CHAPTER 4: CONCLUSION AND FUTURE WORK

The research project was successful in showing that 2-chloropyrazine and 2-chloroquinoxaline gave phenoxy, *N*-alkylamino and *N*-arylamino derivatives with useful fluorescence characteristic. 24 compounds were synthesized successfully using different reaction conditions, solvent systems and new method was developed which is economical and gave high percentage of the products. Generally, the substitution reactions of 2-chloropyrazine and 2-chloroquinoxaline are completed in less than 9 hours. If a better leaving group than chloro were to be used, the pyrazine and quinoxaline systems could give a better yield.

Fluorescence characteristic of compounds studied showed that solvent effects can be dramatic and a complete change in the nature of the emission can occur with the change of solvent. 2-*N*-Piperidinopyrazine **(37)**, 2-*N*-anilinopyrazine **(46)**, 2-*N*-piperidinoquinoxaline **(59)** and 2-*N*-anilinoquinoxaline **(62)** showed the highest fluorescence intensity in polar aprotic solvent with higher dielectric constant. A decrease in fluorescence intensity was observed in ethanol.

Molecular rigidity is also necessary to obtain maximum fluorescence. This can be seen clearly in the case of piperidino derivatives which fluoresce with higher intensities compared to anilino of pyrazine and quinoxaline derivatives. Structural rigidity reduces vibrational amplitudes that promote radiationless losses and is a prime factor in fluorescence capability. Apart from molecular rigidity, conjugation also plays an important role. It can be seen that compounds of 2-substituted quinoxaline fluoresced at a higher wavelength compared to the compounds of 2-substituted pyrazine.

Increasing the number and mobility of the π electrons often results in an increase in fluorescence intensity.

The effect of oxygen on fluorescence varies from compound to compound. The study shows that the fluorescence intensity of capped samples is higher than the uncapped samples. On a prolong exposure of the solution to the atmosphere resulted in reducing the fluorescence intensity. These phenomena were due to the quenching effect of oxygen.

The study of concentration effects is of importance because of the information obtained is about solute-solute and solute solvent interactions. The study shows that when higher concentration is employed, the higher the fluorescence intensity of compound **(37)**, **(38)** and **(39)**. However, increases in concentration of fluorescent solutions usually result in concentration quenching that can decrease the fluorescence intensity. In principle, concentration quenching is not an important analytical difficulty since it can easily be remedied by diluting the solution.

The nature of substituents plays an important role in the nature and extent of a molecule's fluorescence characteristic. The study shows that the presence of substituent such as electron donating and electron withdrawing group in the ring system causes a bathchromic shift to a higher wavelength. Fluorescence intensities are usually altered by ring substitution. Unfortunately in this study, some experimental especially in fluorescence intensity results are contradictive to the theoretical expectations. The explanation to this phenomenon has been discussed in discussion.

Many compounds are capable of undergoing ionisation. Almost all the ionic forms of a compound exhibit different fluorescence characteristics from those of the unionised form. From the study, a few generalisations can be made about the intensity of fluorescence behaviour of selected 2-substituted pyrazines and 2-substituted quinoxalines with different pH values. Higher intensity was observed in neutral and alkaline conditions, whereas in acidic condition, reduced intensity resulted from protonation of the compound studied. Because fluorescence properties are often very pH dependent, one may use pH as a parameter in fluorometric analysis to reduce interference or to obtain the most strongly fluorescent species for analysis. Furthermore, a number of visibly fluorescent compounds have been used as pH indicators.

Based on the fluorescence characteristic of the compounds studied, halogenated starting material may one day can be used to analyse the presence of organic pollutants such as phenols, amines, chloroamines and Polycylic Aromatic Hydrocarbons (PAHs) in air, water and sediments.

The study should be extended to oxygen containing heterocycles of various ring size and as well as in complex organic systems. Thus far, the fluorescence characteristics of organic compounds are not well documented. The fluorescence work will be extended to the study on the effect of various transition metals on the amino and phenoxy derivatives of various heterocycles. It is hoped that one day, a heterocyclic based reagent will be used as the fluorescent indicator to detect the presence of phenol and heavy metals in water and sediments.