Preface

Thermal diffusion is a process in which partial separation of an isotopic or nonisotopic component occurs in a homogeneous binary or ternary gas mixture under the influence of temperature gradient. The phenomenon is well known for its wide applicability in gases, liquids and solids. It is also important in the study of various types of physicochemical natural phenomena like flames, planetary atomosphere, stellar interiors and nabulae. Moreover, thermal diffusion phenomenon being a second order effect, is concerned with the relative motions of the components in a homogeneous gas mixture under temperature gradient. It is thus important to separate ordinary and rare isotopes from technical point of view.

The main purpose of the thesis entitled "Column Calibration Factor and Force Parameters to Predict Temperature and Composition Dependence of Thermal Diffusion Factor of some Simple Molecules," is concerned with the estimation of Thermal diffusion factor α_T and force parameters of the isotopic gas mixture by thermal diffusion column measurement. The theory of thermal diffusion column (TDC) is a very complicated phenomenon. In order to improve the column theory a scaling factor F_s called the column calibration factor (CCF) as a function of cold and hot wall radii r_c and r_h, geometrical length L of a column and mean temperature $\bar{T}$ is introduced. F_s is, however, related to TD factor α_T and $\ln q_{max}$ of a TD column. q_{max} is the maximum value of separation factor q_e defined by:

$$q_e = (x_i / x_j)_{top} \big/ (x_i / x_j)_{bottom}$$

x_i and x_j are the mass or mole fractions of the lighter (i) and the heavier (j) components of a gas mixture to be investigated.

The first chapter of the thesis is concerned with the general introduction of various experimental techniques involved in thermal diffusion. Various aspects of all the experimental techniques have widely been discussed under the heading "General introduction: Experimental details". A brief review of work on thermal diffusion column measurements has been made in chapter 2 entitled, "Brief review of the previous theoretical and experimental works".

"The scope and objective of the present works" of chapter 3 deals with the role of column calibration factor in determining α_T of a gas mixture. It is also interesting to note that α_T is a sensitive parameter to investigate intermolecular forces like ε_{ij}/k and σ_{ij} of the molecules. Here, an attempt is made to determine the force parameters of the interacting molecules by α_T through F_s of the column.

The thermal diffusion factor α_T is of much importance to examine whether elastic or inelastic collisions occurs among the experimental molecules. So in chapter 4 different theoretical aspects to determine α_T as well as experimental α_T by the existing methods have been discussed under the title" Estimation of theoretical and experimental thermal diffusion factor."

Chapter 5 of the thesis deals with composition dependence of TDF of some inert gas mixtures at a given experimental temperature where as chapter 6 is related to the estimation of α_T of hydrogenic trace mixtures like He- T_2, He- HT and He- HD. In both cases α_T's are calculated from F_s and $\ln q_{max}$.

Chapter 7 and 8 of the thesis are concerned with the determination of the force parameters of some isotopic inert gas mixtures from their temperature dependence of α_T's obtained by the CCF method. Further the model independency of the CCF is established in chapter 8.

Thus, it becomes necessary to derive a functional relationship of F_s with r_c, r_h, L and $\bar{T}$. From the Navier- Stokes hydrodynamical equation an approximate formulation of F_s is, however, derived in chapter 9 of "The functional relationship of the column calibration factor in thermal diffusion column measurement." Approximate F_s of four different column geometries is found to be in good agreement with the respective experimental F_s. Further, the molecular force parameters of Ne as obtained from α_T by the CCF method agree well with the literature values.

The column parameters as formulated in chapter 9 are again used to get the optimum pressure of the light isotopic gas mixture like He^3- He^4. The experimental F_s when plotted against $\bar{T}$ in chapter 10 of the thesis shows the similar magnitudes and trends with respect to theoretical F_s.

To have a clear birds- eye view on the subject matter of the thesis "The summary and conclusion" is presented in chapter11.

Thus the thesis provides one with the important aspect of the column calibration factor to obtain thermal diffusion factor. Subsequently, molecular force parameters are obtained from thermal diffusion phenomenon. Moreover, an attempt is made to explain the thermal diffusion column behaviour explicitly by formulation of F_s, derived from Navier- Stokes hydrodynamical equation.