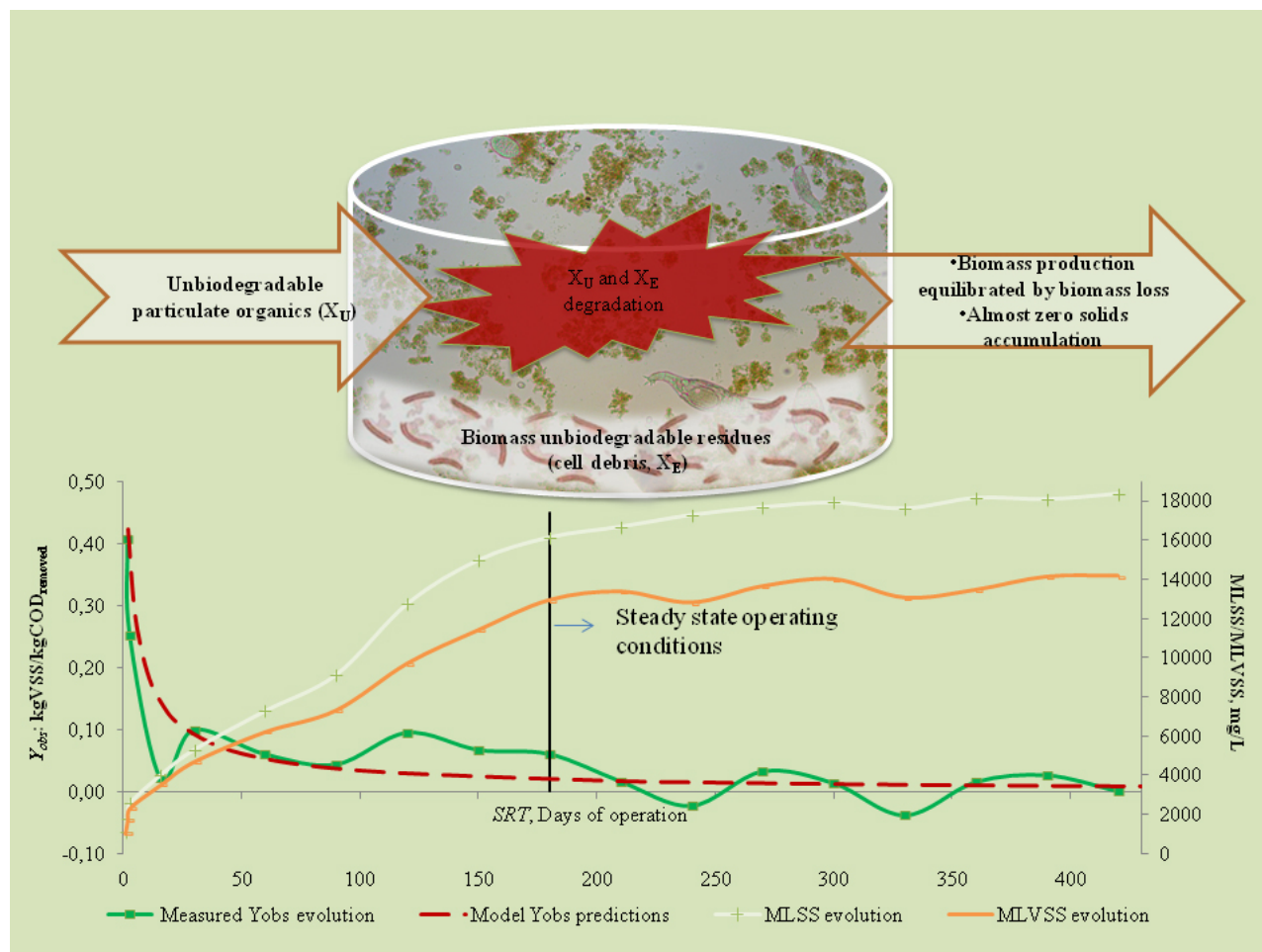


Particulate organics degradation and waste sludge minimization in complete solids retention activated sludge wastewater treatment plants

Activated sludge (AS) process has been widely applied for the treatment of wastewaters containing biodegradable substrates, such as organic compounds. It is based on the microbial utilization of biodegradable substrates that contain carbon, nitrogen and phosphorus. The main pollutants of wastewaters are the organic compounds, usually expressed and quantified as chemical oxygen demand (COD, mgO_2/L) and five days biochemical oxygen demand (BOD_5 , mgO_2/L). The organic compounds are categorized in soluble and particulate fractions (solids), of which a portion is considered as non-biodegradable or unbiodegradable. Furthermore, the products of cellular lysis (death of microorganisms) also release a portion of unbiodegradable particulate organics (X_U), named “cell debris” or endogenous residues (X_E).

Consequently, these unbiodegradable particulate fractions of organics in influent (X_U) and in biomass (X_E) are enmeshed in the activated sludge and can be removed only through sludge wastage. The accumulation of unbiodegradable particulate organics in wastewater treatment plants (WWTPs), which depends on wastewaters composition and WWTP's operating conditions, aggravates the major problem of waste sludge management.



Towards sustainable sludge management, many approaches for sludge minimization have been proposed, of which “complete solids retention AS process” seems very promising. It is based on the total recirculation of activated sludge in the WWTP and the microbial manipulation, resulting in high solids retention time (SRT), increased sludge age, high biomass concentration in bioreactors, which in turn cause extended starvation conditions and growth of predator species, leading to negligible net biomass production (growth yields).

In high SRT AS processes, the new cells production rate becomes equal to the decay rate, while the growth of predator species in biomass assist in the reduction of solids’ accumulation, by utilizing various complex substrates (bacteria, cell debris, etc). In such cases, the net biomass production rate is minimal and tending to zero values.

This study evaluates the assumption that in AS processes and under specific WWTP operating conditions, all particulate organic matter is degraded. It is based on the over a year monitoring of two complete solids retention AS WWTPs that treat high strength wastewaters (slaughterhouse effluents) and on theoretical solids accumulation prediction models.

This assumption does not contradict the dominating perception, which is applicable only in cases with typical SRT (less than 30 days) and considers X_U and X_E fractions as biologically inert. It is demonstrated that low availability of food (starvation conditions) and microbial manipulation occurs under complete SRT, high hydraulic retention time, alternating environments (aerobic, anoxic etc.), highly aerating conditions ($DO > 4$ mg/L) and high recirculating sludge rates (over 600%), resulting in negligible wastage of sludge and in degradation of the considered inert particulate organics.

The operation under complete solids retention resulted in an increase of MLSS concentration in the WWTPs reaching a plateau phase, considered as steady state operating conditions. The studied AS WWTPs reached steady state operation after the 180th and 280th day, when almost zero net biomass production and constant MLVSS to MLSS ratios were observed, indicating that by complete solids retention and specific operating conditions, the considered unbiodegradable organic compounds are consumed by microorganisms.

Furthermore, the solids accumulation predictions models revealed that in steady state operating conditions of complete solids retention AS systems, the solids accumulation is slightly affected by growth and decay kinetic coefficients and that the endogenous residues degradation rate (depended on WWTP operating conditions) is the solids accumulation limiting factor.

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