SLUDGE RHEOLOGY AND ITS APPLICATIONS IN SLUDGE TREATMENT PROCESSES

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ABSTRACT

Sludge rheology is important for the design and operation of sludge treatment processes in terms of process optimisation and maintenance cost reduction. Sludge rheology has a significant impact on the performance of pumps, anaerobic digesters, dewaterability equipment, mixers, and heat exchangers.

A large portion of the total energy consumption in any sludge treatment plants is used for pumping sludge within the treatment processes. The efficient operation of sludge pumps requires an accurate calculation of friction losses for which sludge rheological parameters is an important parameter. Rheological parameters change as composition changes due to season, origin and treatment process. Furthermore, the type of selected rheological model and data fitting process impact on the pressure drop calculation. A validated pressure drops calculation toolkit was developed with up to 10% errors against actual data collected both at industrial scale and a pilot plant of sludge pumping system in a range of solid concentrations of sludge.

Anaerobic digesters are used to treat sludge and produce biogas. The rheology of the sludge can affect the digestion process, as it can impact the ability of microorganisms to break down the organic matter in the sludge. Sludge with high viscosity may have a lower biodegradability, resulting in a longer retention time within the digester, which can increase the size and cost of the digester. Additionally, the rheology of the sludge can impact the efficiency of the mixing within the digester, affecting the biogas production and overall treatment performance. The impact of the extent of digestion in terms of the volatile solids destruction on rheological properties in semi-continuous pilot digesters is also presented. Experimental results from this study indicate that higher volatile solids destruction leads to increased difficulty to flow and dewater. Since rheological behaviour is interlinked with chemical organic content (COD) of sludge, On-line rheometers can be used to monitor this process performance indicator (COD) rather than conducting offline time consuming chemical tests.

There is still much to be learned about the complex interactions between different components in sludge, and that new measurement techniques will be needed to improve our understanding of sludge rheology and its applications in sludge treatment processes.