CHAPTER I

Introduction
There are various mechanisms by which the excitation energy of an organic molecule can be dissipated or transferred to the other molecules in a given liquid system. This energy can either be measured in terms of the fluorescence emission of the acceptor molecules or the quenching of the excited molecules. These processes occur due to the interaction of the excited molecules with the unexcited molecules of the same species or of different species. A host of such processes which may occur in an organic liquid scintillator system consist of: excimerization, energy migration, self quenching, exciplex formation, energy transfer, impurity quenching, fluorescence emission etc.. The process of overall transfer of π-electronic singlet excitation energy from the excited donor to the unexcited acceptor molecules in scintillator systems is influenced by many of these processes including the Brownian diffusion of the interacting molecules. Further, the complexity in understanding such a transfer phenomenon arises because of the possibilities of various intermolecular mechanisms open for both energy migration and transfer processes viz., weak resonance multipole-multipole (e.g., octupole-octupole) interaction or successive excimer formation and dissociation process for energy migration; and long-range coulombic (i.e., dipole-dipole and higher multipole) interaction or short-range collisional or exchange interaction in the case of

Various theoretical models have been put forth by many investigators to describe the energy transfer process in organic liquid scintillators, of which, the following are considered to be of importance.

1. Voltz et al. Model
2. Birks and Conte Model

It may be interesting to note that each model is supported by certain systems. These models differ from
each other in principle over the basic mechanisms responsible for energy migration as well as transfer process, and the relative contribution of the various other processes to the overall transfer. Therefore, a suitable site may be offered to help, sort out the contribution of these basic mechanisms to the overall energy transfer process, by adding a neutral, viscous or non-viscous diluent to a binary liquid scintillator system and altering the temperature. We therefore undertook this study to understand the nature of the basic mechanisms that are involved in the overall energy transfer by varying the physical parameters, such as temperature, dilution and viscosity of the medium which largely influence the basic mechanisms, like excimer formation, Brownian diffusion and collision encounters etc.

We report in this thesis, the results of our investigations on the lines in five neat and dilute organic liquid scintillator systems using toluene as the energy transferring donor, cyclohexane and liquid paraffin as neutral diluents and two organic molecules, namely, 2-(4-Methoxyphenyl)-5-(2-naphthyl)-1, 3, 4-oxadiazole and 4, 4''-Bis-(2-butyloctyloxy)-p-querterphenyl as scintillator acceptors and bromobenzene and anilene as donor quenchers, as a function of temperature and viscosity in the range of 20° - 70°C and 0.6 - 40.0 cp respectively. The data has been analysed using a compact equation formed by us by
combining Voltz et al. and Birks and Conte Models.

The thesis comprises six Chapters. First Chapter pertains to a brief introduction to the phenomenon of scintillation in organic liquid systems.

Second Chapter reviews the experimental work and the theories employed to interpret the results with a special emphasis on the effect of temperature, dilution and viscosity on the process of energy transfer and quenching.

Third Chapter deals with the experimental techniques used to determine the various physical quantities relevant to the present investigation. The viscosity and the density measurements at various temperatures for toluene, toluene-cyclohexane mixture and toluene-paraffin mixture using standard methods are also incorporated in this Chapter. Section II of this Chapter contains the experimental observations and the results obtained in neat toluene systems for both the acceptors along with the analysis and discussion of the results.

Chapter four comprises the experimental observations in toluene + cyclohexane system for acceptor 2. The analysis and discussion of the experimental results in toluene + cyclohexane system is also embodied in this Chapter.
Chapter five enspheres the experimental observations and the analysis and discussion of the results obtained in toluene + paraffin system for acceptor 2.

A critical discussion of the theoretical models in view of the compact equation, and the concluding remarks based on our findings in the present investigation are presented in the sixth chapter.

An additional chapter makes its way as an appendix in the thesis to study the departure of the experimental results obtained in toluene + cyclonexane system with bromobenzene as quencher from the Stern-Volmer relation.

The thesis at the end contains the list of literature cited throughout.