Rhythmic phenomenon of the Belousov-Zhabotinsky reaction catalyzed by cerium and ferroin

Chikahiro Egami
Numazu National College of Technology, Japan
egami@numazu-ct.ac.jp

The Belousov-Zhabotinsky (BZ) reaction is a well-known nonlinear chemical oscillator, and its rhythmic phenomenon is recorded as the color change of reaction solution and the variation of the oxidation-reduction potential (ORP). The properties of oscillation, namely period and amplitude, depend on catalyst action in solution. The reaction mechanism called "Oregonator" of the cerium-catalyzed BZ system, the solution of which changes the color between yellow and colorless, was established due notably to the works of Field, Körös and Noyes. Tyson [1] reduced the Oregonator to a two-variable system. Rovinsky & Zhabotinsky [2] developed a reduced model for the ferroin-catalyzed BZ system, whose solution oscillates between blue and red.

For the BZ system simultaneously catalyzed by cerium and ferroin, the color change of the solution is more complicated and the ORP oscillates with a larger amplitude than the system including either cerium or ferroin. To explain these phenomena of the cerium-ferroin system, we present a model which combines the Tyson model and the RZ model based on chemical kinetics. Our model can have a limit cycle under a reasonable condition through a Hopf bifurcation.

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References

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[2] *A. B. Rovinsky, A. M. Zhabotinsky*: Mechanism and mathematical model of the oscillating bromate-ferroin-bromomalonic acid reaction. J. Phys. Chem. *88* (1984), 6081–6084.