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Supplementary Information

Minimizing biological sludge generation in a sidestream enhanced biological phosphorus removal (S2EBPR) system: full-scale evaluation and modeling insights

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The following are included as supporting information for this paper:

Number of pages: 6

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Table S1: Average influent fractions at the Calumet WRP (as reported also in Sabba et al.[1]).

Parameter	Value	Unit
Fraction of VSS/TSS	90.0	%
Fraction of filtered COD (SCCOD, 1.5 µm, incl. colloids) in total COD (TCOD)	36.0	%
Fraction of flocculated filtered (SCOD, wo colloids) COD in total COD (TCOD)	20.0	%
Fraction of VFA in filtered COD (SCCOD, 1.5 µm, incl. colloids)	0.0	%
Fraction of soluble unbiodegradable organics (SU) in filtered COD (SCCOD, 1.5 µm, incl. colloids)	23.0	%
Fraction of particulate unbiodegradable organics (XU) in total COD (TCOD)	16.0	%
Fraction of heterotrophs (OHO) in total COD (TCOD)	2.0	%
Fraction of endogenous products (XE) of OHOs	7.0	%
Fraction of colloidal unbiodegradable organics (CU) in colloidal COD (SCCOD-SCOD)*	0.0	%
Fraction of NHx in total Kjeldahl nitrogen (TKN)	67.3	%
Fraction of PO4 in total phosphorus (TP)	74.4	%
Fraction of N in readily biodegradable substrate (SB)*	0.0	%
Fraction of N in particulate unbiodegradable substrate (XU)*	0.0	%
Fraction of P in readily biodegradable substrate (SB)*	0.0	%
Fraction of P in particulate unbiodegradable substrate (XU)*	0.0	%

**plant-specific model assumptions*

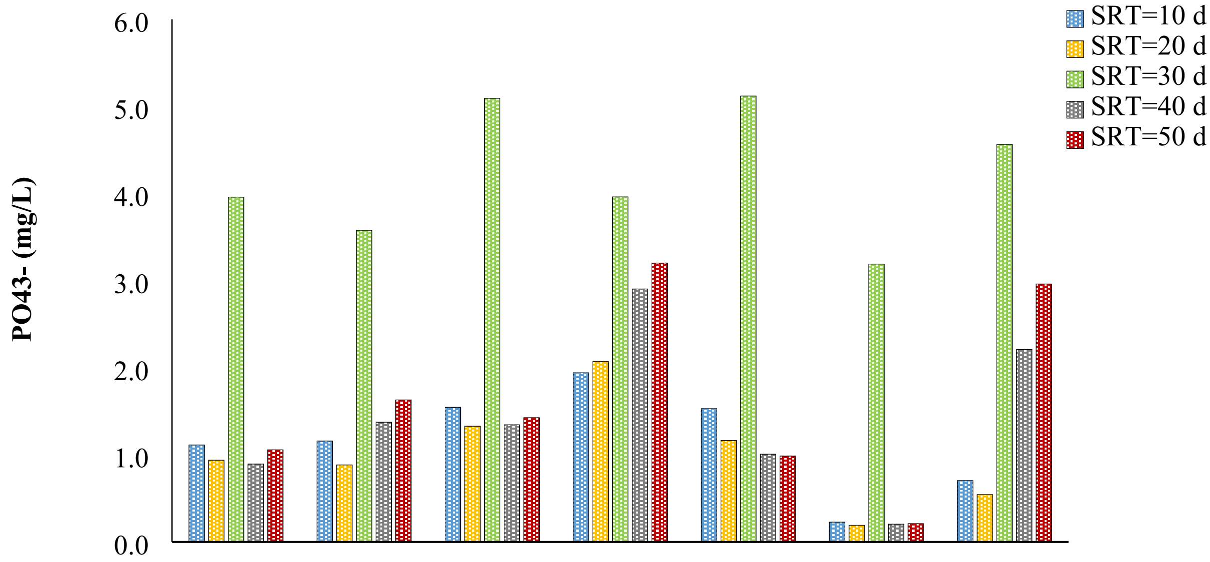
Table S2: SUMO default kinetic parameters used in the model (as reported also in Sabba et al.[1]).

	Ordinary heterotrophic organism kinetics (OHO)		
Symbol	**Name**	**Default**	**Unit**
μ_{OHO}	Maximum specific growth rate of OHOs	4.0	d^{-1}
$\mu_{FERM,OHO}$	Fermentation growth rate of OHOs	0.3	d^{-1}
b_{OHO}	Decay rate of OHOs	0.62	d^{-1}
$\eta_{OHO,anox}$	Reduction factor for anoxic growth of OHOs	0.60	unitless
$K_{SB,AS}$	Half-saturation of readily biodegradable substrate for OHOs (AS)	5.0	g $COD.m^{-3}$
$K_{O2,OHO,AS}$	Half-saturation of O_2 for OHOs (AS)	0.15	g $O_2.m^{-3}$
$K_{VFA,AS}$	Half-saturation of VFA for OHOs (AS)	0.5	g $COD.m^{-3}$
$K_{MEOL,OHO,AS}$	Half-saturation of methanol for OHOs (AS)	0.1	g $COD.m^{-3}$
$K_{NO3,OHO,AS}$	Half-saturation of NO_3 for OHOs (AS)	0.10	g $N.m^{-3}$
$K_{NO2,OHO,AS}$	Half-saturation of NO_2 for OHOs (AS)	0.05	g $N.m^{-3}$
$K_{VFA,FERM,AS}$	Half-saturation of VFA in fermentation of OHOs (AS)	50.0	g $COD.m^{-3}$
$Logrange_{VFA,FERM,AS}$	Effective range of logistic switch for VFA fermentation by OHOs (AS)	0.012	-
$K_{SB,ana,AS}$	Half-saturation of readily biodegradable substrate in fermentation by OHOs in mainstream (AS)	5.0	g $COD.m^{-3}$
$K_{SB,ana,DIG}$	Half-saturation of readily biodegradable substrate in fermentation by OHOs in digester	350.0	g $COD.m^{-3}$

	Carbon storing organism kinetics (CASTO: PAO & GAO)		
Symbol	**Name**	**Default**	**Unit**
μ_{CASTO}	Maximum specific growth rate of CASTOs	1.00	d^{-1}
$q_{PAO,PP}$	Maximum polyphosphate uptake rate of PAOs	0.10	d^{-1}
$\mu_{FERM,PAO}$	Fermentation growth rate of PAOs	0.45	d^{-1}
$\mu_{PAO,lim}$	Maximum specific growth rate of PAOs under P limited	0.49	d^{-1}
b_{CASTO}	Decay rate of CASTOs	0.08	d^{-1}
b_{STC}	Rate of CASTOs maintenance on PHA and GLY	0.07	d^{-1}
$b_{PP,ana}$	Rate of PAOs maintenance under anaerobic conditions (PP cleavage)	0.01	d^{-1}
$q_{PAO,PHA}$	Rate of VFA storage into PHA for PAOs	7.0	d^{-1}
$q_{GAO,GLY}$	Rate of VFA storage into glycogen for GAOs	4.0	d^{-1}
$\eta_{CASTO,anox}$	Reduction factor for anoxic growth of CASTOs	0.66	unitless
$\eta_{bCASTO,anox}$	Reduction factor for anoxic decay of CASTOs	0.50	unitless
$\eta_{bCASTO,ana}$	Reduction factor for anaerobic decay of CASTOs	0.25	unitless
$\eta_{bSTC,anox}$	Reduction factor for anoxic maintenance of CASTOs on PHA and GLY	0.66	unitless
$\eta_{bPP,aer}$	Reduction factor for aerobic maintenance of PAOs on PP	0.25	unitless
$\eta_{bPP,anox}$	Reduction factor for anoxic maintenance of PAOs on PP	0.50	unitless
$K_{PO4,PAO,AS}$	Half-saturation of PO_4 for PAOs (AS)	0.30	$g\ P.m^{-3}$
$Logrange_{PO4,PAO,AS,sat}$	Effective range of logistic switch for PO_4 uptake by PAOs	0.80	-
$Logrange_{PP,PAO,AS,sat}$	Effective range of logistic switch for PP cleavage by PAOs	0.40	-
$K_{PHA,cle}$	Half-saturation of PHA for PAOs at PP cleavage	0.10	$g\ COD.g\ COD^{-1}$
K_{PHA}	Half-saturation of PHA for PAOs	0.01	$g\ COD.g\ COD^{-1}$
K_{STC}	Half-saturation of PHA and GLY for PAOs	0.10	$g\ COD.g\ COD^{-1}$
$K_{O2,CASTO,AS}$	Half-saturation of O_2 for CASTOs (AS)	0.05	$g\ O_2.m^{-3}$
$K_{NO3,CASTO,AS}$	Half-saturation of NO_3 for CASTOs (AS)	0.10	$g\ N.m^{-3}$

$K_{NO2,CASTO,AS}$	Half-saturation of NO_2 for CASTOs (AS)	0.05	g $N.m^{-3}$
$K_{VFA,CASTO,AS}$	Half-saturation of VFA storage for CASTOs (AS)	5.0	g $COD.m^{-3}$
K_{PP}	Half-saturation of PP for PAOs	0.01	g COD.g COD^{-1}
$Ki_{PP,PAO,max}$	Half-inhibition of maximum PP content of PAOs	0.35	g P.g COD^{-1}
$Lograng_{PP,PAO,inh}$	Effective range of logistic switch for PP/PAO inhibition term	0.17	-
$X_{PP,PAO,min}$	PAO PP uptake booster denominator limiting term	0.10	g $COD.m^{-3}$
$Ki_{PHA,PAO,max}$	Half-inhibition of maximum PHA content of PAOs	0.60	g COD.g COD^{-1}
$Lograng_{PHA,PAO,inh}$	Effective range of logistic switch for PHA/PAO inhibition term	0.10	-
$K_{Mg,PAO,AS}$	Half-saturation of Mg (counter-ion in PP storage) for PAOs (AS)	0.001	g $Mg.m^{-3}$
$K_{K,PAO,AS}$	Half-saturation of K (counter-ion in PP storage) for PAOs (AS)	0.001	g $K.m^{-3}$
$K_{Ca,PAO,AS}$	Half-saturation of Ca (counter-ion in PP storage) for PAOs (AS)	0.001	g $Ca.m^{-3}$
$K_{PP,lim}$	Half-saturation of PP (nutrient) for PAOs under PO4 limitation (AS)	0.002	g $P.m^{-3}$
$Ki_{PO4,lim,AS}$	Half-inhibition of PO_4 for PAOs under PO4 limitation (AS)	0.005	g $P.m^{-3}$
$Logsat_{ORP,PAO,Half}$	Logistic half-saturation of ORP switching in fermentation of PAO	-170.0	mV
$Logsat_{ORP,PAO,Slope}$	Logistic slope of ORP switching in fermentation of PAO	0.1	mV^{-1}
$\eta_{bGLY,ana}$	Reduction factor for anaerobic maintenance of GAOs on glycogen	0.10	unitless
K_{GLY}	Half-saturation of glycogen for GAOs (AS)	0.05	g COD.g COD^{-1}
$Ki_{GLY,GAO,max}$	Half-inhibition of maximum glycogen content of GAOs (AS)	0.5	g COD.g COD^{-1}
$Lograng_{GLY,GAO,inh}$	Effective range of logistic switch for GLY/GAO inhibition term	0.12	-
$Switch_{GAO,Act,VFA}$	Manual Switch for Activity of VFA Uptake by GAO	0.00	-
$Logsat_{ORP,GAO,Half,15}$	Half-value of ORP switch of glycogen storage by GAO at 15°C / 59°F	-30	mV
$Logsat_{ORP,GAO,Half,25}$	Half-value of ORP switch of glycogen storage by GAO at 25°C / 77°F	-110	mV
$Logsat_{ORP,GAO,Slope}$	Logistic slope of ORP switching of GAOs	0.035	mV^{-1}

Figure S1: Impact of SRT on effluent OP.



References

1 F. Sabba, M. Farmer, Z. Jia, F. Di Capua, P. Dunlap, J. Barnard, C. D. Qin, J. A. Kozak, G. Wells and L. Downing, Impact of operational strategies on a sidestream enhanced biological phosphorus removal (S2EBPR) reactor in a carbon limited wastewater plant, *Sci. Total Environ.*, 2023, 857, 159280. DOI: **10.1016/j.scitotenv.2022.159280.**