

Comparing Semi-Implicit and Full-Implicit Method for Solving Stiff Density Dependent Diffusion-Reaction Equations Arising in Biofilm Growth Models

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Abstract

This is the abstract. The discussion of the difference between fully-implicit and semi-implicit method will be discussed in this paper.

1 Intro

Bacterial biofilms are communities of microorganisms that adhere on immersed aqueous surfaces that can support microbial growth based on the environmental conditions. Biofilms are prevalent on both organic or inorganic surfaces in natural, industrial, or hospital settings. When attached to a surface, these bacteria embed themselves in a self-produced extracellular polymeric substance (EPS). The EPS provides a layer of protection against washout and biocides, making harmful biofilms difficult to remove. This attribute of biofilms is a problem since they are associated with medical issues in the form of, bacterial infections, dental plaque, and other diseases and industrial issues, such as biocorrosion of water pipes. They also contribute positively to wastewater treatment, groundwater protection, soil remediation, and other environmental engineering technologies.

To further the understanding of biofilms, a diffusion-reaction model for biofilm growth was proposed in [1]. This model is based

It's kinda like the semi-implicit euler method. Where you solve two equations, one uses the previous time step and the other (solved afterwards) uses the current timestep.

(a) (b)
(c) (d)

Figure 1: Typical simulation using parameters from *appendix A or something* at (a) $t = 0$, (b) $t = 10$, (c) $t = 20$, (d) $t = 30$

2 Model

3 Method

4 Results

4.1 Simulation Setup

4.2 Results

4.3 Comparisons

Define what ϵ_{sol} is here. Use something like the sum of the norm:

$$\epsilon_{sol} = \frac{||u_1 - u_2||}{||u_1||} \quad (1)$$

Tol. 1	Computation Time	ϵ_{sol}	Avg. Iter. 1	Max Iter. 1	Avg. Iter. 2	Max Iter. 2
0	—	—	—	—	—	—
10^{-2}	—	—	—	—	—	—
10^{-4}	—	—	—	—	—	—
10^{-8}	—	—	—	—	—	—

Table 1: Results from running simulation with different Tolerance 1 values. Note, Tolerance 1 of 0 is the semi-implicit method.

5 Conclusions

References

- [1] H.J. Eberl, D.F. Parker, and van Loosdrecht M.C.M. A new deterministic spatio-temporal continuum model for biofilm development. *Journal of Theoretical Medicine*, pages 161–175, 2001.