

Settling characterisation using on-line sensors at a full-scale wastewater treatment plant

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Abstract

An on-line settlometer is presented which automatically records sludge settling curves. From these curves the sensor deduces the initial hindered zone settling velocity (V_s). In order to evaluate the information gathered by the sensor, the instrument was used at an information-rich full-scale wastewater treatment plant (Klagshamn, Sweden). This plant is operated as a single sludge post-denitrification activated sludge system with an external carbon source. With the sensor a diurnal pattern of V_s could be detected. This pattern was mainly caused by the diurnal change of the sludge concentration. Using the Vesilind equation it was possible to standardise V_s to the sludge concentration (V_s'). The variation in the standardised V_s' was less compared to the experimental V_s . Still, it was possible to detect a sudden drop in V_s' on nearly daily basis. At two of these instances rising sludge was even detected in the settlometer during the 35 min lasting sedimentation period. The fact that this could be observed is remarkable as the water temperature was only 7.5°C, the bulk liquid entering the settlometer was aerobic and only a very low amount of carbon sources was found in the effluent. Hypotheses are put forward that could give an explanation for the occurrence of rising sludge under these circumstances. In the observed post-denitrification plant a positive correlation could be found between the airflow to the reaeration tank and the sedimentation velocity.

Introduction

In the global activated sludge process final clarification is a very important unit process (Albertson, 1992). The separation of the sludge from the purified water and its thickening is dependent on the amount and physical properties of the flocs and the hydraulic conditions in the clarifier. The hydraulic loading of the settler can change rather rapidly. On the occurrence of a rain event, the hydraulic loading can easily become five times as high as during dry weather conditions. Apart from this, changes in the physical properties of the sludge are also possible. For instance, bacterial population dynamics induced by changes in operational conditions can have a strong influence on the sludge settling properties. These shifts occur rather slowly and have time constants in the order of days or even weeks. Reid and Nason (1993) suggested a dependency of the settling characteristics on the pollutant concentration remaining in the mixed liquid entering the final clarifier. Also changes in conductivity can influence the floc formation (Zita and Hermansson, 1994). The wastewater composition can change within a matter of hours, so their effect on the sludge settling can be much faster as in the case with population shifts.

Sedimentation characteristics are normally determined manually using batch settling tests (Catunda and Van Haandel, 1992). These measurements are usually performed only once a day. This frequency is obviously too low to enable the operator to detect short-time changes in the sludge settleability. Furthermore, laboratory experiments such as the SVI (sludge volume index) have often been criticised (Dick and Vesilind, 1969) and the settling conditions can be quite different from the ones encountered in full-scale settlers: in small settling columns bridging can become important and settling properties are often evaluated at reduced sludge concentrations.

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Methods

At the University of Gent (Belgium) a settlometer was developed in which sludge settling characteristics are determined in a very simple and natural way (Fig. 1) (Vanrolleghem et al., 1996). The core of this apparatus is formed by a 10 l down-scaled Pyrex decanter equipped with a stirrer (0.3 r/min). This model decanter is operated in a batch mode: the decanter is filled with sludge, the sludge is mixed with air and then the sludge is allowed to settle.

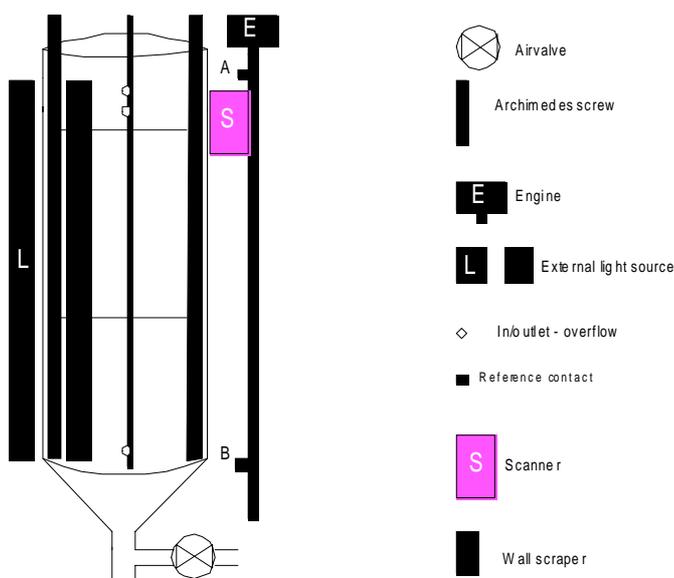


Figure 1
Schematic diagram of the settlometer