438b Monte Carlo Simulation of Dynamic Behavior of Bacteria during Disinfection

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Bacteria are discrete and mesoscopic in size, thereby giving rise to their random behavior exhibiting incessant fluctuations in a fluid medium. Such is the case during their disinfection, especially at the final stage where their population is exceedingly low, and the concomitant fluctuations are appreciably magnified. Furthermore, it is highly likely that the interaction among the bacteria, fluid medium, and disinfection agent is profoundly complex, and therefore, is non-linear. Consequently, it is appropriate, or even desirable, to regard the disinfection of bacteria in a fluid medium as a non-linear stochastic process and to model and simulate it as such. The disinfection of bacteria is simulated here by means of the Monte Carlo method; this method is based on random sampling from the underlying probability distribution of the process, which can be evolving with time. Naturally, it is one of the most, if not the most, suitable numerical methods for simulating stochastic processes, particularly those that are strongly non-linear, and hence, are not readily amenable to the analytical solution or simulation by the conventional numerical techniques. For illustration, the mean and variance of the number concentration of bacteria during thermal disinfection have been computed through Monte Carlo simulation of the disinfection based on a non-linear mechanistic rate law. The results are compared with the available experimental data. *Keywords*: Disinfection, Dynamical biosystems, Monte Carlo method, Non-linear Markov processes, Simulation