

ผลของความแรงตัวทำละลายต่อพฤติกรรมโครมาโทกราฟีของสารประกอบ
ฟีนอลิกบางชนิดในรีเวิร์สเฟสไฮเพอร์ฟอร์มันซ์ลิกวิดโครมาโทกราฟี



นาย สมศักดิ์ ศิริไชย

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

ภาควิชาเคมี

บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

พ.ศ. 2538

ISBN 974-632-892-1

ลิขสิทธิ์ของบัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

±17031795

EFFECT OF SOLVENT STRENGTH ON THE CHROMATOGRAPHIC BEHAVIOR
OF CERTAIN PHENOLIC COMPOUNDS IN REVERSED PHASE
HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Mr. Somsak Sirichai

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science

Department of Chemistry

Graduate School

Chulalongkorn University

1995

ISBN 974-632-892-1

Thesis Title Effect of Solvent Strength on the Chromatographic Behavior of Certain Phenolic Compounds in Reversed Phase High Performance Liquid Chromatography

By Mr.Somsak Sirichai

Department Chemistry

Thesis Advisor Associate Professor Vithaya Ruangpornvisuti

Thesis Coadvisor Assistant Professor Surapote Wongyai



Accepted by the Graduate School , Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree.

Santi Thoongsuwon

.....Dean of Graduate School

(Associate Professor Santi Thoongsuwon, Ph.D.)

Thesis Committee

Siri Varothai

.....Chairman

(Associate Professor Siri Varothai, Ph.D.)

Vithaya Ruangpornvisuti

.....Thesis Advisor

(Associate Professor Vithaya Ruangpornvisuti, Dr.rer.nat.)

S. Wongyai

.....Thesis Co-advisor

(Assistant Professor Surapote Wongyai, Dr.rer.nat.)

Ratana Magee

.....Member

(Associate Professor Ratana Magee, Ph.D.)

Warinthorn Chavasiri

.....Member

(Assistant Professor Warinthorn Chavasiri , Ph.D.)

สมศักดิ์ ศิริไชย : ผลของความแรงตัวทำละลายต่อพฤติกรรมโครมาโทกราฟีของสารประกอบฟีนอลิกบางชนิดในเฟสย้อนกลับของโครมาโทกราฟีไฮเพอร์ฟอร์แมนซ์ลิควิดโครมาโทกราฟี (EFFECT OF SOLVENT STRENGTH ON THE CHROMATOGRAPHIC BEHAVIOR OF CERTAIN PHENOLIC COMPOUNDS IN REVERSED PHASE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY) อ.ที่ปรึกษา : รศ.ดร. วิทยา เรืองพรวิสุทธิ, อ.ที่ปรึกษาร่วม : ผศ.ดร.สุรพจน์ วงศ์ใหญ่ , 157 หน้า. ISBN 974-632-892-1

ในงานวิจัยครั้งนี้ ได้ศึกษาผลของความแตกต่างของความแรงระหว่างตัวทำละลายสำหรับสารตัวอย่างและตัวชะต่อพฤติกรรมทางโครมาโทกราฟีของกลุ่มสารพวกฟีนอล คือ พาราเซตามอล ฟีนอล เมธิลพาราเบน เอธิลพาราเบน และโพรพิลพาราเบน บนคอลัมน์ชนิดรีเวิร์สเฟสไฮเพอร์ฟอร์แมนซ์ลิควิดโครมาโทกราฟีในช่วงอุณหภูมิ 20° ถึง 35 °ซ. คอลัมน์ที่ใช้ในการศึกษาได้แก่ LiChrosorb RP-8 และ LiChrosorb RP-18 โดยมีขนาดอนุภาค 10 ไมโครเมตร ซึ่งบรรจุอยู่ในคอลัมน์ขนาดเส้นผ่าศูนย์กลางภายใน 4.6 มม. และยาว 25 ซม. โดยที่องค์ประกอบของตัวชะ คือ เมธานอลและน้ำ ในอัตราส่วน 60 ต่อ 40 (โดยปริมาตร)

จากการศึกษาพบว่า จำนวนเพลตตามทฤษฎี (the number of theoretical plates , N) เพิ่มขึ้น เมื่อเปอร์เซ็นต์ของน้ำในตัวทำละลายสารตัวอย่างเพิ่มขึ้น และมีค่ามากที่สุดเมื่อความเข้มข้นของน้ำในตัวทำละลายมากกว่า 40 เปอร์เซ็นต์ และพบว่า ผลที่เกิดขึ้นเนื่องจากความแรงของตัวทำละลายจะเพิ่มขึ้นเมื่ออุณหภูมิเพิ่มขึ้น จากการทดลองพบว่า ปริมาณน้ำในตัวทำละลายสารตัวอย่างทำให้จำนวนเพลตตามทฤษฎีเพิ่มขึ้น โดยมีความสัมพันธ์ระหว่าง N กับ polarity index (P_i) ของตัวทำละลาย เป็นฟังก์ชันโพลีโนเมียล องศาสอง ตามสมการ $N = A_0 + A_1P_i + A_2P_i^2$ ของทุกอุณหภูมิที่ศึกษา สำหรับรีเทนชันไทม์ (retention time) ของสารที่ศึกษาจะไม่เปลี่ยนแปลงตามความแรงของตัวทำละลาย พร้อมกันนี้ได้อธิบายผลอันเกิดจากความแรงของตัวทำละลายนี้ในรูปแบบของการเกิด peak distortion และ peak compression

ภาควิชา.....เคมี
สาขาวิชา.....เคมี
ปีการศึกษา.....2538

ลายมือชื่อนิสิต.....สมศักดิ์ ศิริไชย
ลายมือชื่ออาจารย์ที่ปรึกษา.....
ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....

C625187 :MAJOR CHEMISTRY

KEY WORD : SOLVENT STRENGTH / REVERSED-PHASE HPLC / PHENOLIC COMPOUNDS

SOMSAK SIRICHAJ : EFFECT OF SOLVENT STRENGTH ON THE CHROMATOGRAPHIC BEHAVIOR OF CERTAIN PHENOLIC COMPOUNDS IN REVERSED PHASE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY. THESIS ADVISOR : ASSOC.PROF.VITHAYA RUANGPORNVISUTI, Dr.rer.nat., ASSIST.PROF.SURAPOTE WONGYAI, Dr.rer.nat. 157 pp. ISBN 974-632-892-1

The effects resulting from differences between sample solvent and mobile phase composition on chromatographic behavior of paracetamol, phenol, methylparaben, ethylparaben and propylparaben at 20° to 35°C on reversed-phase high-performance liquid chromatography were investigated. Two columns used in this study were LiChrosorb RP-8 (10 µm, 4.6 mm I.D. x 25 cm.) and LiChrosorb RP-18 (10 µm, 4.6 mm I.D. x 25 cm.) with methanol/water (60:40, v/v) as mobile phase. The number of theoretical plates (N) for the studied compounds increased as the % (v/v) water in dissolving solvent increased and reached maximum value after 40% (v/v) water concentration. The effect of sample solvent strength was enhanced at higher temperature. At 0 to 40% (v/v) water in dissolving solvent, the number of theoretical plates varied with the solvent polarity index (P_i) as a second-degree polynomial function, i.e., $N = A_0 + A_1P_i + A_2P_i^2$ at all temperature studied. The retention time of each compound was not affected by the solvent strength. The proposed mechanisms of peak distortion and peak compression occurring from this effect are discussed.

ภาควิชา.....เคมี

สาขาวิชา.....เคมี

ปีการศึกษา.....2538

ลายมือชื่อนิสิต.....สมศักดิ์ ศรีไชย

ลายมือชื่ออาจารย์ที่ปรึกษา.....

ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....



ACKNOWLEDGEMENTS

The author would like to express his sincere gratitude to his advisor, Associate Professor Vithaya Ruangpornvisuti and his coadvisor Assistant Professor Surapote Wongyai for their kind help, guidance, correction and encouragement throughout the course of this study. Moreover, thanks are extended to the Department of Chemistry, Faculty of Science, and graduate school, Chulalongkorn University for the financial support and also to the staffs for their kind cooperation.

He is grateful to the Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Rangsit University for apparatus and chemicals.

Finally, the author is greatly indebted and deeply grateful to his parents and the family members for their encouragement and understanding throughout the entire course of his study.

CONTENTS



	Page
ABSTRACT IN THAI.....	IV
ABSTRACT IN ENGLISH.....	V
ACKNOWLEDGMENT.....	VI
LIST OF TABLES.....	IX
LIST OF FIGURES.....	XV
CHAPTER I : INTRODUCTION	
Problem Definition.....	1
Literature Reviews.....	3
Purpose of the Study.....	8
CHAPTER II : THEORY	
Band Broadening Mechanisms.....	9
CHAPTER III : EXPERIMENTAL	
Apparatus.....	16
Chemicals.....	17
Preparation of Standard Solutions.....	18
Chromatographic Conditions.....	19
CHAPTER IV : RESULTS AND DISCUSSIONS.....	20
CHAPTER V : CONCLUSION.....	77
REFERENCES.....	79

	Page
APPENDIX	
APPENDIX A.....	84
APPENDIX B.....	136
APPENDIX C.....	156
VITA.....	157

LIST OF TABLES

Table		Page
3.1	Chromatographic conditions for the study of effect of solvent strength on chromatographic behavior of analytes on RP-8 column.....	19
3.2	Chromatographic conditions for the study of effect of solvent strength on chromatographic behavior of analytes on RP-18 column.....	19
4.1	Statistical fitting parameters of appropriate model for paracetamol on RP-8 at various temperatures , where the following relationship in equation (4.1).....	54
4.2	Statistical fitting parameters of appropriate model for phenol on RP-8 at various temperatures , where the following relationship in equation (4.1).....	55
4.3	Statistical fitting parameters of appropriate model for methylparaben on RP-8 at various temperatures , where the following relationship in equation (4.1).....	56
4.4	Statistical fitting parameters of appropriate model for ethylparaben on RP-8 at various temperatures , where the following relationship in equation (4.1).....	57
4.5	Statistical fitting parameters of appropriate model for propylparaben on RP-8 at various temperatures , where the following relationship in equation (4.1).....	58
4.6	Statistical fitting parameters of appropriate model for paracetamol on RP-18 at various temperatures , where the following relationship in equation (4.1).....	59
4.7	Statistical fitting parameters of appropriate model for phenol on RP-18 at various temperatures , where the following relationship in equation (4.1).....	60

4.8	Statistical fitting parameters of appropriate model for methylparaben on RP-18 at various temperatures , where the following relationship in equation (4.1).....	61
4.9	Statistical fitting parameters of appropriate model for ethylparaben in RP-18 at various temperatures , where the following relationship in equation (4.1).....	62
4.10	Statistical fitting parameters of appropriate model for propylparaben on RP-18 at various temperatures , where the following relationship in equation (4.1).....	63
4.11	Statistical fitting parameters of appropriate model for paracetamol on RP-8 at temperatures 25°C and 35°C. , where the following relationship in equation (4.2).....	65
4.12	Statistical fitting parameters of appropriate model for phenol on RP-8 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	66
4.13	Statistical fitting parameters of appropriate model for methylparaben on RP-8 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	67
4.14	Statistical fitting parameters of appropriate model for ethylparaben on RP-8 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	68
4.15	Statistical fitting parameters of appropriate model for propylparaben on RP-8 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	69

4.16	Statistical fitting parameters of appropriate model for paracetamol on RP-18 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	70
4.17	Statistical fitting parameters of appropriate model for phenol on RP-18 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	71
4.18	Statistical fitting parameters of appropriate model for methylparaben on RP-18 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	72
4.19	Statistical fitting parameters of appropriate model for ethylparaben on RP-18 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	73
4.20	Statistical fitting parameters of appropriate model for propylparaben on RP-18 at temperatures of 25°C and 35°C. , where the following relationship in equation (4.2).....	74
B1	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 20°C. The chromatographic conditions as given in Table 3.1.....	136
B2	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 25°C. The chromatographic conditions as given in Table 3.1.....	137

B3	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 30°C. The chromatographic conditions as given in Table 3.1.....	138
B4	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 35°C. The chromatographic conditions as given in Table 3.1.....	139
B5	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 20°C. The chromatographic conditions as given in Table 3.2.....	140
B6	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 25°C. The chromatographic conditions as given in Table 3.2.....	141
B7	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 30°C. The chromatographic conditions as given in Table 3.2.....	142
B8	The effect of solvent strength on number of theoretical plates for each phenolic compound in standard mixtures at 35°C. The chromatographic conditions as given in Table 3.2.....	143
B9	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 20°C. The chromatographic conditions as given in Table 3.1.....	144

B10	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 25°C. The chromatographic conditions as given in Table 3.1.....	145
B11	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 30°C. The chromatographic conditions as given in Table 3.1.....	146
B12	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 35°C. The chromatographic conditions as given in Table 3.1.....	147
B13	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 20°C. The chromatographic conditions as given in Table 3.2.....	148
B14	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 25°C. The chromatographic conditions as given in Table 3.2.....	149
B15	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 30°C. The chromatographic conditions as given in Table 3.2.....	150
B16	The effect of solvent strength on retention time (t_R) and capacity factor (k) for each phenolic compound in standard mixtures at 35°C. The chromatographic conditions as given in Table 3.2.....	151

B17	The effect of viscosity on the number of theoretical plates on RP-8 at 25°C.....	152
B18	The effect of viscosity on the number of theoretical plates on RP-8 at 35°C.....	153
B19	The effect of viscosity on the number of theoretical plates on RP-18 at 25°C.....	154
B20	The effect of viscosity on the number of theoretical plates on RP-18 at 25°C.....	155

LIST OF FIGURES

Figure	Page
4.1	Effect of varying concentrations of water on the chromatographic behavior of phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.1 at 20°C.21
4.2	Effect of varying concentrations of water on the chromatographic behavior of phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.1 at 25°C.22
4.3	Effect of varying concentrations of water on the chromatographic behavior of phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.1 at 30°C.23
4.4	Effect of varying concentrations of water on the chromatographic behavior for phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.1 at 35°C.24
4.5	Effect of varying concentrations of water on the chromatographic behavior for phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.2 at 20°C.25
4.6	Effect of varying concentrations of water on the chromatographic behavior for phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.2 at 25°C.26

4.7	Effect of varying concentrations of water on the chromatographic behavior for phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.2 at 30°C.	27
4.8	Effect of varying concentrations of water on the chromatographic behavior for phenols (Dependence of N on the water to methanol ratio). Chromatographic conditions as given in Table 3.2 at 35°C.	28
4.9	Effect of varying temperatures on the N_{\max}/N_{\min} ratio for phenols. Chromatographic conditions as given in Table 3.1.	29
4.10	Effect of varying temperatures on the N_{\max}/N_{\min} ratio for phenols. Chromatographic conditions as given in Table 3.2.	30
4.11	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 20°C.	32
4.12	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 25°C.	33
4.13	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 30°C.	34
4.14	Chromatograms of standard mixtures of phenol on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 30°C.	35

4.15	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 35°C.	36
4.16	Chromatograms of standard mixtures of phenol on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.1 at 35°C.	37
4.17	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.2 at 20°C.	38
4.18	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.2 at 25°C.	39
4.19	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.2 at 30°C.	40
4.20	Chromatograms of standard mixtures of phenols on a reversed-phase column dissolved in either methanol (a) or water/methanol (b,40:60 v/v) . Chromatographic conditions as given in Table 3.2 at 35°C.	41
4.21	Effect of varying concentrations of water on retention time of phenols at 20°C. Chromatographic conditions as given in Table 3.1.....	45
4.22	Effect of varying concentrations of water on retention time of phenols at 25°C. Chromatographic conditions as given in Table 3.1.....	46

4.23	Effect of varying concentrations of water on retention time of phenols at 30°C. Chromatographic conditions as given in Table 3.1.....	47
4.24	Effect of varying concentrations of water on retention time of phenols at 35°C. Chromatographic conditions as given in Table 3.1.....	48
4.25	Effect of varying concentrations of water on retention time of phenols at 20°C. Chromatographic conditions as given in Table 3.2.....	49
4.26	Effect of varying concentrations of water on retention time of phenols at 25°C. Chromatographic conditions as given in Table 3.2.....	50
4.27	Effect of varying concentrations of water on retention time of phenols at 30°C. Chromatographic conditions as given in Table 3.2.....	51
4.28	Effect of varying concentrations of water on retention time of phenols at 35°C. Chromatographic conditions as given in Table 3.2.....	52
4.29	The relationship between number of theoretical plates (N) of paracetamol in RP-8 at various temperatures and polarity index (P_i) in the injection solvent.	54
4.30	The relationship between number of theoretical plates (N) of phenol in RP-8 at various temperatures and polarity index (P_i) in the injection solvent.	55
4.31	The relationship between number of theoretical plates (N) of methylparaben in RP-8 at various temperatures and polarity index (P_i) in the injection solvent.	56
4.32	The relationship between number of theoretical plates (N) of ethylparaben in RP-8 at various temperatures and polarity index (P_i) in the injection solvent.	57
4.33	The relationship between number of theoretical plates (N) of propylparaben in RP-8 at various temperatures and polarity index (P_i) in the injection solvent.	58

4.34	The relationship between number of theoretical plates (N) of paracetamol in RP-18 at various temperatures and polarity index (P_i) in the injection solvent.	59
4.35	The relationship between number of theoretical plates (N) of phenol in RP-18 at various temperatures and polarity index (P_i) in the injection solvent.	60
4.36	The relationship between number of theoretical plates (N) of methylparaben in RP-18 at various temperatures and polarity index (P_i) in the injection solvent.	61
4.37	The relationship between number of theoretical plates (N) of ethylparaben in RP-18 at various temperatures and polarity index (P_i) in the injection solvent.	62
4.38	The relationship between number of theoretical plates (N) of propylparaben in RP-18 at various temperatures and polarity index (P_i) in the injection solvent.	63
4.39	The relationship between number of theoretical plates (N) of paracetamol in RP-8 at temperatures 25° and 35°C and polarity index (P_i) in the injection solvent.	65
4.40	The relationship between number of theoretical plates (N) of phenol in RP-8 at temperatures 25° and 35°C and polarity index (P_i) in the injection solvent.	66
4.41	The relationship between number of theoretical plates (N) of methylparaben in RP-8 at temperatures 25° and 35°C and polarity index (P_i) in the injection solvent.	67
4.42	The relationship between number of theoretical plates (N) of ethylparaben in RP-8 at temperatures 25° and 35°C and polarity index (P_i) in the injection solvent.	68

4.43	The relationship between number of theoretical plates (N) of propylparaben in RP-8 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	69
4.44	The relationship between number of theoretical plates (N) of paracetamol in RP-18 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	70
4.45	The relationship between number of theoretical plates (N) of phenol in RP-18 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	71
4.46	The relationship between number of theoretical plates (N) of methylparaben in RP-18 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	72
4.47	The relationship between number of theoretical plates (N) of ethylparaben in RP-18 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	73
4.48	The relationship between number of theoretical plates (N) of propylparaben in RP-18 at temperatures 25° and 35°C and polarity index (P _i) in the injection slovent.	74
A1	Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column. Peak identification and chromatographic conditions as given in Figure 4.9	84

- A2 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) ,
10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) ,
50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) ,
90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.10.....90
- A3 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) ,
10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) ,
50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) ,
90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.11.....96
- A4 Chromatograms of phenol where phenol dissolved in 2% methanol (a) ,
10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) ,
50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) ,
90% methanol (j) and pure methanol (k) on reversed-phase column.
Chromatographic conditions as given in Figure 4.12.....101
- A5 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) ,
10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) ,
50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) ,
90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.13.....105

- A6 Chromatograms of phenol where phenol dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column.
Chromatographic conditions as given in Figure 4.14.....110
- A7 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.15.....114
- A8 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.16.....120
- A9 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g), 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.17.....126

- A10 Chromatograms of standard mixtures of phenols dissolved in 2% methanol (a) , 10% methanol (b) , 20% methanol (c) , 30% methanol (d) , 40% methanol (e) , 50% methanol (f) , 60% methanol (g) , 70% methanol (h) , 80% methanol (i) , 90% methanol (j) and pure methanol (k) on reversed-phase column.
Peak identification and chromatographic conditions as given in Figure 4.18.....131