

Report: Estimation of Monod parameters in aerobic digestion process in batch cultures

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Summary

Three batch experiments were conducted with microorganisms in artificial wastewater. We managed in finding the Monod parameters K_s and μ_{max} by fitting the curve to the growth data with the Excel solver Add-in. We also can find the undigestible substrate concentration with this method.

1 Theory and methods

Published more than half century, the Monod equation has been the most used for predicting the microbial growth until now. The equation expresses the dependence the specific growth rate μ of miorgs on the digestible substrate concentration S and simplified to the form: $\mu(S) = \frac{\mu_{max} \times S}{K_s + S}$ (hr^{-1})

with μ_{max} is the maximum specific growth rate (hr^{-1}) that microbial society can achieve and K_s is the Monod constant or saturation constant (mg/L), $K_s=S$ when $\mu = \frac{\mu_{max}}{2}$. Experiments show that the

constant K_s is not the same in each different cases. Button (1985) pointed out that environmental conditions (pH, temperature, ect.) make the difference among K_s of different experiments. The derivation of the Monod equation can be found in the work of Liu (2007). However, we also considered the Monod equation can provide most satisfactory curve fitting for the growth data as Gaudy (1980) noted.

The reason for seeking the part of substrate (in concentration) that microorganisms can not eat is that when doing COD, dichromate $\text{Cr}_2\text{O}_7^{-2}$ is a strong oxidant than the average microorganisms' digesting system (C.Zhang 2007).

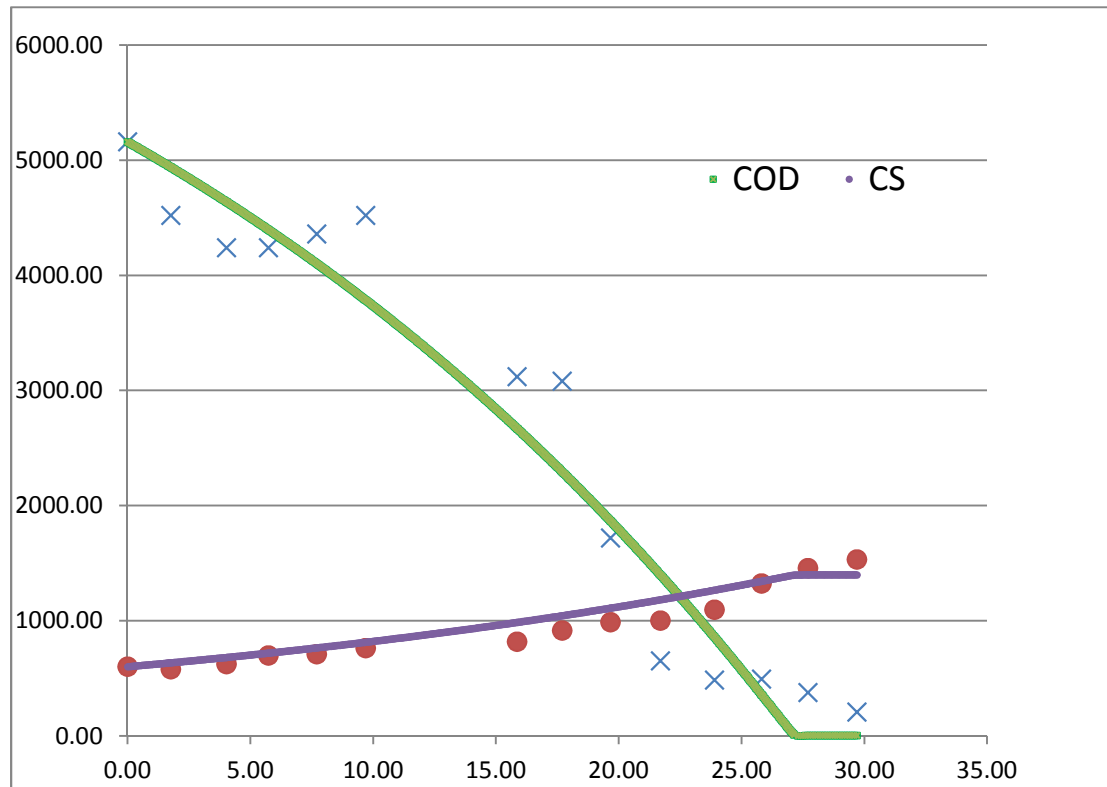
3 Results

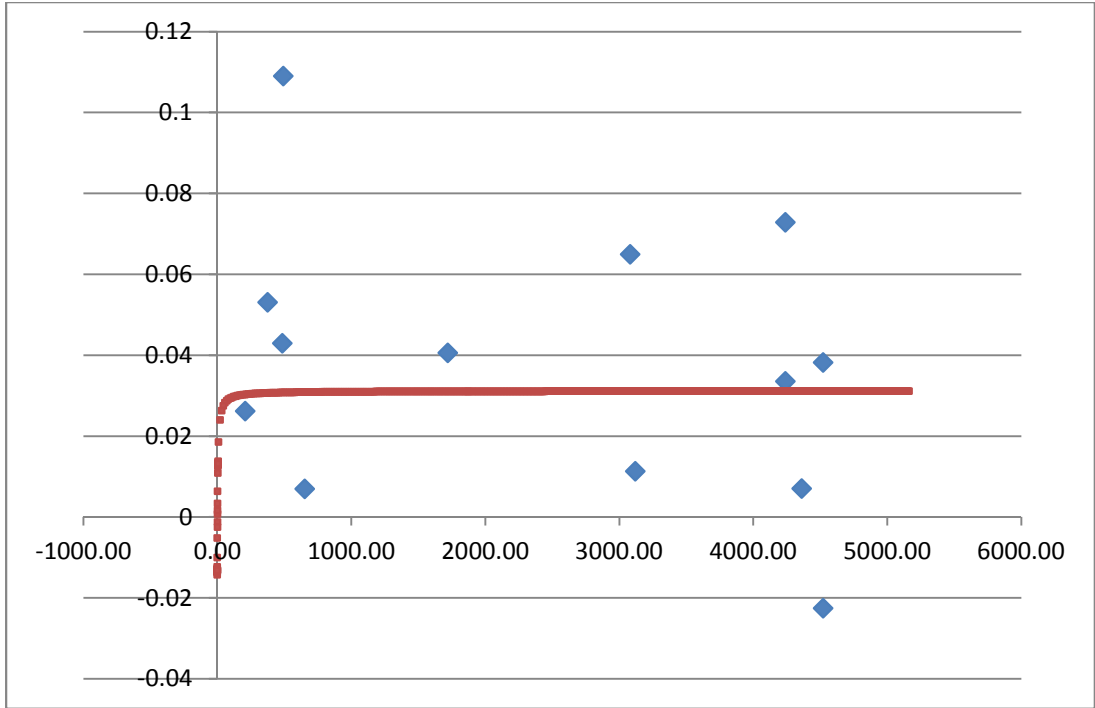
Parameters computed for three experiments are represented in the table below:

Experiment No.	μ_{\max} [h^{-1}]	K_s [$\frac{\text{mg}}{\text{L}}$]	Undigestable [$\frac{\text{mg}}{\text{L}}$]
1	0,031	5,6	0
2	0,071	67,7	65
3	0,070	28,8	18

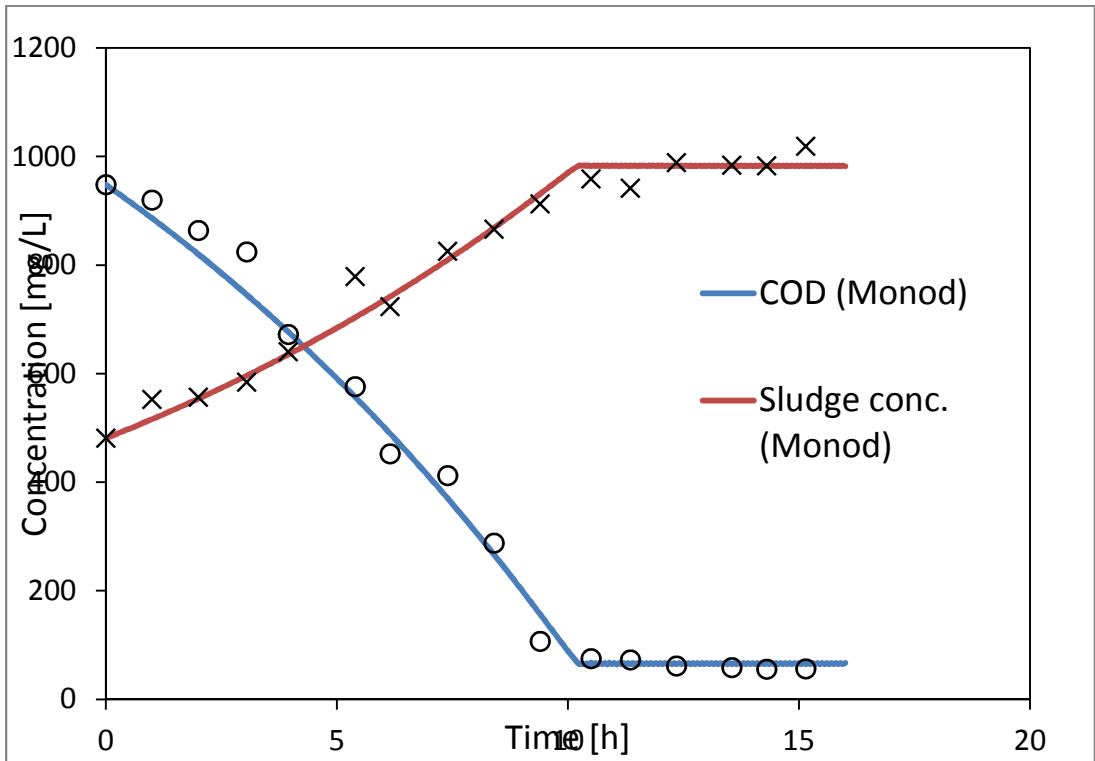
Graphs below shows the COD and microbe's concentration from the Monod equation and the measured.

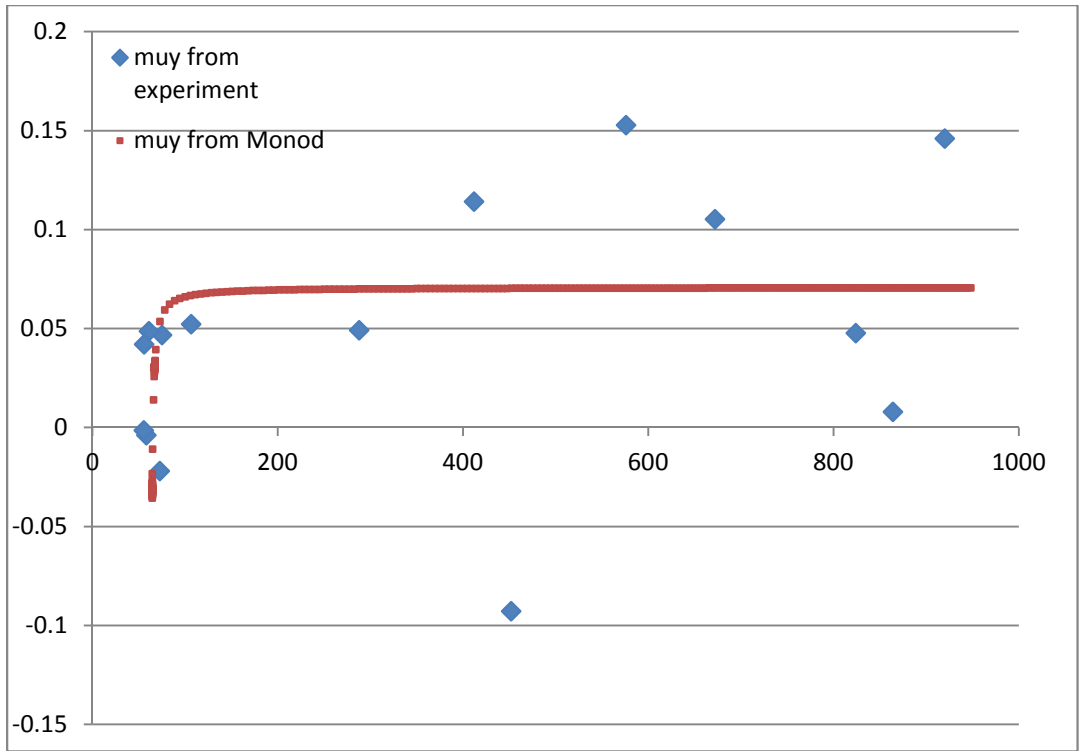
Experiment 1:



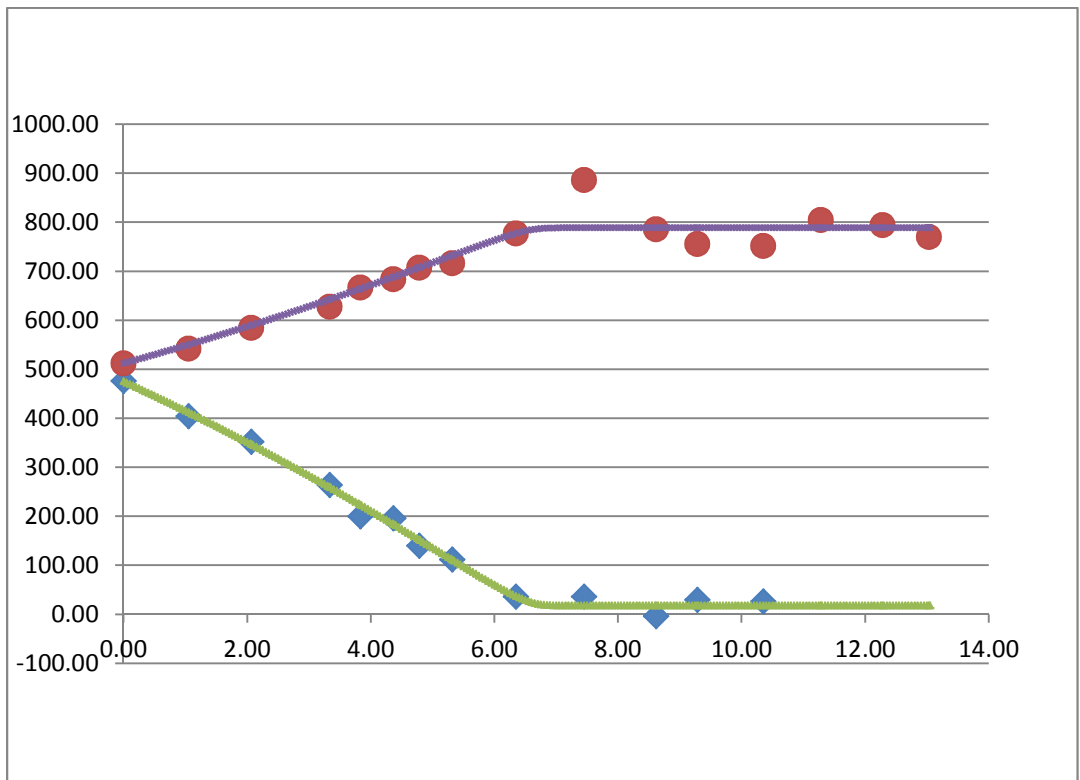


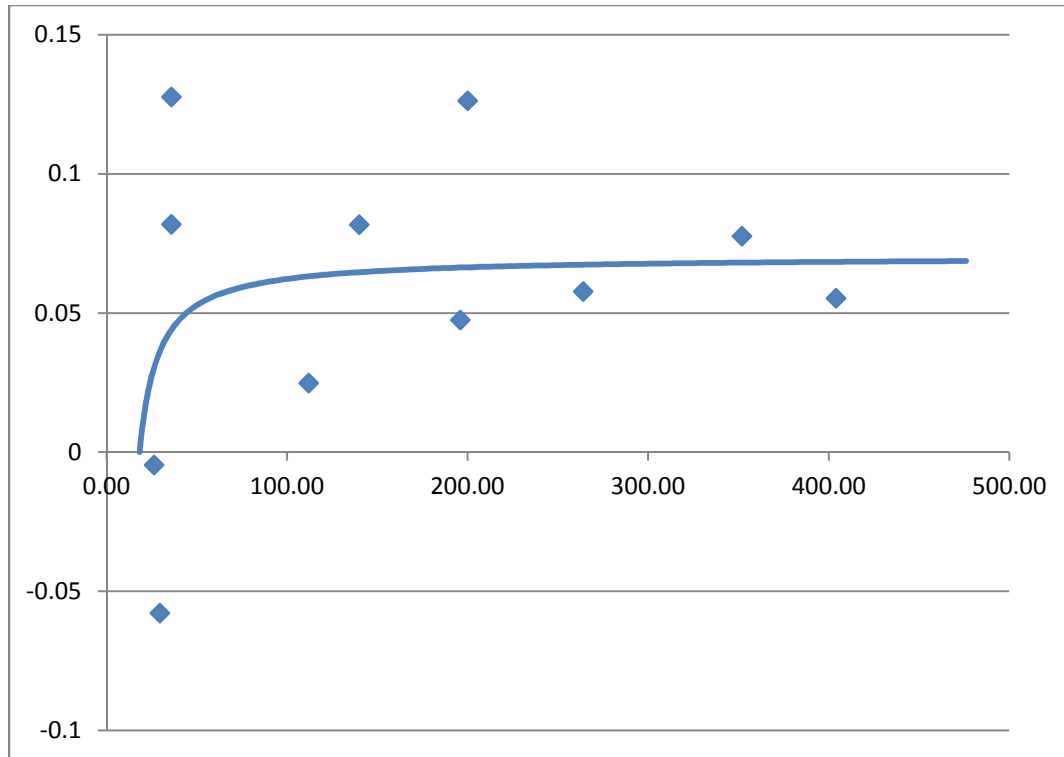
Experiment 2:





Experiment 3:





4 Discussion

- Sources of errors: irregular sampling may cause errors in duration; errors made in the analysis procedure due to lack of skills;
- The first experiment's results look unrealistic and the rate of growth are unpredictable. However, there were improvements through experiment 2 and experiment 3 when COD and S 's graph seem grow in the right direction and μ seemed to predictable. Computed undigestable concentration in the two later experiments is also more realistic.

5 Works Cited

Button, D.K. "Kinetics of nutrient limited transport and microbial growth." *Microbiological Review*, no. 49 (1985): 270-297.

C.Zhang. *Fundamentals of Environmental Sampling and Analysis*. New Jersey: Wiley, 2007.

Gaudy AF, Gaudy ET. *Microbiology for environmental scientists and engineers*. New York: McGraw-Hill, 1980.

Grady CPL, Daigger GT, Lim HC. *Biological wastewater treatment*. New York: Marcel Dekker, 1999.

Y.Liu. "Overview of some theoretical approaches for derivation of the Monod equation." *Appl Microbiol Biotechnol*, 2007.