12, 18.
8. Ratkovich, N.; Horn, W.; Helmus, F. P.; Rosenberger, S.; Naessens, W.; Nopens, I.; Bentzen, T. R. Activated Sludge Rheology: A Critical Review on Data Collection and Modelling. Water Res. 2013, 47 (2), 463–482. https://doi.org/10.1016/j.watres.2012.11.021.
9. Liang, F.; Sauceau, M.; Dusserre, G.; Arlabosse, P. A Uniaxial Cyclic Compression Method for Characterizing the Rheological and Textural Behaviors of Mechanically Dewatered Sewage Sludge. Water Res. 2017, 113, 171–180. https://doi.org/10.1016/j.watres.2017.02.008.