

Characterisation and biodegradation of settleable organic matter for domestic wastewater

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Abstract

Biodegradation of settled COD is studied by evaluating the associated OUR profile obtained in an aerated batch reactor. Hydrolysis was selected, as in current modelling, as the rate-limiting step for O₂ consumption. Settled COD was found to incorporate a significant fraction of active biomass that needs to be accounted for in the evaluation. The analysis of the OUR profile yielded a significantly slower hydrolysis mechanism for settled COD, compared to its soluble slowly biodegradable counterpart.

Nomenclature

b_H	=	endogenous decay rate [d ⁻¹]
C_{S1}	=	influent total biodegradable COD [mg COD/l]
C_S	=	total biodegradable COD [mg COD/l]
C_T	=	influent total COD [mg COD/l]
f_E	=	inert fraction of endogenous biomass
k_{hs}	=	maximum specific hydrolysis rate for soluble COD components [d ⁻¹]
k_{hx}	=	maximum specific hydrolysis rate for particulate COD components [d ⁻¹]
K_S	=	half saturation constant for growth [mg COD/l]
K_{XS}	=	hydrolysis half saturation constants for soluble COD components [gCOD/gcellCOD]
K_{XX}	=	hydrolysis half saturation constants for particulate COD components [gCOD/gcellCOD]
S_{H1}	=	influent rapidly hydrolysable COD [mg COD/l]
S_I	=	influent soluble inert COD [mg COD/l]
S_{S1}	=	influent readily biodegradable COD [mg COD/l]
S_{T1}	=	influent total soluble COD [mg COD/l]
SS	=	suspended solids [mg/l]
VSS	=	volatile suspended solids [mg/l]
X_F	=	fixed solids [mg COD/l]
X_H	=	active heterotrophic biomass [mg COD/l]
X_{I1}	=	influent particulate inert COD [mg COD/l]
X_S	=	slowly biodegradable particulate COD [mg COD/l]
X_{SS}	=	slowly biodegradable settleable COD [mg COD/l]
X_T	=	total particulate COD [mg COD/l]
Y_H	=	heterotrophic yield coefficient [gcellCOD/(gCOD)]
OUR	=	oxygen uptake rate [mg/l-h]
$\hat{\mu}_H$	=	maximum heterotrophic growth rate [d ⁻¹]

Introduction

The success of nutrient removal in activated sludge systems mainly depends on the delicate balance between the organic carbon, nitrogen and phosphorus content of the wastewater. In this balance, the amount of organic carbon is only meaningful when it is

expressed in terms of various fractions with different mechanisms and rates of biodegradation. In this respect, COD fractionation has been introduced as a very useful tool for the evaluation of biological treatment processes (Henze, 1992).

Significant COD removal is achieved in the primary settling of domestic sewage. The settled portion has been subject to a few investigations: Hydrolysate dosing was found to improve the removal efficiency of biological nitrogen removal, especially for a BNR system operated with low C/N and C/P ratios (Brinch et al., 1994). Similarly, Andreassen et al. (1997) argued that low effluent P concentrations could be attained by using primary sludge hydrolysate in EBPR activated sludge systems. It is now a common understanding that this portion represents a potential additional organic carbon source for nutrient removal, where needed. It was also stated that limited fermentation of primary sludge, if properly controlled, could increase this potential, by converting COD into more easily biodegradable components (Hatziconstantinou et al., 1996; Bannister and Pretorius, 1998; Moser-Engeler et al., 1998). Process modifications were suggested to use this COD fraction for enhancing nutrient removal in multi-phased systems (Grady et al., 1999; Pitman, 1995). Little is known, however, about the character of this fraction other than it usually undergoes a slower biological breakdown than the rest of the organic particulate matter in domestic sewage. There is certainly a need for additional information on the biodegradation of settleable organics, as compared to other significant biodegradable COD fractions. This information is to be derived in the same conceptual framework that today sets the basis for the kinetic evaluation of domestic sewage. The collected information may then help to decide whether settleable COD may be considered as an indistinguishable part of the particulate slowly biodegradable COD, or else it needs to be identified as a new parameter on the basis of markedly different kinetic characteristics.

The objective of the study is to explore the biodegradation of settleable COD fraction in domestic sewage in a way that can be readily incorporated into current models as a model component. In this context, the paper intends to cover characterisation of settleable organics as a different COD fraction than the rest, based on its biodegradation (hydrolysis) rate. This assessment is routinely performed for other COD fractions under aerobic conditions and a correction factor is applied for anoxic conditions (Ekama et al., 1986; Henze et al., 1987).

This type of an assessment, derived from the kinetic interpretation of the oxygen uptake rate (OUR) data is also very important for the biological nutrient removal (BNR) process,

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