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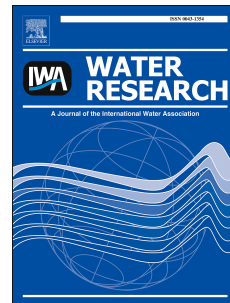
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Corrigendum to “Design, analysis and validation of a simple dynamic model of a submerged membrane bioreactor”

Guilherme A. Pimentel^{a,b,d}, Alain Vande Wouwer^a, Jérôme Harmand^{b,c}, Alain Rapaport^{b,d}

^aUniversity of Mons - Automatic Control Laboratory - Biosys, Boulevard Dolez 31, 7000 Mons, Belgium

^bEquipe Projet INRA-INRIA MODEMIC, Route des Lucioles 06902 Sophia-Antipolis, France

^cINRA, UR050, Laboratoire de Biotechnologie de l'Environnement, Av. des Etangs, F-11100 Narbonne, France

^dUMR INRA-SupAgro MISTEA, 2 Place Viala 34060 Montpellier, France

Abstract

In this paper, the readers can find the corrections of the published article. The authors apologize for any inconvenience caused.

SECTION 4.2 - Three-time-scale singular perturbation

The small parameters are assumed to be $\epsilon_1 = |\gamma|$ and $\epsilon_2 = \frac{1}{V}$.

Hypothesis 1. γ is small.

Hypothesis 2. The volume V is large, with $V < \frac{1}{|\gamma|}$.

The application of the procedure introduced in the previous subsection yields:

Email addresses: guilherme.araujopimentel@umons.ac.be (Guilherme A. Pimentel),

alain.vandewouwer@umons.ac.be (Alain Vande Wouwer),

jerome.harmand@supagro.inra.fr

(Jérôme Harmand), rapaport@supagro.inra.fr (Alain Rapaport)

First: The stretched time-scale $\tau_1 = \epsilon_1 t \rightarrow \frac{1}{dt} = \frac{\epsilon_1}{d\tau_1}$

$$\frac{dx_{sl}}{d\tau_1} = \text{sign}(\gamma)x_{sl} \quad (\text{Slow})$$

$$\epsilon_1 \frac{dy_1}{d\tau_1} = g_1(y_1, y_2) = -\frac{1}{Y}\mu(y_1)y_2 + \frac{Q_{in}}{V}(S_{in} - y_1) \quad (\text{Fast})$$

$$\begin{aligned} \epsilon_1 \frac{dy_2}{d\tau_1} = g_2(x_{sl}, y_1, y_2, z) = \\ \mu(y_1)y_2 + \frac{Q_{in}}{V}X_{in} - \frac{Q_{in}}{V}y_2 + x_{sl}\frac{J_{air}}{V}\frac{z^2}{K_{air}+z} \quad (\text{Fast}) \end{aligned}$$

$$\epsilon_1 \frac{dz}{d\tau_1} = h(x_{sl}, y_2, z) = Q_{cake}y_2 - x_{sl}J_{air}\frac{z^2}{K_{air}+z} \quad (\text{Fast})$$

Considering $Q_w = Q_{in} - Q_{cake}$ and letting $\bar{S}_{in} = S_{in} + \frac{X_{in}}{Y} > S_{in}$ the following slow-fast approximation can be developed:

$$0 = g_1(y_1, y_2) \rightarrow \mu(y_1) = \frac{Q_w S_{in} - y_1}{V \bar{S}_{in} - y_1} \quad (11)$$

$$0 = g_2(x_{sl}, y_1, y_2, z) \rightarrow y_2 = \frac{Q_{in}(\bar{S}_{in} - Yy_1)}{Q_w} \quad (12)$$

$$0 = h(x_{sl}, y_2, z) \rightarrow \frac{x_{sl}J_{air}z^2}{V(K_{air}+z)} = Q_{out}y_2 \quad (13)$$

Second: The stretched time-scale $\tau_2 = \epsilon_2 \tau_1 = \epsilon_2 \epsilon_1 t \rightarrow \frac{1}{d\tau} = \frac{\epsilon_2}{d\tau_2}$ and x_{sl} is constant.

$$\epsilon_1 \frac{dy_1}{d\tau_2} = -\frac{1}{Y\epsilon_2}\mu(y_1)y_2 + Q_{in}(S_{in} - y_1) \quad (\text{Fast})$$

$$\epsilon_1 \frac{dy_2}{d\tau_2} = \left(\frac{\mu(y_1)}{\epsilon_2} - Q_w\right)y_2 + Q_{in}X_{in} - Q_{cake}y_2 + x_{sl}J_{air}\frac{z^2}{K_{air}+z} \quad (\text{Fast})$$

$$\epsilon_2 \epsilon_1 \frac{dz}{d\tau_2} = h(x_{sl}, y_2, z) = Q_{cake}y_2 - x_{sl}J_{air}\frac{z^2}{K_{air}+z} \quad (\text{Ultrafast})$$

$$0 = h(x_{sl}, y_2, z) \rightarrow z = \frac{\frac{Q_{cake}Q_{in}Y\bar{S}_{in}}{Q_w} + \sqrt{Q_{cake}^2\left(\frac{Q_{in}Y\bar{S}_{in}}{Q_w}\right)^2 + 4\frac{Q_{cake}Y\bar{S}_{in}K_{air}J_{air}x_{sl}Q_{in}}{Q_w}}}{2x_{sl}J_{air}} \quad (14)$$

TABLE 2

Table 2: Parameters with their confidence interval.

	Ultrafast [0.02 Days]	Fast [6 Days]	Slow [20 Days]	All Parameters
β_0	$(4.819 \pm 0.573) \times 10^4$	fixed value	fixed value	$(5.531 \pm 0.643) \times 10^4$
K_{air}	$(4.773 \pm 0.575) \times 10^1$	fixed value	fixed value	$(4.596 \pm 0.134) \times 10^1$
Y	fixed value	$(8.996 \pm 0.022) \times 10^{-1}$	fixed value	$(8.985 \pm 0.016) \times 10^{-1}$
$\mu_{S,max}$	fixed value	(2.004 ± 0.722)	fixed value	(2.265 ± 0.343)
γ	fixed value	fixed value	(0.001 ± 0.882)	(0.001 ± 0.535)
$min(f_{cost}(\theta))$	53.55	0.8592	6.42	22.79