

Modelling inorganic material in activated sludge systems

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Abstract

A simple predictive model for the activated sludge reactor inorganic suspended solids (ISS) concentration is presented. It is based on the accumulation of influent ISS in the reactor and an ordinary heterotrophic organism (OHO) ISS content (f_{iOHO}) of 0.15 mg ISS/mgOHOVSS and a variable phosphate accumulating organism (PAO) ISS content (f_{iPAO}) proportional to their P content (f_{XBGP}). The model is validated with data from 21 investigations conducted over the past 15 years on 30 aerobic and anoxic-aerobic nitrification denitrification (ND) systems and 18 anaerobic-anoxic-aerobic ND biological excess P removal (BEPR) systems variously fed artificial and real wastewater and operated from 3 to 20 d sludge age. The predicted reactor VSS/TSS ratio reflects the observed relative sensitivity to sludge age, which is low, and to BEPR, which is high. For effective use of the model for design, two significant issues require attention: measurement of the influent ISS concentration, which is not commonly done in wastewater characterisation analyses; and estimating *a priori* the P content of PAOs (f_{XBGP}), which can vary considerably depending on the extent of anoxic P uptake BEPR that takes place in the system. Some guidance on selection of the mixed liquor VSS/TSS ratio for design is given.

Keywords: activated sludge, inorganic suspended solids, modelling, biological nutrient removal

Abbreviations

Aer	= Aerobic reactor	MP	= Mitchells Plain wastewater treatment plant
An	= Anaerobic reactor	MUCT	= Modified University of Cape Town NDBEPR system
ANO	= Autotrophic nitrifier organisms	ND	= Nitrification denitrification
Art	= Artificial wastewater	NDBEPR	= Nitrification denitrification biological excess phosphorus removal
AS	= Activated sludge	NOx	= Nitrate plus nitrite concentration
ASIM	= Activated sludge simulation programme - a platform for using AS models	OHO	= Ordinary heterotrophic organisms
ASM	= Activated sludge model	OHOVSS	= Volatile suspended solids of the ordinary heterotrophic organisms
Ax	= Anoxic reactor	OP	= Orthophosphate
BEPR	= Biological excess phosphorus removal	OUR	= Oxygen utilisation rate
BNR	= Biological nutrient removal	PAO	= Phosphate accumulating organisms
Cntl	= Control	PAOVSS	= Volatile suspended solids of the phosphate accumulating organisms
COD	= Chemical oxygen demand	RBCOD	= Readily biodegradable chemical oxygen demand concentration
conc.	= concentration	SB	= Sewage batch
degC	= degrees Centigrade	SCFA	= Short chain fatty acids
DSVI	= Diluted sludge volume index	SSP	= Steady state period (a number of consecutive sewage batch periods)
Exp	= Experimental	TDS	= Total dissolved solids
FA	= Fully aerobic	TIS	= Total inorganic solids
FSA	= free and saline ammonia	TKN	= Total Kjeldahl nitrogen
I#	= Investigation number	TP	= Total phosphorus
IAND	= Intermittently aerated nitrification denitrification system	TSS	= Total suspended solids
IDS	= Inorganic dissolved solids	UCT	= University of Cape Town NDBEPR system
ISS	= Inorganic suspended solids	USCOD	= Unbiodegradable soluble chemical oxygen demand
IWA	= International Water Association	UPCOD	= Unbiodegradable particulate chemical oxygen demand
MLE	= Modified Ludzack-Ettinger nitrification denitrification system	VDS	= Volatile dissolved solids
		VSS	= Volatile suspended solids
		WRC	= Water Research Commission
		WW	= Wastewater
		WWTP	= Wastewater treatment plant
		1Ax	= First anoxic reactor in the Modified UCT system
		2Ax	= Second anoxic reactor in the Modified UCT system

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