

Supplementary Materials

Design of Feedback Control Strategies in a Plant-Wide Wastewater Treatment Plant for Simultaneous Evaluation of Economics, Energy Usage, and Removal of Nutrients

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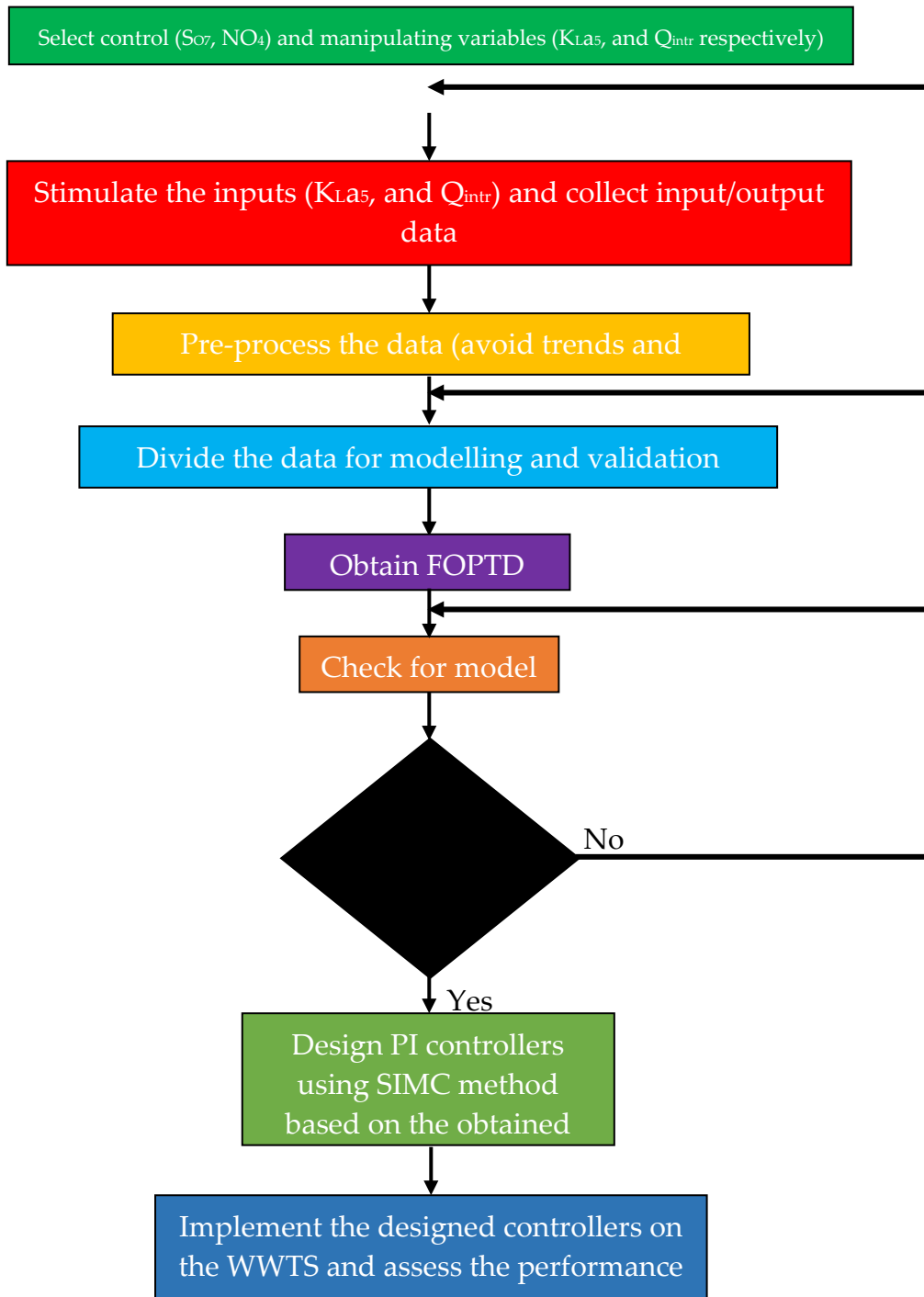


Figure S1. Systematic procedure for model identification and control implementation.

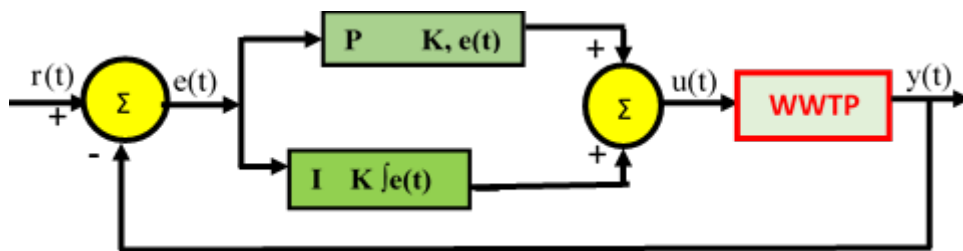


Figure S2. A simple PI controller in WWTP.

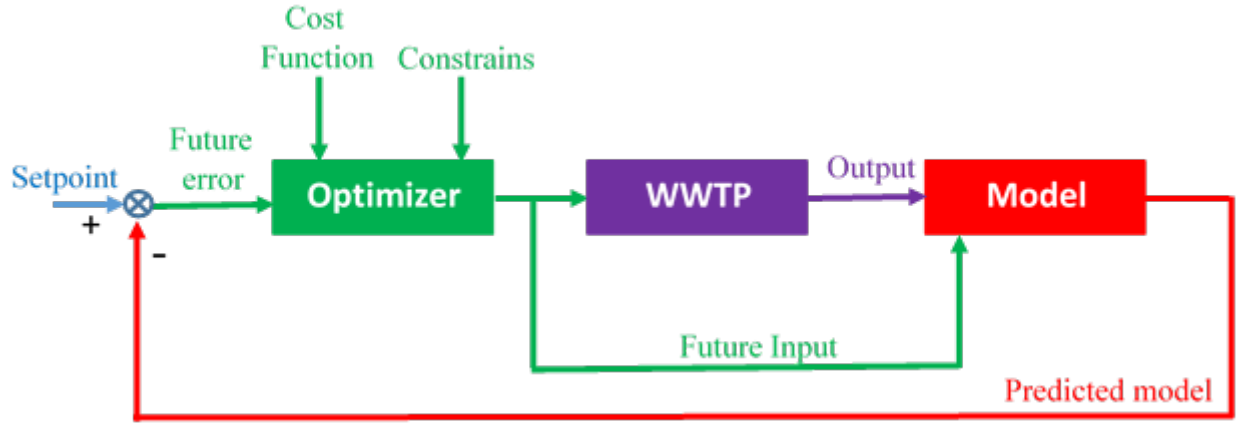


Figure S3. Model Predictive Controller scheme in WWTP.

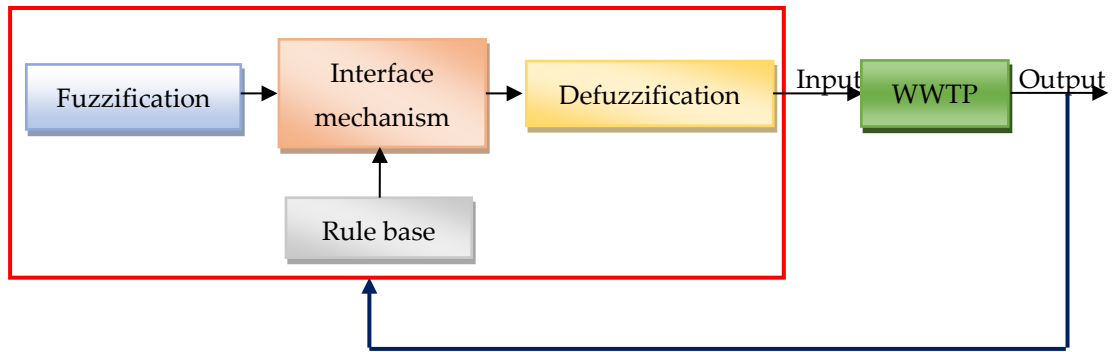


Figure S4. A classical Fuzzy controller in WWTP.

Table S1. State variables of ASM2d, units with notations, and average influent data.

Notation	Parameters	Units	Average influent data
S_O	Dissolved oxygen	$\text{g O}_2/\text{m}^3$	0
S_F	Fermentable substrate	g/m^3	69.9
S_A	Acetate	g/m^3	57.4
S_I	Soluble inerts	kg/m^3	26.5
S_{NH4}	Ammonium	g/m^3	25.1
S_{N2}	Dinitrogen	g/m^3	0
S_{NOX}	Nitrate plus nitrite	g/m^3	0
S_{PO4}	Phosphate	g/m^3	5.6
S_I	Saturation index	$\text{kg COD}/\text{m}^3$	84
X_i	Inert particulate organics	$\text{g COD}/\text{m}^3$	94.09
X_S	Sulfate reducing bacteria	$\text{kg COD}/\text{m}^3$	369.9
X_H	Heterotrophic biomass	$\text{g COD}/\text{m}^3$	51.5
X_{PAO}	Phosphorus accumulating organisms	$\text{g COD}/\text{m}^3$	0
X_{PP}	Polyphosphates	$(\text{g}/\text{m}^3) (\text{kmol}/\text{m}^3)$	0
X_{PHA}	Polyhydroxy alkanooates	$(\text{g COD}/\text{m}^3) (\text{kg COD}/\text{m}^3)$	0
X_A	Autotrophic biomass	$\text{g COD}/\text{m}^3$	0
X_{TSS}	Total suspended solids	$\text{g SS}/\text{m}^3$	374.6
S_K	Potassium	$(\text{g m}/\text{m}^3) (\text{kmol}/\text{m}^3)$	20
S_{Mg}	Magnesium	$(\text{g m}/\text{m}^3) (\text{kmol m}/\text{m}^3)$	30
Q	Flow	m^3/d	20648
Temp	Temperature	$^{\circ}\text{C}$	15
S_{Na}	Sodium	$(\text{g}/\text{m}^3) (\text{kmol}/\text{m}^3)$	175

S_{Cl}	Chloride	(g /m ³) (kmol /m ³)	300
S_{Ca}	Calcium	(g /m ³) (kmol /m ³)	60
S_{SO4}	Sulfate	(g /m ³) (kmol /m ³)	0
S_{Fe2}	Iron (II)	(g /m ³) (kmol /m ³)	0
S_{Fe3}	Iron (III)	(g /m ³) (kmol /m ³)	0
S_{Al}	Alkalinity	kmol/m ³	0
S_{Is}	Inorganic total sulfides	kg COD /m ³	0
X_{HFOL}	Hydrous ferric oxide with low number of active sites	(g /m ³) (kmol /m ³)	0
X_{HFOH}	Hydrous ferric oxide with high number of active sites	(g /m ³) (kmol /m ³)	0
X_{HFOLP}	XHFO_L with bounded adsorption sites	g/m ³	0
X_{HFOHP}	XHFO_H with bounded adsorption sites	g/m ³	0
X_{S0}	Elemental sulfur	(g/m ³) (kg/m ³)	0
X_{SRB}	Sulfate-reducing bacteria	kg/m ³	0
X_{ISS}	Inorganic suspended solids	g SS/m ³	33.5
