A mathematical model for sickle cell depolymerization: dynamical properties and numerical experiments

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Abstract. This paper considers a mathematical model to assess the effects of carbon monoxide (CO) on sickle cell hemoglobin (HbS) during HbS polymer melting. Assuming a buffer solution in which a mixture of HbS solution and fibers is rapidly mixed with CO, the model describes the subsequent dynamic interaction of four phases of the HbS components. Stability analysis of the model is presented in the CO-free case, the CO-saturated case and the general case. Numerical experiments are reported which monitor the effects of CO levels in the buffer solution. The model supports the proposition that CO binds directly to solution phase as well as polymerized HbS, and it predicts that while all the HbS becomes CO-bound at equilibrium, not all the HbS fibers are necessarily melted, indicating the presence of CO-bound fiber molecules.

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1. Introduction

Sickle cell disease is an inherited genetic blood disorder that affects red blood cells. The disease is due to the mutation of the sixth position of the beta globin chain of hemoglobin, where the amino acid glutamic acid (which is hydrophilic) of normal

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