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APPENDIX A: CELLULAR KINETICS - TABLE 1

Biochemical rate coefficients ($v_{i,j}$) and kinetic rate equations (ρ_j) for particulate components (i= 1 – 12; j= 1 - 19)

Component → | i		1	2	3	4	5	6	7	8	9	10	11	12	Kinetic Rates
j	Process ↓	S_{su}	S_{aa}	S_{fa}	S_{va}	S_{bu}	S_{pro}	S_{ac}	S_{h2}	S_{ch4}	S_{IC}	S_{IN}	S_I	(ρ_j, kg COD·m^{-3}·d^{-1})
1	Disintegration										$-\sum_{i=1-9,11-24} C_i v_{i,1}$	$-\sum_{i=1-9,11-24} N_i v_{i,1}$	$f_{SI,xc}$	$k_{dis} \cdot X_c$
2	Hydrolysis of carbohydrates	1									$-\sum_{i=1-9,11-24} C_i v_{i,2}$			$K_{hyd,ch} \cdot X_{ch}$
3	Hydrolysis of proteins		1								$-\sum_{i=1-9,11-24} C_i v_{i,3}$			$K_{hyd,pr} \cdot X_{pr}$
4	Hydrolysis of lipids	$1-f_{fa,li}$		$f_{fa,li}$							$-\sum_{i=1-9,11-24} C_i v_{i,4}$			$K_{hyd,li} \cdot X_{li}$
5	Uptake of Sugars	-1				$(1-Y_{su}) \cdot f_{bu,su}$	$(1-Y_{su}) \cdot f_{pro,su}$	$(1-Y_{su}) \cdot f_{ac,su}$	$(1-Y_{su}) \cdot f_{h2,su}$		$-\sum_{i=1-9,11-24} C_i v_{i,5}$	$-(Y_{su}) \cdot N_{bac}$		$k_{m,su} \frac{S_{su}}{K_{S,su}+S_{su}} X_{su} I_1$
6	Uptake of Amino Acids		-1		$(1-Y_{aa}) f_{va,aa}$	$(1-Y_{aa}) \cdot f_{bu,aa}$	$(1-Y_{aa}) \cdot f_{pro,aa}$	$(1-Y_{aa}) \cdot f_{ac,aa}$	$(1-Y_{aa}) \cdot f_{h2,aa}$		$-\sum_{i=1-9,11-24} C_i v_{i,6}$	$-\sum_{i=1-9,11-24} N_i v_{i,6}$		$k_{m,aa} \frac{S_{aa}}{K_{S,aa}+S_{aa}} X_{aa} I_1$
7	Uptake of LCFA			-1				$(1-Y_{fa}) \cdot 0.7$	$(1-Y_{fa}) \cdot 0.3$		$-\sum_{i=1-9,11-24} C_i v_{i,7}$	$-(Y_{fa}) \cdot N_{bac}$		$k_{m,fa} \frac{S_{fa}}{K_{S,fa}+S_{fa}} X_{fa} I_2$
8	Uptake of Valerate				-1		$(1-Y_{c4}) \cdot 0.54$	$(1-Y_{c4}) \cdot 0.31$	$(1-Y_{c4}) \cdot 0.15$		$-\sum_{i=1-9,11-24} C_i v_{i,8}$	$-(Y_{c4}) \cdot N_{bac}$		$k_{m,c4} \frac{S_{va}}{K_{S,c4}+S_{va}} X_{c4} \frac{1}{1+S_{bu}/S_{va}} I_2$
9	Uptake of Butyrate					-1		$(1-Y_{c4}) \cdot 0.8$	$(1-Y_{c4}) \cdot 0.2$		$-\sum_{i=1-9,11-24} C_i v_{i,9}$	$-(Y_{c4}) \cdot N_{bac}$		$k_{m,c4} \frac{S_{bu}}{K_{S,c4}+S_{bu}} X_{c4} \frac{1}{1+S_{va}/S_{bu}} I_2$
10	Uptake of Propionate						-1	$(1-Y_{pro}) \cdot 0.57$	$(1-Y_{pro}) \cdot 0.43$		$-\sum_{i=1-9,11-24} C_i v_{i,10}$	$-(Y_{pro}) \cdot N_{bac}$		$k_{m,pro} \frac{S_{pro}}{K_{S,pro}+S_{pro}} X_{pro} I_2$
11	Uptake of Acetate							-1		$(1-Y_{ac})$	$-\sum_{i=1-9,11-24} C_i v_{i,11}$	$-(Y_{ac}) \cdot N_{bac}$		$k_{m,ac} \frac{S_{ac}}{K_{S,ac}+S_{ac}} X_{ac} I_3$
12	Uptake of Hydrogen								-1	$(1-Y_{h2})$	$-\sum_{i=1-9,11-24} C_i v_{i,12}$	$-(Y_{h2}) \cdot N_{bac}$		$k_{m,h2} \frac{S_{h2}}{K_{S,h2}+S_{h2}} X_{h2} I_1$
13	Decay of X_{su}										$-\sum_{i=1-9,11-24} C_i v_{i,13}$	$-\sum_{i=1-9,11-24} N_i v_{i,13}$		$k_{dec,Xsu} X_{su}$
14	Decay of X_{aa}										$-\sum_{i=1-9,11-24} C_i v_{i,14}$	$-\sum_{i=1-9,11-24} N_i v_{i,14}$		$k_{dec,Xaa} X_{aa}$
15	Decay of X_{fa}										$-\sum_{i=1-9,11-24} C_i v_{i,15}$	$-\sum_{i=1-9,11-24} N_i v_{i,15}$		$k_{dec,Xfa} X_{fa}$
16	Decay of X_{c4}										$-\sum_{i=1-9,11-24} C_i v_{i,16}$	$-\sum_{i=1-9,11-24} N_i v_{i,16}$		$k_{dec,Xc4} X_{c4}$
17	Decay of X_{pro}										$-\sum_{i=1-9,11-24} C_i v_{i,17}$	$-\sum_{i=1-9,11-24} N_i v_{i,17}$		$k_{dec,Xpro} X_{pro}$
18	Decay of X_{ac}										$-\sum_{i=1-9,11-24} C_i v_{i,18}$	$-\sum_{i=1-9,11-24} N_i v_{i,18}$		$k_{dec,Xac} X_{ac}$
19	Decay of X_{h2}										$-\sum_{i=1-9,11-24} C_i v_{i,19}$	$-\sum_{i=1-9,11-24} N_i v_{i,19}$		$k_{dec,Xh2} X_{h2}$
		Sugar (kg COD/m^3)	Amino acids (kg COD/m^3)	LCFA (kg COD/m^3)	Total Valerate (kg COD/m^3)	Total butyrate (kg COD/m^3)	Total propionate (kg COD/m^3)	Total acetate (kg COD/m^3)	Hydrogen (kg COD/m^3)	Methane (kg COD/m^3)	Inorganic Carbon (kmole C/ m^3)	Inorganic Nitrogen (kmole N/m^3)	Soluble inerts (kg COD/m^3)	

APPENDIX B: CELLULAR KINETICS - TABLE 2

Biochemical rate coefficients ($v_{i,j}$) and kinetic rate equations (ρ_j) for particulate components (i= 13 - 24; j= 1 - 19)

Component → i		13	14	15	16	17	18	19	20	21	22	23	24	25	26	Kinetic Rates
j	Process ↓	Xc	X_{ch}	X_{pr}	X_{li}	X_{su}	X_{aa}	X_{fa}	X_{c4}	X_{pro}	X_{ac}	X_{h2}	X_I	S_{cat}	S_{an}	(ρ_j, kg COD·m^{-3}·d^{-1})
1	Disintegration	-1	$f_{ch,xc}$	$f_{pro,xc}$	$f_{li,xc}$								$f_{XI,xc}$			$k_{dis}\cdot X_c$
2	Hydrolysis of carbohydrates		-1													$K_{hyd,ch}\cdot X_{ch}$
3	Hydrolysis of proteins			-1												$K_{hyd,pr}\cdot X_{pr}$
4	Hydrolysis of lipids				-1											$K_{hyd,li}\cdot X_{li}$
5	Uptake of Sugars					Y_{su}										$k_{m,su}\frac{S_{su}}{K_{s,su}+S_{su}}X_{su}I_1$
6	Uptake of Amino Acids						Y_{aa}									$k_{m,aa}\frac{S_{aa}}{K_{s,aa}+S_{aa}}X_{aa}I_1$
7	Uptake of LCFA							Y_{fa}								$k_{m,fa}\frac{S_{fa}}{K_{s,fa}+S_{fa}}X_{fa}I_2$
8	Uptake of Valerate								Y_{c4}							$k_{m,c4}\frac{S_{va}}{K_{s,c4}+S_{va}}X_{c4}\frac{1}{1+S_{bu}/S_{va}}I_3$
9	Uptake of Butyrate								Y_{c4}							$k_{m,c4}\frac{S_{bu}}{K_{s,c4}+S_{bu}}X_{c4}\frac{1}{1+S_{va}/S_{bu}}I_3$
10	Uptake of Propionate									Y_{pro}						$k_{m,pro}\frac{S_{pro}}{K_{s,pro}+S_{pro}}X_{pro}I_4$
11	Uptake of Acetate										Y_{ac}					$k_{m,ac}\frac{S_{ac}}{K_{s,ac}+S_{ac}}X_{ac}I_5$
12	Uptake of Hydrogen											Y_{h2}				$k_{m,h2}\frac{S_{h2}}{K_{s,h2}+S_{h2}}X_{h2}I_6$
13	Decay of X_{su}	1				-1										$k_{dec,Xsu}X_{su}$
14	Decay of X_{aa}	1					-1									$k_{dec,Xaa}X_{aa}$
15	Decay of X_{fa}	1						-1								$k_{dec,Xfa}X_{fa}$
16	Decay of X_{c4}	1							-1							$k_{dec,Xc4}X_{c4}$
17	Decay of X_{pro}	1								-1						$k_{dec,Xpro}X_{pro}$
18	Decay of X_{ac}	1									-1					$k_{dec,Xac}X_{ac}$
19	Decay of X_{h2}	1										-1				$k_{dec,Xh2}X_{h2}$
	Units	Composites (kg COD/m^3)	Carbohydrates (kg COD/m^3)	Proteins (kg COD/m^3)	Lipids (kg COD/m^3)	Sugars degraders (kg COD/m^3)	Amino acids degraders (kg COD/m^3)	LCFA degraders (kg COD/m^3)	Vale- & Butyrate degraders (kg COD/m^3)	Propionate degraders (kg COD/m^3)	Acetate degraders (kg COD/m^3)	Hydrogen degraders (kg COD/m^3)	Particulate inerts (kg COD/m^3)	Cations (kmole/m^3)	Anions (kmole/m^3)	

APPENDIX C: PAPER 1

Study of inhibition in plug flow anaerobic digesters using mathematical modeling and simulation. Journal of The Institute of Incorporated Engineers, Sri Lanka, Vol 13, No 1, July 2013. (Karunarathne H.D.S.S., Rathnasiri P.G., University of Moratuwa)