CHAPTER V

CONCLUSIONS

Separation of styrene oxide and its derivatives with different numbers, types, and positions (*ortho*-, *meta*-, *para*-) of substitution as well as aliphatic epoxides were studied by gas chromatography using chiral stationary phases containing modified γ-cyclodextrins: octakis(2,3-di-*O*-methyl-6-*O*-*tert*-butyldimethylsilyl)-γ-cyclodextrin (abbreviated as GSiMe) and octakis(2,3-di-*O*-acetyl-6-*O*-*tert*-butyldimethylsilyl)-γ-cyclodextrin (abbreviated as GSiAc). Both chiral selectors possess identical glucose units and C6 position substituents (-*O*-*tert*-butyldimethylsilyl), but have different substituents at C2 and C3 chiral carbons. All analytes could be enantioseparated with either GSiMe or GSiAc phase, or both of them except for aliphatic epoxides **hexa, octa**, **deca**, **9dece** and **dodec** that could not be separated. The information acquired systematically from the gas chromatographic experiment were used to calculate thermodynamic parameters for the association between analytes and cyclodextrin derivatives in order to rationalize the effect of analyte and selector structure on enantiorecognition.

From thermodynamic data obtained by van't Hoff approach, the $-\Delta H$ and $-\Delta S$ values of analytes on the chiral GSiMe and GSiAc columns are greater than the non-chiral polysiloxane column, indicating the two chiral columns have stronger interactions with the analytes than does the non-chiral one. Comparing the thermodynamic data acquired from both chiral columns, both $-\Delta H_2$ and $-\Delta S_2$ display similar trend. Furthermore, these values of all analytes on the same column are relatively comparable indicating that the epoxy group of analyte mainly interacts with the stationary phase. Nonetheless, the interaction strength does not necessarily correlate with the discrimination of enantiomers, since some analytes having strong interaction with stationary phase do not exhibit high enantioseparation.

On the GSiMe column, the position of substituent has greater effect on the enantioseparation than does the type of substituent, as seen from the mono-substituted analytes. The *ortho*-styrene oxide derivatives seem to enhance the enantiorecognition

than the *meta-* or *para-* styrene oxide derivatives. However, type of substituent also plays important role in enantioseparation. Among all the analytes tested, 2,4-difluorostyrene oxide (**24F**) and *trans*-phenylpropylene oxide (*trans*-**2**) show highest degree of enantioseparation. However, all aliphatic epoxides could not be separated by the GSiMe column.

On the GSiAc column, the similar trends to the GSiMe column were observed, but with greater enantiorecognition than on the GSiMe column. All aromatic epoxides which could not be separated on the GSiMe column were separated on the GSiAc column. Likewise, all aliphatic epoxides also could not be separated by this column except 1,2-epoxy-5-hexene (**5-hexe**). The analyte showing the best degree of enantioseparation is *cis*-phenylpropylene oxide (*cis*-**2**).

To understand the mechanism of chiral recognition, the molecular docking method using Lamarckian genetic algorithms (LGA) with AutoDock 4, including binding energy calculation with Gaussian 03, were employed. The results demonstrated that the differences in retention and degree of enantioseparation for all of epoxide enantiomers on both GSiMe and GSiAc columns depended on several factors, such as type, position, number of substitution, structure of epoxide. The GSiAc column generally has higher enantioseparation ability than does the GSiMe column because the host GSiAc molecular structure is less symmetric and hence facilitating the chiral discrimination from the stronger three-point interactions with the guest analytes.