Preface

Nonlinear dynamics is the study of how systems whose behaviour depends in a nonlinear fashion on the values of key variables, like concentrations in a chemical reaction, evolve in time. Nearly all systems of interest, including living ones, are nonlinear, often extremely so, but scientists often find it convenient, e.g., in the case of relaxation kinetics, to utilise conditions where the system under consideration behaves linearly. The prototypical phenomenon of nonlinear chemical dynamics is chemical oscillation, the temporally periodic, or nearly periodic, variation of the concentrations of one or more species in a reaction. While reports of electrochemical oscillation date back to 1828, the prevailing wisdom among chemists as late as the 1970s was that chemical oscillation was impossible, a violation of the Second Law of Thermodynamics. Indeed, during the first half of the twentieth century, Bray’s report of the first homogeneous chemical oscillator, the iodate-induced decomposition of hydrogen peroxide, generated more articles devoted to debunking it than to explain it mechanistically. The best known and understood oscillatory chemical system is the Belousov-Zhabotinsky reaction as discovered by B. P. Belousov in 1950’s is cerium ion catalysed oxidation of citric acid by bromate ion and show temporal oscillations. BZ reaction was further extended for various other organic substrates and different metal ion catalysts, but bromate could not be substituted. Another fundamental example of oscillatory chemical reaction is provided by the Briggs Rauscher reaction (BR) which involves the metal ion catalysed oxidation of malonic acid by a mixture of hydrogen peroxide and iodate in aqueous acid medium and there is a periodic consumption and production of I₂, iodide ion and other intermediates during the oscillatory regime. The phenomenon of oscillations, traveling waves and chaos in oscillating chemical systems began as curiosities, but now support an active international research field. Such a type of oscillating chemical reaction helps us in understanding important processes in biology including the developing of cardiac arrhythmias, nerve signal transmission and animal coat patterning.

Academically much mechanistic and modeling work is yet to be done with the presently known chemical oscillators and also introducing new oscillators in view of their relationship with materials of importance.

The work presented in the thesis pertains to the study of the BR reaction comprising of mixed organic substrate system in CSTR mode and the effect of some additives, perturbants and surfactants on the dynamic chemical behavior of the system. The various co-substrates like itaconic acid, mesaconic acid, citraconic acid and tyrosine were chosen because of their sufficient solubility in aqueous acid medium and having some biological importance e.g., amino-acid Tyrosine as a co-substrate with Malonic acid based Briggs Rauscher (BR) oscillatory system was chosen in order to understand the in-vitro mechanistic details of thyroid metabolism. Thus, the study of nonlinear dynamics of BR system employing these co-substrates would help to gain insight into some natural phenomena occurring in living systems.