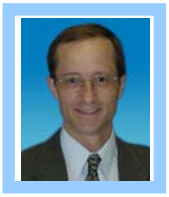

# New framework for standardized notation in wastewater treatment modelling


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## The objective of this work is to present a new notational framework for state variables and parameters

**Problem**: The notation standard of Grau et al. (1987) has been in use for many years but it is becoming obsolete. Many unit process models are now available, using different modelling concepts, and as a consequence the complexity of WWT models has significantly increased over the last 25 years. All of these models use their own notation, causing problems for presentation, documentation, implementation and connection of different models.

**Solution:** Propose a new notational framework which is rigorous, simple, extendable and with unique meaningful names

## The need for a new notation

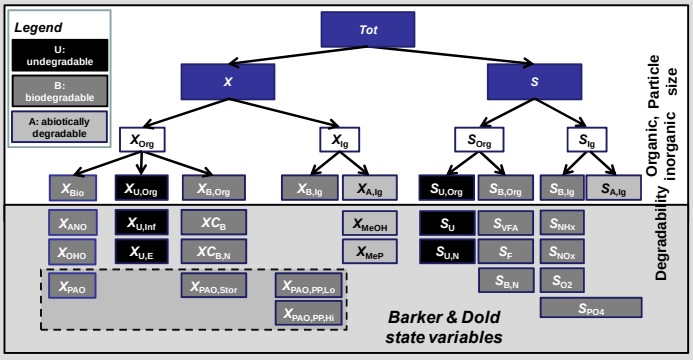
### Different naming systems

| Description | ASM1 | ASM2d | ASM3 | ASDM | UCTPHO | UCTPHO+ | TU Delft-P | ADM1 |
|---|---|---|---|---|---|---|---|---|
| Particulate inert endogenous products | $X_P$ | $X_I$ | $X_I$ | $Z_E$ | $Z_E$ | $X_E$ | | |
| Soluble biodegradable organic N | $S_{ND}$ | | | $N_{OS}$ | $N_{obs}$ | | | |
| Fermentable organic matter | | $S_F$ | | $S_{BSC}$ | $S_{bs,c}$ | $S_F$ | $S_F$ | |
| Soluble inert organic matter | $S_I$ | $S_I$ | $S_I$ | $S_{US}$ | $S_{US}$ | $S_I$ | $S_I$ | $S_I$ |
| Rate constant for storage of $X_{PHA}$ (base $X_{PP}$) | | $q_{PHA}$ | $q_{PHA}$ | $K_{SCFA}$ | $K_P$ | $q_{PHA}$ | $q_{Ac}$ | |

### Different abbreviations

| Description | ASM1 | ASM2d | ASM3 | ASDM | UCTPHO | UCTPHO+ | TU Delft-P | ADM1 |
|---|---|---|---|---|---|---|---|---|
| Propionate | | | | $S_{BSP}$ | | | | $S_{pro}$ |
| Dissolved oxygen | $S_O$ | $S_{O2}$ | $S_O$ | DO | O | $S_{O2}$ | $S_O$ | |
| Total ammonia | $S_{NH}$ | $S_{NH4}$ | $S_{NH}$ | $S_{NH3}$ | $N_a$ | $S_{NH4}$ | $S_{NH}$ | $S_{IN}$ |
| Nitrifying organisms ($NH_4$ to $NO_3$) | $X_{B,A}$ | $X_{AUT}$ | $X_A$ | | $Z_{BA}$ | $X_{NIT}$ | $X_A$ | |
| Yield for autotrophic biomass | $Y_A$ | $Y_A$ | $Y_A$ | | $Y_{ZA}$ | $Y_{NIT}$ | $Y_A$ | |
| Saturation coeff. for phosphate | | $K_P$ | $K_{PO4,PAO}$ | $K_P$ | $K_{PS}$ | $K_{PO4-gro}$ | $K_P$ | |

## Barker & Dold example for state variables




| Barker & Dold | $S_{BSC}$ | $S_{BSA}$ | $S_{US}$ | $S_O$ | $S_{ENM}$ | $S_{UP}$ | $Z_E$ | $N_{H3}$ | $N_{O3}$ | $N_{BP}$ | $N_{BS}$ | $N_{US}$ | $P_{O4}$ | $Z_H$ | $Z_A$ | $Z_P$ | $S_{PHB}$ | $P_{PP\text{-}LO}$ | $P_{PP\text{-}HI}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New notation | $S_F$ | $S_{VFA}$ | $S_U$ | $S_{O2}$ | $XC_B$ | $X_{U,Inf}$ | $X_{U,E}$ | $S_{NHx}$ | $S_{NOx}$ | $XC_{B,N}$ | $S_{B,N}$ | $S_{U,N}$ | $S_{PO4}$ | $X_{OHO}$ | $X_{ANO}$ | $X_{PAO}$ | $X_{PAO,Stor}$ | $X_{PAO,PP,Lo}$ | $X_{PAO,PP,Hi}$ |

**Find the complete translation of state variables and parameters into the new notation for ASM1, ASM2d, ASM3, ASM3-P, Barker&Dold, UCTPHO+, TUDelft Bio-P in Corominas et al. (2010)**

## Framework

**MAIN SYMBOL**

***M***

**SUBSCRIPT**

SUBSCRIPT 1, SUBSCRIPT 2 , SUBSCRIPT 3 ... SUBSCRIPTn

**Only those levels that make the name unique *within the model context* are needed in creating the symbol.**

**STATE VARIABLES**

**MAIN SYMBOLS**

***PARTICLE SIZE*** → *X; C; S*

**SUBSCRIPT**

DEGRADABILITY → U; B; A , ORGANIC/ INORGANIC → Org; Ig , NAME → COMPOUND ORGANISM , SPECIFICATIONS → INTERNAL CELL COMP. ORIGIN COMPARTMENT ...

**PARAMETERS**

**MAIN SYMBOLS**

***Y*** ***i; f*** ***K*** ***μ*** ***b*** ***m*** ***q*** ***η*** ***θ***

**LIST OF ABBREVIATIONS**

| *Main symbols* | | *Processes* | |
|---|---|---|---|
| *Parameters* | | ab | Acid-base reaction |
| *b* | Decay rate | ads | Adsorption |
| *f* | Fraction | am | Ammonification |
| *μ* | Growth rate | dis | Dissociation |
| *i* | Composition coefficient | fe | Fermentation |
| *K* | Saturation coefficient | gro | Growth |
| *m* | Maintenance rate | hyd | Hydrolysis |
| *η* | Reduction factor | lys | Lysis |
| *r* | Reaction rate | pre | Precipitation |
| *q* | Other rates than *μ*, *b* and *m* | red | Redissolution |
| *Y* | Yield | stor | Storage of cell-internal compounds |
| *State variables* | | *Environmental conditions* | |
| *C* | Colloidal | An | Anaerobic |
| *S* | Soluble | Ax | Anoxic (nitrite and nitrate present) |
| *X* | Particulate | Ax2 | Anoxilic (nitrite present) |
| *Origin* | | Ax3 | Anoxalic (nitrate present) |
| E | Endogenous product | Ox | Oxic or aerobic |
| Inf | Compound originating from the influent | *Compartments* | |
| *Other* | | F | Inner biofilm |
| Max | Maximum | G | Gas |
| Plim | Rate limited by phosphorus | L | Liquid |
| | | LF | Biofilm surface |

## References


Corominas Ll., Rieger L., Takács I., Ekama G., Hauduc H., Vanrolleghem P.A., Oehmen A., Gernaey K.V., van Loosdrecht M.C.M. and Comeau Y. (2010) New framework for standardized notation in wastewater treatment modelling. *Water Sci. Technol.* **61**(4), 841-857.

Grau P., Sutton P.M., Henze M., Elmaleh S., Grady C.P.L., Gujer W. and Koller J. (1987) Notation for the use in the description of wastewater treatment processes. *Water Res.* **21**(2), 135-139.