

Mass balance-based plant-wide wastewater treatment plant models – Part 2: Tracking the influent inorganic suspended solids

GA Ekama*, MC Wentzel and SW Sötemann

Water Research Group, Department of Civil Engineering, University of Cape Town, Rondebosch, 7701, Cape, South Africa

Abstract

From an experimental and theoretical investigation of the continuity of influent inorganic suspended solids (ISS) along the links connecting the primary settling tank, fully aerobic or N removal activated sludge and anaerobic and aerobic digestion unit operations, it was found that the influent wastewater (fixed) ISS concentration is conserved through activated sludge and aerobic digestion unit operations. However, the measured ISS flux at different stages through a series of wastewater treatment plant unit operations is not equal to the influent ISS flux, because the ordinary heterotrophic organism (OHO) biomass contributes to the ISS flux by differing amounts depending on the active (OHO) fraction of the Volatile Suspended Solids (VSS) at that stage. Literature data indicated that conservation of influent ISS through primary sludge anaerobic digestion was within $\pm 10\%$, which is too wide to be conclusive.

Keywords: wastewater treatment, influent inorganic suspended solids, anaerobic digestion, activated sludge, aerobic digestion, model validation

List of abbreviations

AD	anaerobic digestion
ADM1	Anaerobic Digestion Model No. 1
AerD	aerobic digestion
Alk	alkalinity with respect to the H_2CO_3^* reference species
ADWF	average dry weather flow
AS	activated sludge
ASM1,2,3	Activated Sludge Models No. 1, 2 or 3
BEPR	biological excess phosphorus removal
BNR	biological nutrient removal
C	carbon
$^{\circ}\text{C}$	degrees Centigrade
Ca	calcium
COD	chemical oxygen demand
d	day
Eq	equation
FSA	free and saline ammonia
H	hydrogen
ISS	inert suspended solids
K	potassium
ℓ	litres
Mg	magnesium
N	nitrogen
ND	nitrifying - denitrifying
NDBEPR	nitrifying - denitrifying biological excess phosphorus removal
O	oxygen
OHO	ordinary heterotrophic organism
OP	ortho-phosphorus

OrgN	organic nitrogen
OTR	oxygen transfer rate
OUR	oxygen utilisation rate, subscripts c, n and t denote carbonaceous, nitrification and total
P	phosphorus
PAO	phosphorus accumulating organism
pH	negative log of the hydrogen ion activity
PS	primary sludge
PST	primary settling tank
Q	flow
R	hydraulic retention time or sludge age for anaerobic digester
RBCOD	readily biodegradable COD
SBCOD	slowly biodegradable COD
SOUR	specific oxygen utilisation rate ($\text{mgO}/(\text{gVSS}\cdot\text{d})$. Subscripts c, n and t denote carbonaceous, nitrification and total.
SS	settleable solids
TKN	total Kjeldahl nitrogen
TP	total phosphorus
TSS	total suspended solids
V	volume
VFA	volatile fatty acids
VSS	volatile suspended solids
VS	volatile solids
WAS	waste activated sludge
WW	wastewater
WWTP	wastewater treatment plant

List of symbols

b_{iP} , b'_{iH}	OHO endogenous respiration and death rates ($1/\text{d}$). Additional subscripts T and 20 denote rates at T and 20°C
f_{av} , f_{at}	OHO fraction of AS with respect to VSS and TSS. Additional subscripts i or e denote aerobic digester influent or effluent.

* To whom all correspondence should be addressed.

☎ +2721 650 2588; fax: +27 21 689 7471;

e-mail: ekama@ebe.uct.ac.za

Received 5 August 2005; accepted in revised form 28 April 2006.