CHAPTER III

RESULTS AND DISCUSSION

3.1 The Study of Shaking Time

The effect of the shaking time on percent recovery of each halogenated alkane i.e., methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane with each extracting solvent including, hexane, cyclohexane and isooctane for the different sample-to-solvent ratios including 9:1, 5:5 and 2:8 obtained from the procedure in section 2.5.1 are shown in Table 3.1-3.15 and Figure 3.1-3.9. It is found that the percent recovery of each halogenated alkane from the study reaches a maximum and remains constant after 2 min for each extracting solvent. Therefore, the 15 minutes would be used as the optimum shaking time for the microextraction studies to ensure that the system would be in the equilibrium .

3.2 Microextraction Studies of Halogenated Alkanes in Single Component Solutions.

The results of percent recoveries of halogenated alkanes including methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane in the single component solutions with each extracting solvent i.e., hexane, cyclohexane and isooctane for each sample-to-solvent ratio i.e., 9:1, 5:5 and 2:8 are shown in Table 3.16-3.33. It is found that the percent recovery of each halogenated alkane would be increased as in the following

order of sample-to-solvent ratio : 9:1, 5:5 and 2:8. The percent recoveries of halogenated alkanes for the sample-to-solvent ratio of 9:1 as shown in Table 3.16-3.17,3.22-3.23 and 3.28-3.29 are in the range of 31.31-101.46 % with the percent RSD in the range of 0.23-6.41 %. The percent recoveries of halogenated alkanes for the sample-to-solvent ratio of 5:5 shown in Table 3.18-3.19,3.24-3.25 and 3.30-3.31 and 2:8 shown in Table 3.20-3.21,3.26-3.27 and 3.32-3.33 are in the ranges of 63.21-105.04 % with the percent RSD in the range of 0.29-9.02 % and 67.28-107.99 % with the percent RSD in the range of 0.05-8.94 %, respectively. However, the sample-to-solvent ratio of 9:1 is considered to be the suitable ratio for the microextraction of halogenated alkanes. It is because the compounds of interest are concentrated into the organic solvent and the percent RSD of this ratio is lower than that of the other two ratios i.e., 5:5 and 2:8.

The percent recovery of each halogenated alkane with each extracting solvent including hexane, cyclohexane and isooctane for the same sample-to-solvent ratio differs insignificantly since these solvents are classified as non polar solvents. Therefore, either one of them would be suitable to use as the solvent in microextraction of these compounds. However, isooctane is selected as the appropriate solvent for microextraction technique of these compounds and the reason of this is that isooctane elutes from the column after the compounds of interest and it would result in lowering the minumum detectable level, MDL, of halogenated alkanes as can be seen from the Table 3.52.

Table 3.1 The effect of the shaking time on the percent recovery of 9.95 ppm of methylene chloride solution with hexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	35.73	39.90
	5	34.83	38.90
	10	34.69	38.74
	20	33.88	37.84
	30	34.50	38.53
5:5	2	6.30	63.30
	5	6.54	65.72
	10	6.35	63.80
	20	6.30	63.33
	30	6.23	62.56
2:8	2	1.67	67.17
	5	1.65	66.24
	10	1.65	66.41
	20	1.58	63.54
	30	1.61	64.59

Triplicate analyses

Table 3.2 The effect of the shaking time on the percent recovery of 10.04 ppm of chloroform solution with hexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	56.22	62.22
	5	56.63	62.67
	10	56.90	62.97
	20	56.90	62.93
	30	57.02	63.10
5:5	2	8.45	84.17
	5	8.52	84.91
	10	8.44	84.10
	20	8.53	84.95
	30	8.45	84.13
2:8	2	2.43	96.74
	5	2.45	97.58
	10	2.42	96.51
	20	2.40	95.75
	30	2.46	97.85

Triplicate analyses

Table 3.3 The effect of the shaking time on the percent recovery of 9.94 ppm of 1,1,1-trichloroethane solution with hexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	60.72	67.87
	5	63.36	70.83
	10	61.23	68.44
	20	62.57	69.94
	30	61.90	69.19
5:5	2	9.69	97.50
	5	9.87	99.27
	10	9.63	96.93
	20	9.60	96.56
	30	9.63	96.86
8:2	2	2.47	99.62
	5	2.36	94.88
	10	2.57	103.38
	20	2.43	97.92
	30	2.49	100.00

Triplicate analyses

Table 3.4 The effect of the shaking time on the percent recovery of 10.00 ppm of carbontetrachloride solution with hexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	68.64	76.27
	5	68.97	76.63
	10	68.56	76.18
	20	67.74	75.27
	30	68.55	76.17
5:5	2	8.97	90.81
	5	8.97	89.69
	10	8.93	89.32
	20	9.05	90.48
	30	9.03	90.28
2:8	2	2.28	91.20
	5	2.27	90.87
	10	2.27	90.73
	20	2.21	88.57
	30	2.24	89.41

Triplicate analyses

Table 3.5 The effect of the shaking time on the percent recovery of 9.94 ppm of 1,2-dichloropropane solution with hexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	75.19	84.04
	5	73.44	82.08
	10	74.20	82.88
	20	74.70	83.49
	30	74.94	83.75
5:5	2	9.78	98.44
	5	9.85	99.13
	10	9.79	98.54
	20	9.65	97.12
	30	9.77	98.31
2:8	2	2.48	99.94
	5	2.49	100.15
	10	2.45	98.80
	20	2.43	97.93
	30	2.58	103.99

Triplicate analyses

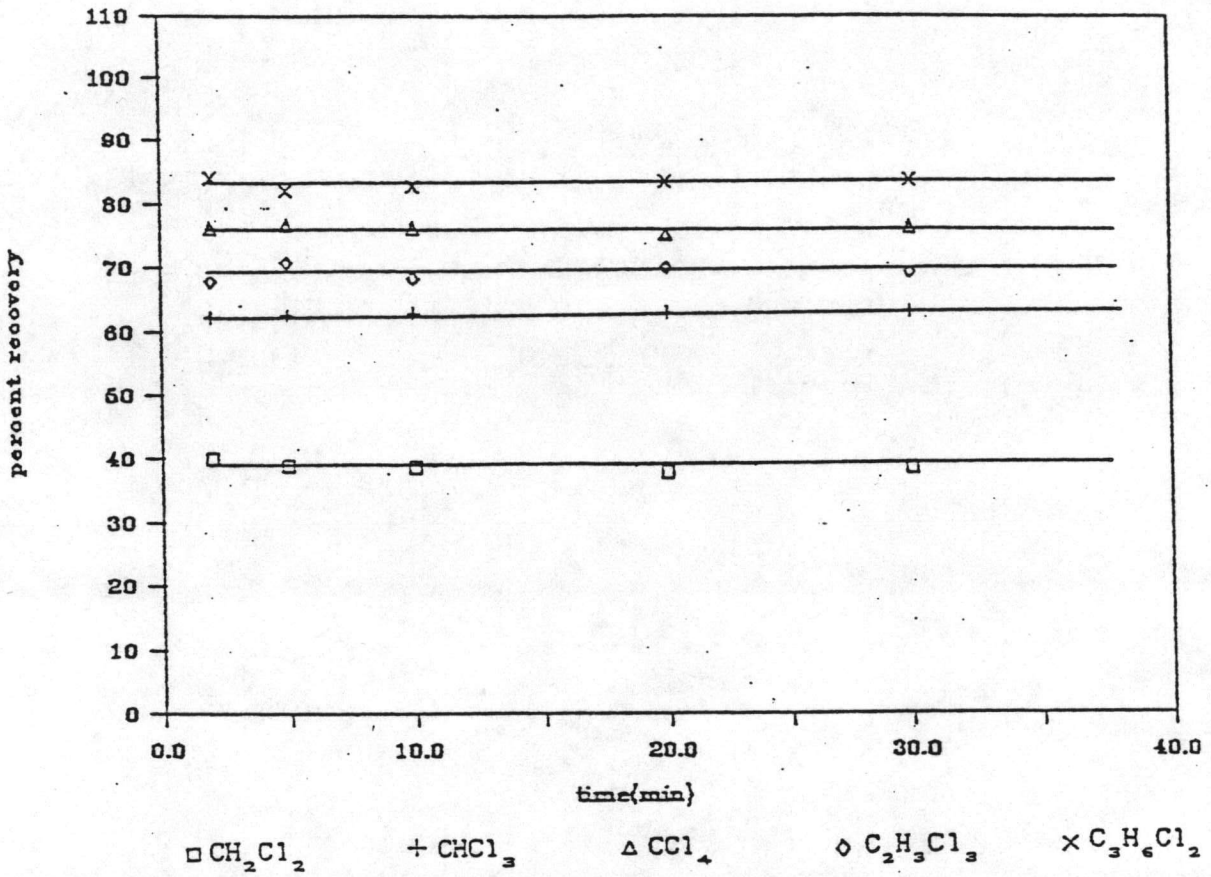

Figure 3.1 The shaking time of halogenated alkanes with hexane for 9:1 extraction.

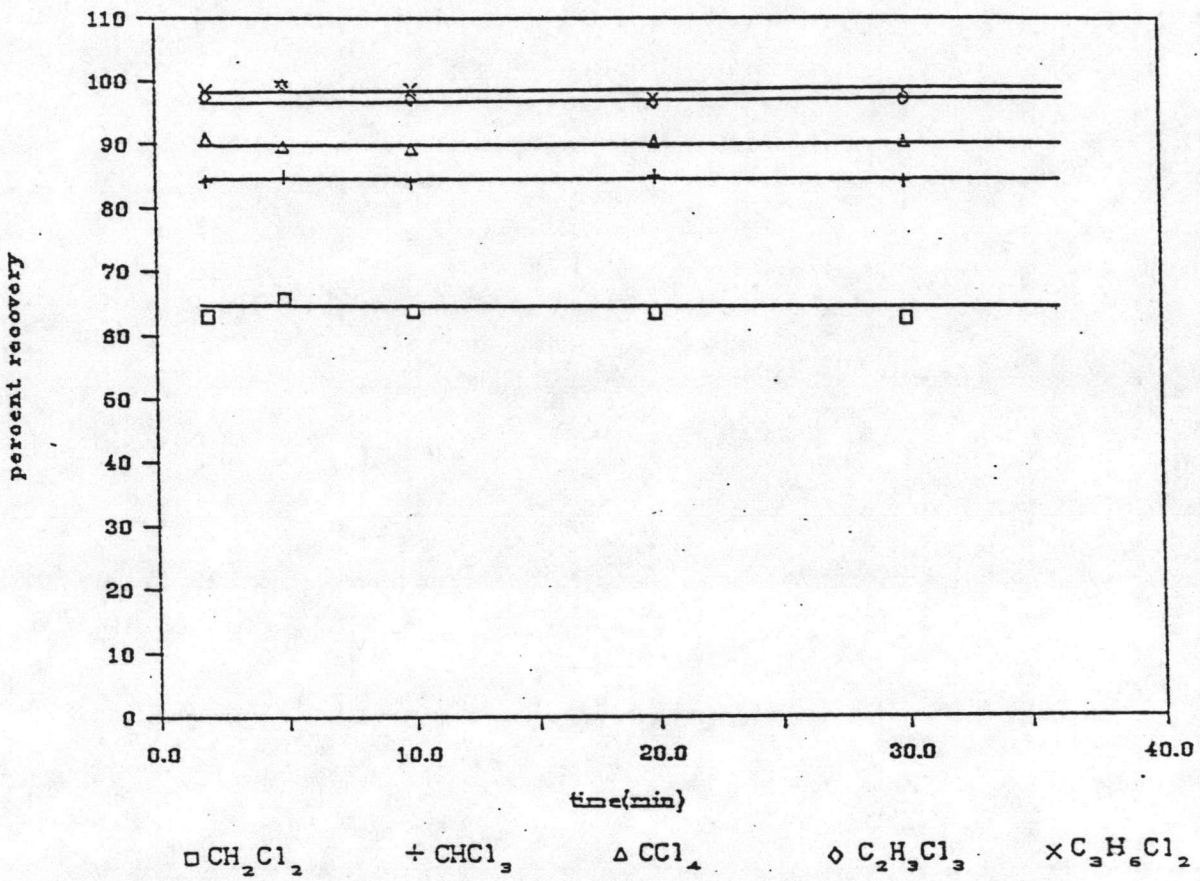

Figure 3.2 The shaking time of halogenated alkanes with hexane for 5:5 extraction.

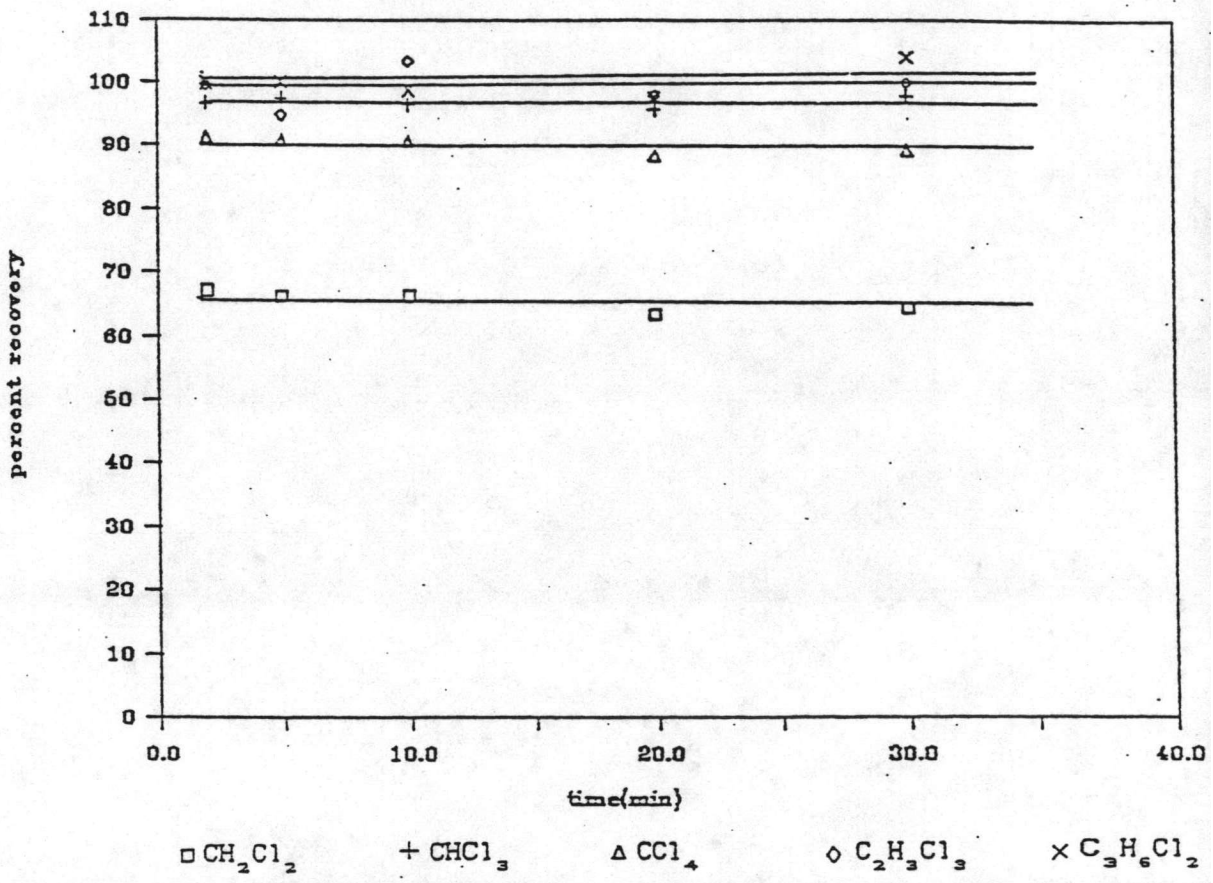

Figure 3.3 The shaking time of halogenated alkanes with hexane for 2:8 extraction.

Table 3.6 The effect of the shaking time on the percent recovery of 9.95 ppm of methylene chloride solution with cyclohexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	36.63	40.91
	5	34.55	38.58
	10	33.89	37.85
	20	35.59	40.08
	30	34.53	38.57
5:5	2	7.66	76.99
	5	7.60	76.45
	10	7.48	75.06
	20	7.72	77.62
	30	7.56	76.01
2:8	2	2.49	99.95
	5	2.43	97.63
	10	2.45	98.79
	20	2.49	100.26
	30	2.46	98.80

Triplicate analyses

Table 3.7 The effect of the shaking time on the percent recovery of 10.04 ppm of chloroform solution with cyclohexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	71.98	79.66
	5	71.97	79.65
	10	71.14	78.74
	20	71.70	79.35
	30	70.22	77.71
5:5	2	9.72	96.81
	5	9.78	97.38
	10	9.59	95.47
	20	9.84	97.96
	30	9.94	98.98
2:8	2	2.54	101.30
	5	2.49	99.15
	10	2.53	100.93
	20	2.53	100.77
	30	2.53	100.91

Triplicate analyses

Table 3.8 The effect of the shaking time on the percent recovery of 9.94 ppm of 1,1,1-trichloroethane solution with cylohexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	78.39	87.63
	5	76.06	85.02
	10	77.56	86.70
	20	77.55	86.54
	30	76.71	85.75
5:5	2	9.07	99.13
	5	9.84	99.01
	10	9.45	95.11
	20	9.63	96.86
	30	9.78	98.40
2:8	2	2.32	93.23
	5	2.36	95.00
	10	2.35	94.45
	20	2.31	93.06
	30	2.30	92.49

Triplicate analyses

Table 3.9 The effect of the shaking time on the percent recovery of 10.00 ppm of carbontetrachloride solution with cyclohexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	76.64	85.16
	5	75.85	84.28
	10	74.22	82.47
	20	76.36	84.84
	30	75.74	84.16
5:5	2	8.86	88.62
	5	8.75	87.55
	10	9.13	90.03
	20	8.92	89.23
	30	9.05	90.50
2:8	2	2.20	88.17
	5	2.26	90.39
	10	2.23	89.30
	20	2.18	87.38
	30	2.23	89.50

Triplicate analyses

Table 3.10 The effect of the shaking time on the percent recovery of 1,2-dichloropropane solution with cyclohexane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	75.70	84.61
	5	76.77	85.80
	10	75.21	84.06
	20	76.43	85.42
	30	77.75	86.90
5:5	2	9.83	98.94
	5	9.69	97.51
	10	9.72	97.91
	20	9.82	98.82
	30	9.74	98.43
2:8	2	2.45	98.59
	5	2.41	96.92
	10	2.46	99.10
	20	2.49	99.10
	30	2.41	97.08

Triplicate analyses

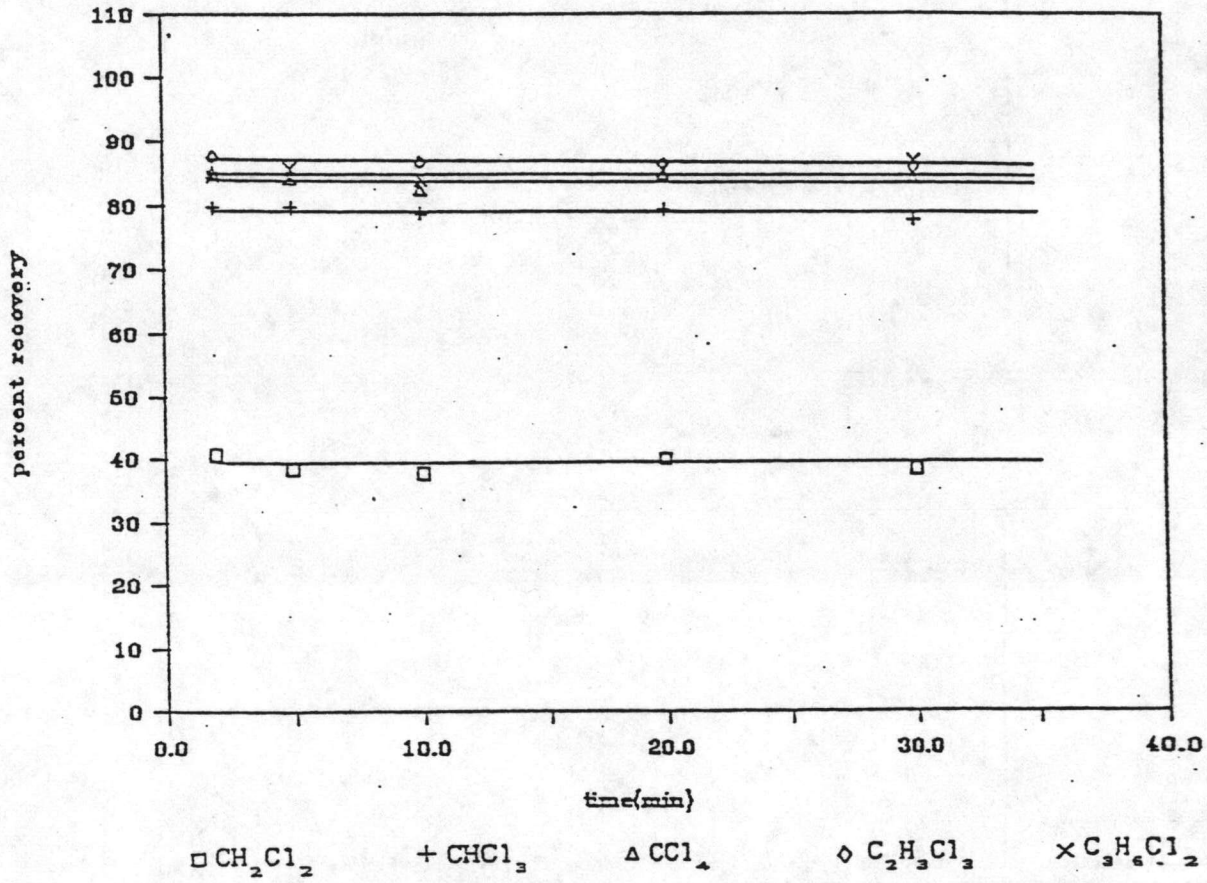

Figure 3.4 The shaking time of halogenated alkanes with cyclohexane for 9:1 extraction.

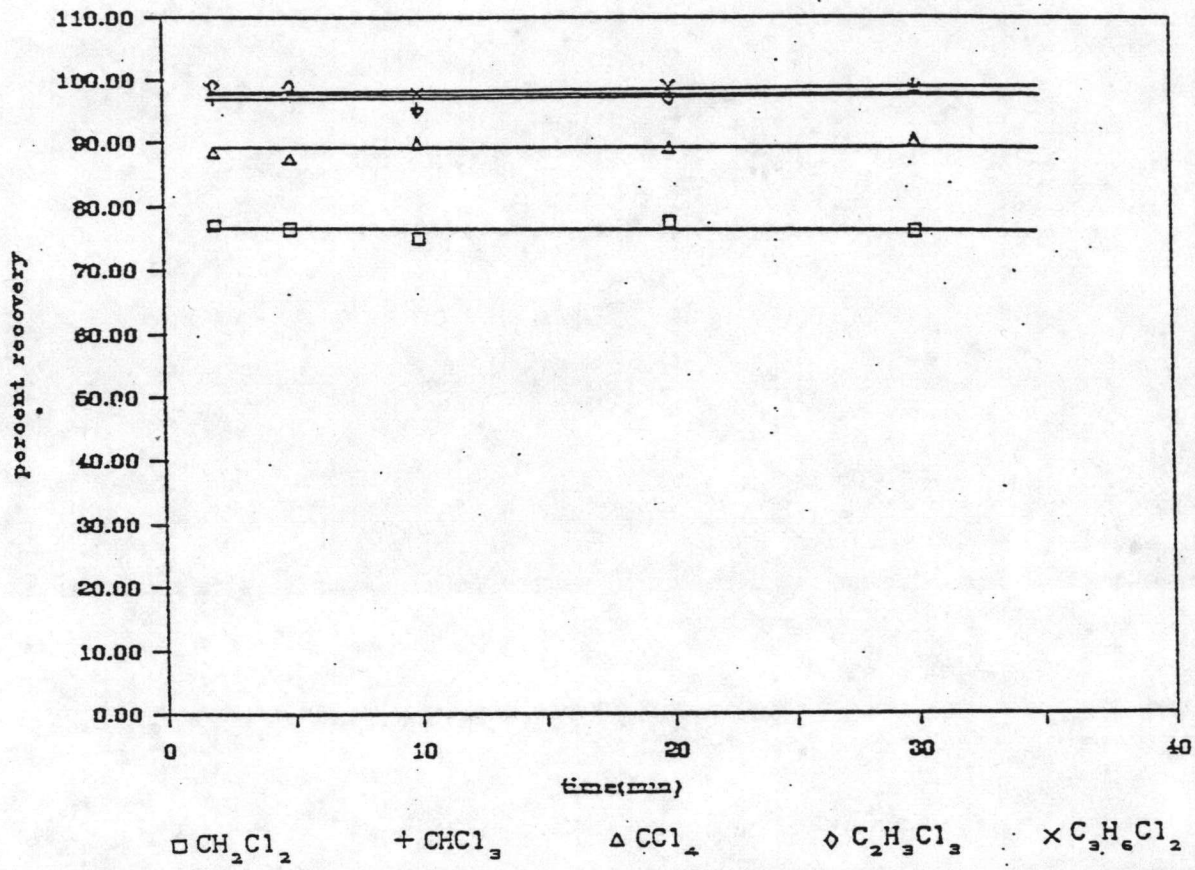

Figure 3.5 The shaking time of halogenated alkanes with cyclohexane for 5:5 extraction.

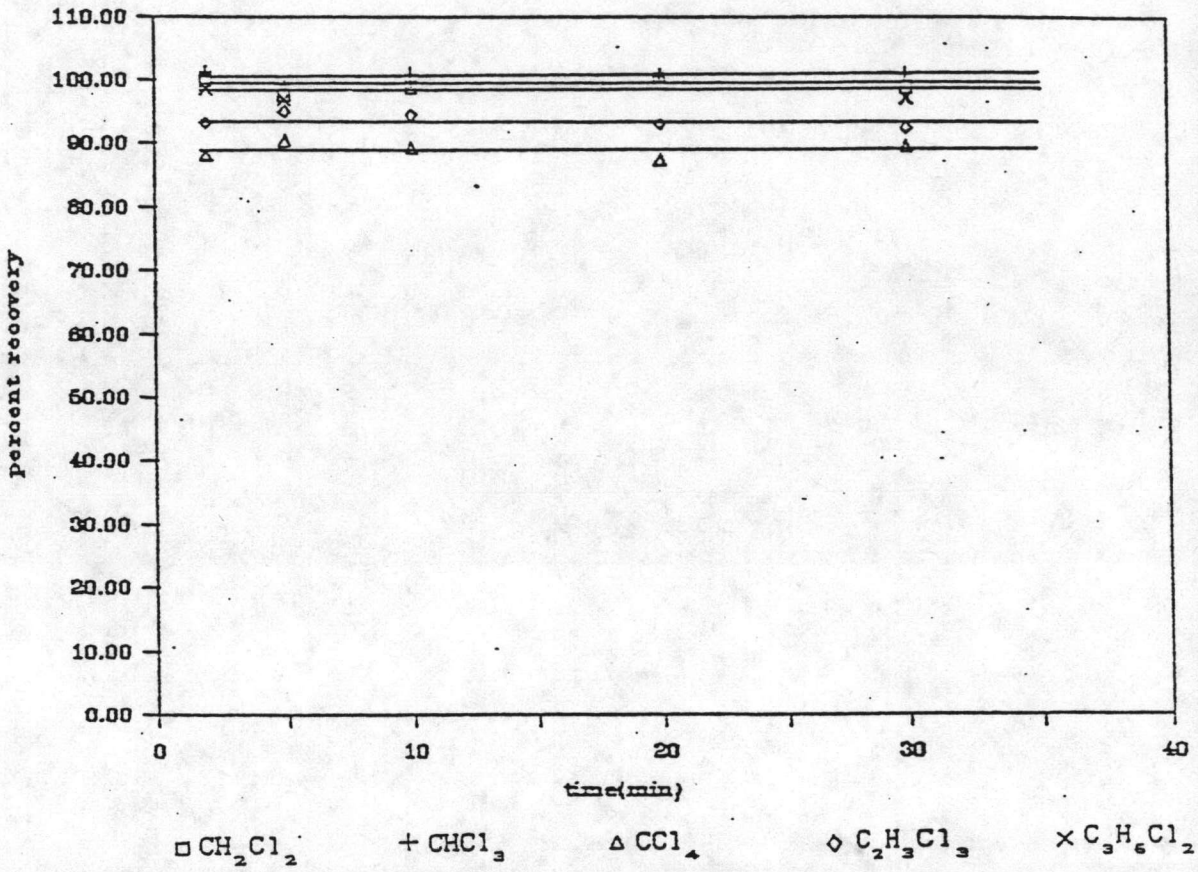

Figure 3.6 The shaking time of halogenated alkanes with cyclohexane for 2:8 extraction.

Table 3.11 The effect of the shaking time on the percent recovery of 9.95 ppm of methylene chloride solution with isooctane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	32.20	35.96
	5	30.83	34.44
	10	31.36	35.03
	20	31.23	34.87
	30	31.77	35.48
5:5	2	7.70	77.41
	5	7.49	75.28
	10	7.32	73.56
	20	7.41	74.53
	30	7.27	73.12
2:8	2	2.07	83.40
	5	2.08	83.78
	10	1.97	79.29
	20	1.97	79.30
	30	2.02	81.35

Triplicate analyses

Table 3.12 The effect of the shaking time on the percent recovery of 10.04 ppm of chloroform solution with isooctane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	52.31	57.89
	5	52.44	58.04
	10	52.02	57.57
	20	52.67	58.30
	30	52.72	58.34
5:5	2	9.20	91.61
	5	9.31	92.75
	10	9.14	91.01
	20	9.14	91.01
	30	9.22	91.89
2:8	2	2.50	99.78
	5	2.52	100.25
	10	2.55	101.56
	20	2.50	99.61
	30	2.46	97.98

Triplicate analyses

Table 3.13 The effect of the shaking time on the percent recovery of 9.94 ppm of 1,1,1-trichloroethane solution with isooctane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	71.87	80.34
	5	73.28	81.92
	10	70.84	79.19
	20	70.61	78.93
	30	70.69	79.02
5:5	2	9.61	96.69
	5	9.89	99.47
	10	9.66	96.84
	20	9.43	94.61
	30	9.50	95.54
2:8	2	2.45	98.66
	5	2.48	99.95
	10	2.48	100.04
	20	2.53	101.66
	30	2.45	98.47

Triplicate analyses

Table 3.14 The effect of the shaking time on the percent recovery of 10.00 ppm of carbontetrachloride solution with isooctane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	75.08	83.42
	5	76.17	84.63
	10	74.92	83.25
	20	75.92	84.35
	30	75.03	83.37
5:5	2	9.11	91.12
	5	9.39	93.86
	10	9.37	93.71
	20	8.73	87.32
	30	9.34	93.46
2:8	2	2.45	98.03
	5	2.36	94.56
	10	2.44	97.70
	20	2.45	98.13
	30	2.45	97.85

Triplicate analyses

Table 3.15 The effect of the shaking time on the percent recovery of 9.94 ppm of 1,2-dichloropropane solution with isooctane.

Sample-to-Solvent Ratio	Time (min)	Concentration (ppm)	%E
9:1	2	82.12	91.78
	5	80.33	89.78
	10	81.61	91.21
	20	77.80	86.95
	30	80.67	90.14
5:5	2	10.49	105.57
	5	10.22	102.80
	10	10.26	103.25
	20	10.29	103.52
	30	10.44	105.05
2:8	2	2.46	99.12
	5	2.55	102.73
	10	2.52	101.53
	20	2.55	102.83
	30	2.55	102.38

Triplicate analyses

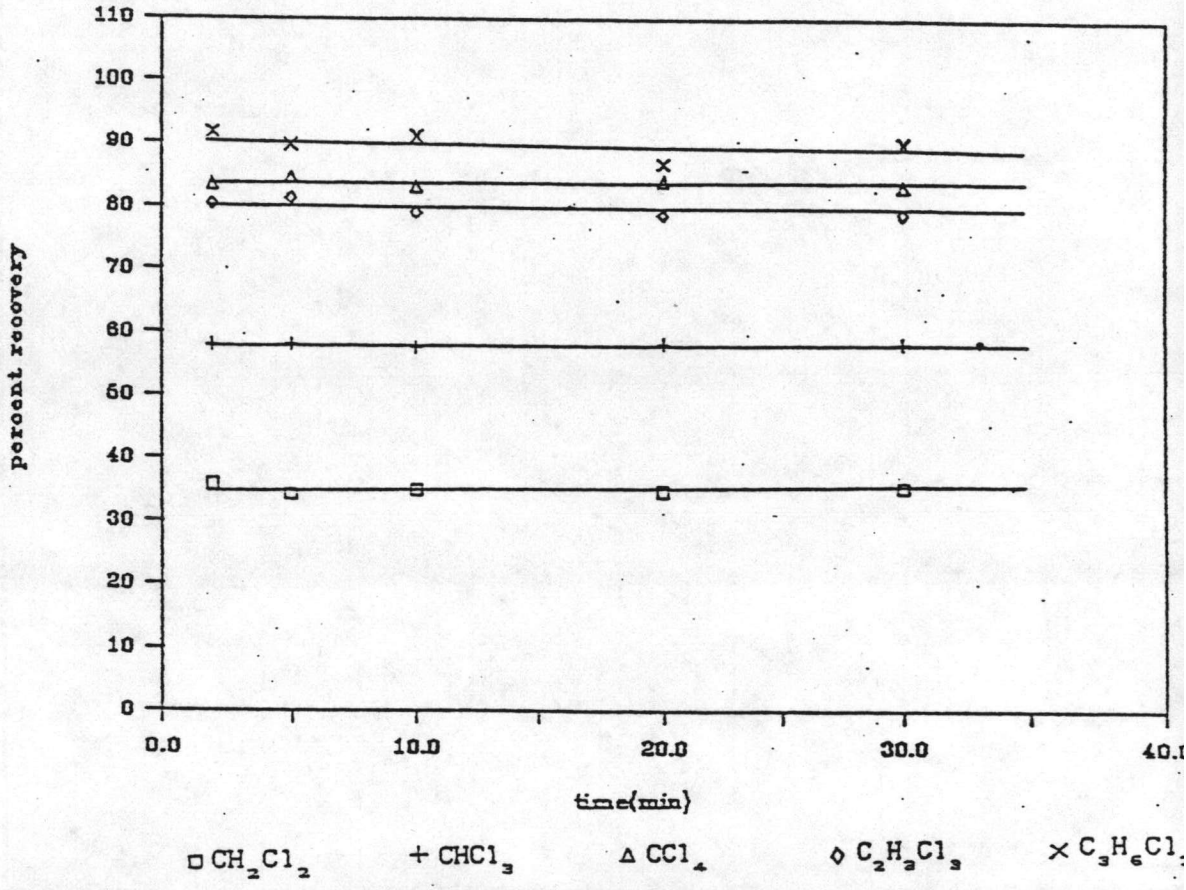

Figure 3.7 The shaking time of halogenated alkanes with isooctane for 9:1 extraction.

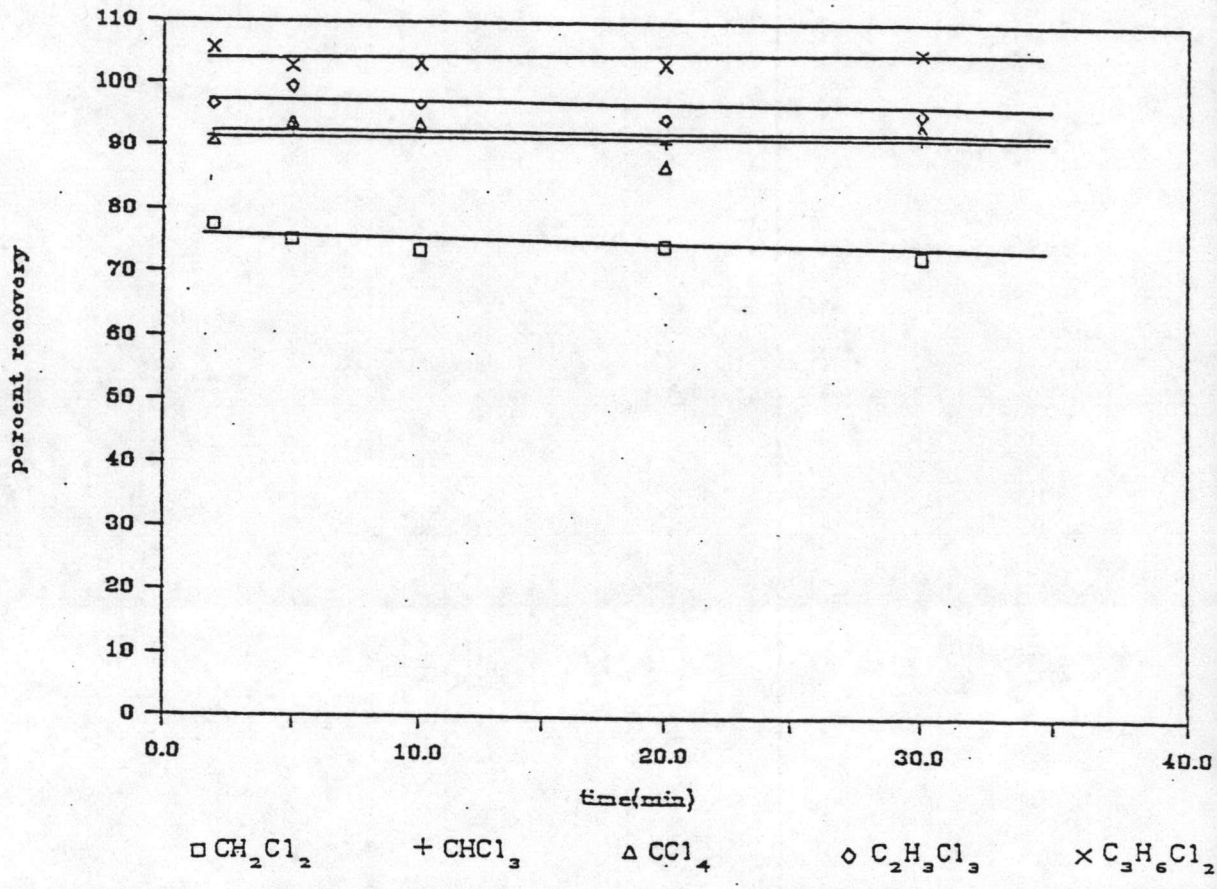

Figure 3.8 The shaking time of halogenated alkanes with isooctane for 5:5 extraction.

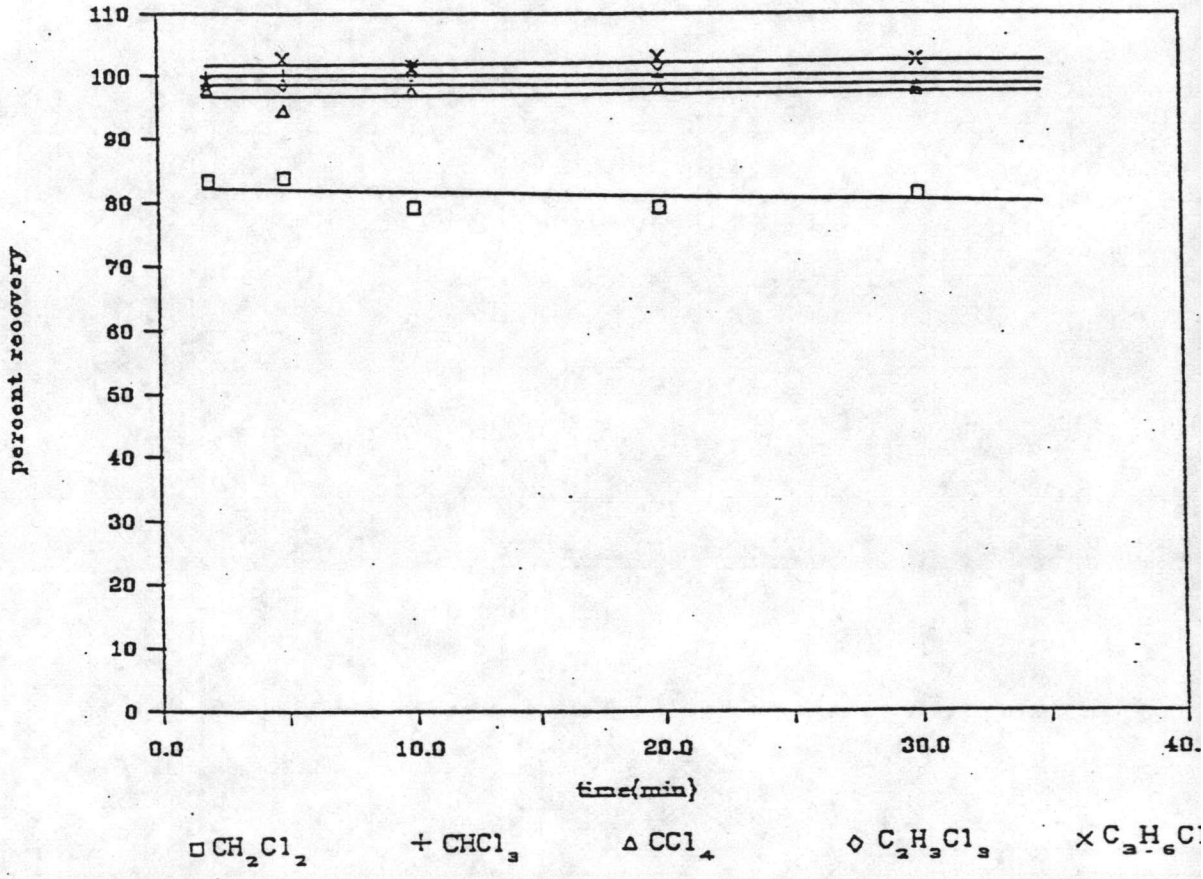

Figure 3.9 The shaking time of halogenated alkanes with isooctane for 2:8 extraction.

The effect of adding salt including sodium sulfate and sodium chloride on the percent recoveries of halogenated alkanes i.e., methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane with each extracting solvent i.e.,hexane cyclohexane and isooctane for sample-to-solvent ratios of 9:1, 5:5 and 2:8 are shown in Table 3.16-3.33 and Figure 3.10-3.27. The percent recovery of each halogenated alkane in 9:1 extraction with hexane, cyclohexane and isooctane shown in Table 3.16-3.21, 3.22-3.27 and 3.28-3.33, respectively, is increased by adding sodium sulfate or sodium chloride. However, the effect of adding sodium sulfate on percent recovery of each halogenated alkane is higher than the effect of adding sodium chloride. The effect of adding salt on percent recovery of each halogenated alkane for the sample-to-solvent ratios of 5:5 and 2:8 is less significant than in 9:1 extraction since the percent recovery of each halogenated alkane with each extracting solvent for the sample-to-solvent ratios of 5:5 and 2:8 is quite high as can be seen from the Table 3.16-3.33.

The effect of concentration on percent recovery of each halogenated alkane at the high concentration and at the low concentration for the same sample-to-solvent ratio with the same extracting solvent does not differ significantly as shown in the Table 3.16-3.33. Therefore there is no effect of concentration of halogenated alkanes in the range of study on their percent recovies.

3.3 Microextraction Studies of Halogenated Alkanes in Mixture Solutions.

The results of percent recoveries of the halogenated alkanes

(1)

Table 3.16 The results of 9:1 extraction of halogenated alkanes with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	35.21 ±0.22	5.83	39.32 ±1.69
	Na_2SO_4	56.99 ±2.10	15.75	63.64 ±1.48
	NaCl	53.04 ±0.50	13.07	59.23 ±0.23
$CHCl_3$	No Salt	61.94 ±2.75	19.62	68.55 ±1.95
	Na_2SO_4	70.49 ±1.95	31.92	78.01 ±1.38
	NaCl	67.28 ±0.77	26.24	74.46 ±0.55
$C_2H_3Cl_3$	No Salt	70.96 ±1.41	34.52	79.32 ±1.00
	Na_2SO_4	75.30 ±2.17	47.85	84.17 ±1.54
	NaCl	74.14 ±2.29	43.54	82.87 ±1.60
CCl_4	No Salt	69.20 ±1.81	29.31	76.51 ±1.76
	Na_2SO_4	72.58 ±0.33	36.55	80.24 ±0.30
	NaCl	72.48 ±0.85	36.29	80.13 ±0.79
$C_3H_6Cl_2$	No Salt	74.89 ±3.39	46.28	83.72 ±3.51
	Na_2SO_4	79.63 ±2.52	72.89	89.01 ±3.12
	Na Cl	79.35 ±1.48	70.65	88.70 ±1.58

Triplicate analyses

Note (1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.94, 10.00 and 9.94 ppm, respectively.

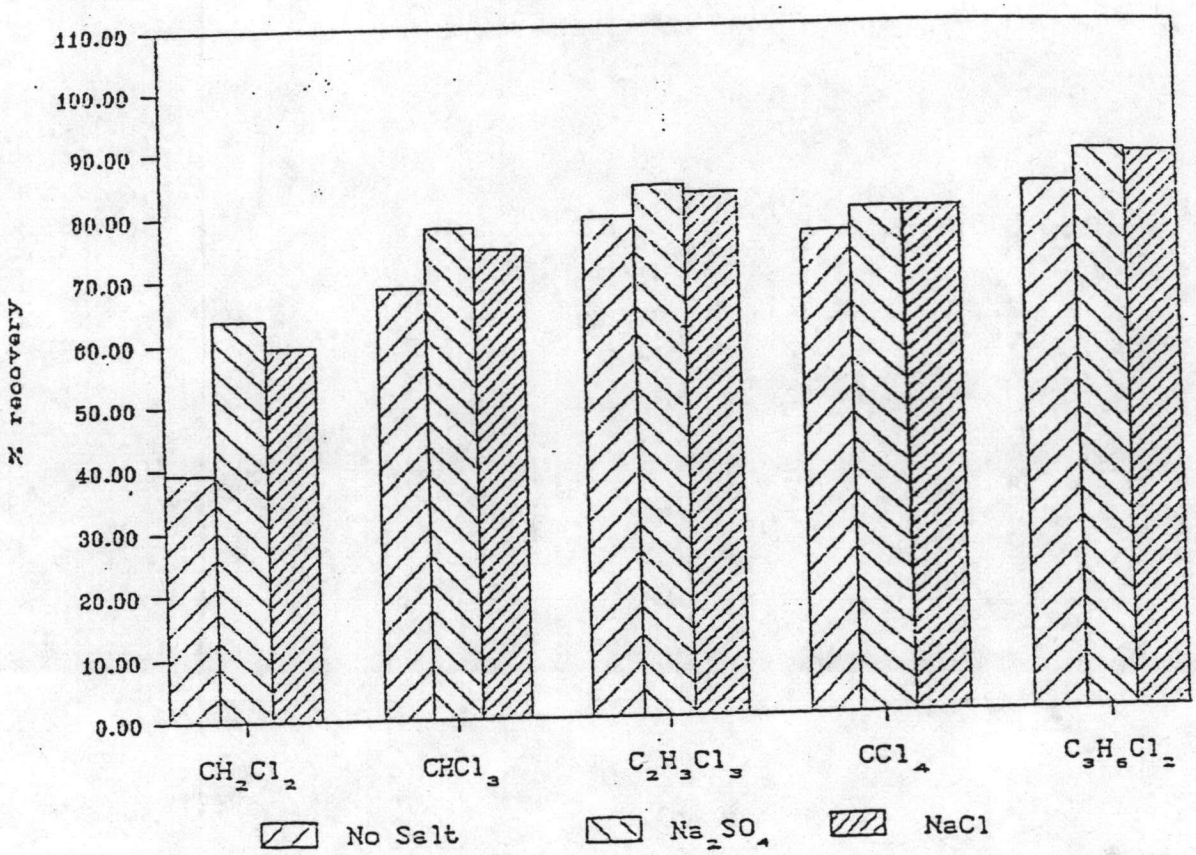

Figure 3.10 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 9:1 .

(2)

Table 3.17 The results of 9:1 extraction of halogenated alkanes with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.79 ±0.08	4.10	31.31 ±1.93
	Na_2SO_4	4.59 ±0.19	9.59	51.59 ±2.92
	NaCl	4.08 ±0.18	7.59	45.75 ±3.03
$CHCl_3$	No Salt	5.52 ±0.03	14.28	61.35 ±0.21
	Na_2SO_4	6.16 ±0.40	19.53	68.45 ±3.05
	NaCl	6.08 ±1.45	18.79	67.62 ±1.32
$C_2H_3Cl_3$	No Salt	6.48 ±0.08	24.08	71.79 ±0.83
	Na_2SO_4	7.19 ±0.41	37.56	80.67 ±3.86
	NaCl	7.19 ±0.13	37.53	80.66 ±2.41
CCl_4	No Salt	6.61 ±0.17	24.87	73.43 ±1.78
	Na_2SO_4	7.45 ±0.34	43.36	82.81 ±3.19
	NaCl	7.16 ±0.09	34.92	79.81 ±0.91
$C_3H_6Cl_2$	No Salt	6.25 ±0.47	21.14	70.14 ±5.27
	Na_2SO_4	7.52 ±0.48	48.62	84.38 ±4.49
	Na Cl	7.37 ±0.18	42.75	82.66 ±2.72

Triplicate analyses

Note (2) The initial concentrations of methylene choloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 9.99 ppm, respectively.

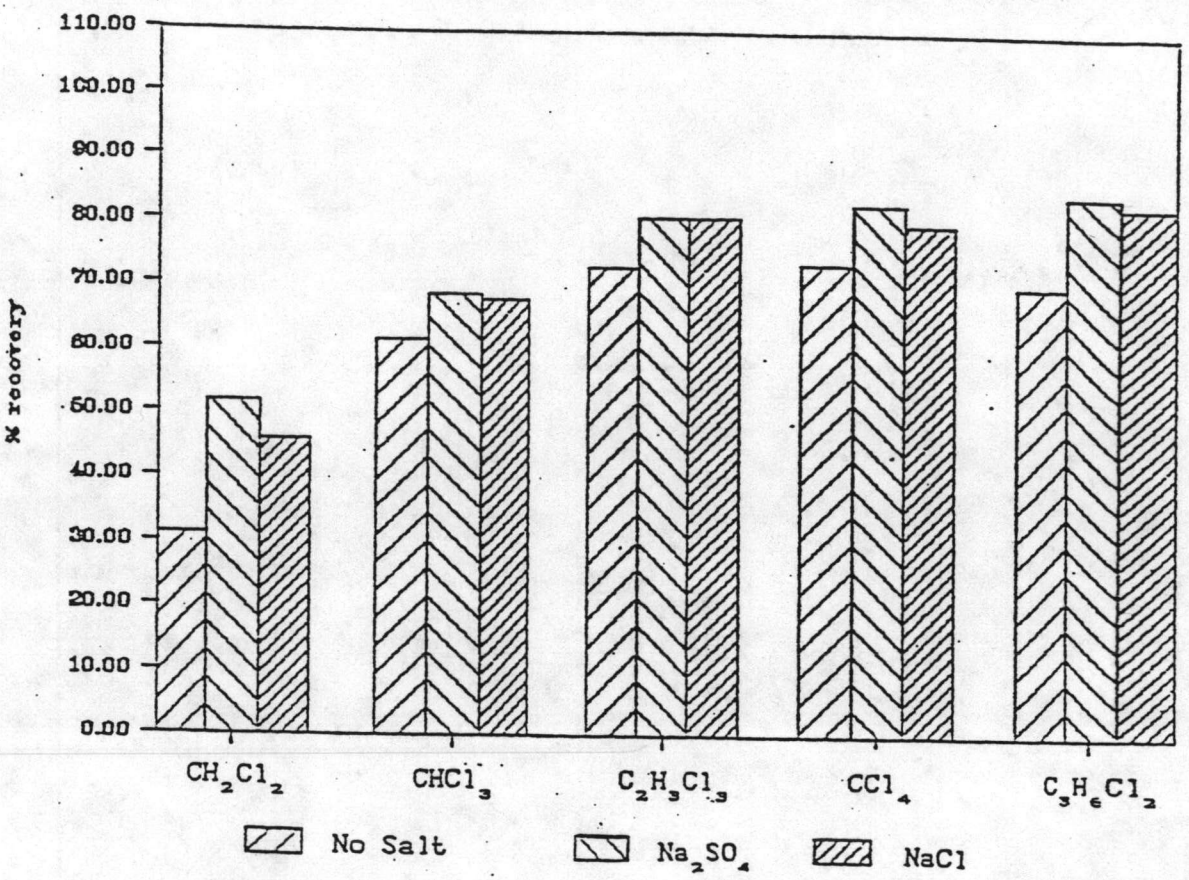

Figure 3.11 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 9:1

Table 3.18 The results of 5:5 extraction of halogenated alkanes (1) with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	6.31 ±0.45	1.73	63.43 ±5.07
	Na_2SO_4	7.04 ±0.24	2.41	70.71 ±2.76
	NaCl	6.88 ±0.36	2.24	69.12 ±5.29
$CHCl_3$	No Salt	8.61 ±0.23	6.05	85.81 ±1.91
	Na_2SO_4	8.80 ±0.29	7.07	87.61 ±2.03
	NaCl	8.80 ±0.09	7.12	87.68 ±0.78
$C_2H_3Cl_3$	No Salt	9:67 ±0.26	35.63	97.27 ±1.87
	Na_2SO_4	9.75 ±0.04	51.36	98.09 ±0.29
	NaCl	9.56 ±0.17	25.25	96.19 ±1.22
CCl_4	No Salt	9.22 ±0.25	11.16	91.78 ±1.92
	Na_2SO_4	9.28 ±0.12	12.04	92.33 ±0.91
	NaCl	9.22 ±0.34	11.11	91.74 ±2.50
$C_3H_6Cl_2$	No Salt	9.84 ±0.43	94.24	98.95 ±4.33
	Na_2SO_4	9.95 ±0.24	*	100.11 ±2.39
	Na Cl	9.99 ±0.56	*	100.48 ±5.55

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene choloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.94, 10.00 and 9.94 ppm, respectively.

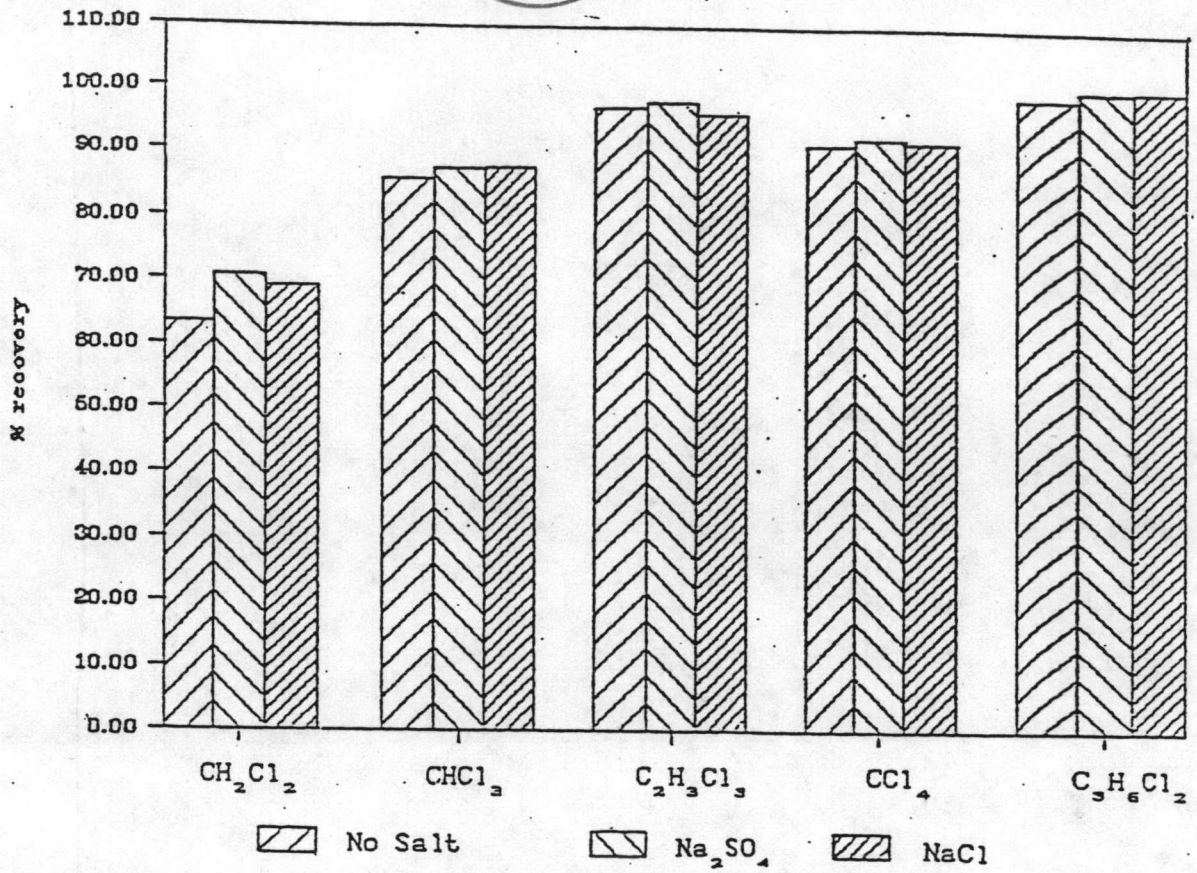

Figure 3.12 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 5:5.

(2)

Table 3.19 The results of 5:5 extraction of halogenated alkanes with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.78 ±0.03	3.62	78.38 ±2.83
	Na_2SO_4	0.91 ±0.02	11.48	91.92 ±2.15
	NaCl	0.86 ±0.03	6.69	87.03 ±3.81
$CHCl_3$	No Salt	0.87 ±0.03	6.79	87.17 ±1.68
	Na_2SO_4	0.90 ±0.01	9.02	90.02 ±1.75
	NaCl	0.91 ±0.02	10.38	91.21 ±1.12
$C_2H_3Cl_3$	No Salt	0.87 ±0.00	7.26	87.89 ±0.11
	Na_2SO_4	0.86 ±0.01	6.79	87.16 ±0.50
	NaCl	0.88 ±0.01	7.80	88.64 ±0.83
CCl_4	No Salt	1.01 ±0.01	*	100.74 ±0.83
	Na_2SO_4	1.02 ±0.03	*	101.63 ±1.75
	NaCl	1.00 ±0.02	*	100.09 ±1.02
$C_3H_6Cl_2$	No Salt	0.90 ±0.04	10.24	91.10 ±3.22
	Na_2SO_4	0.90 ±0.02	10.23	91.20 ±2.01
	Na Cl	0.89 ±0.06	9.30	90.29 ±4.90

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 0.99 ppm, respectively.

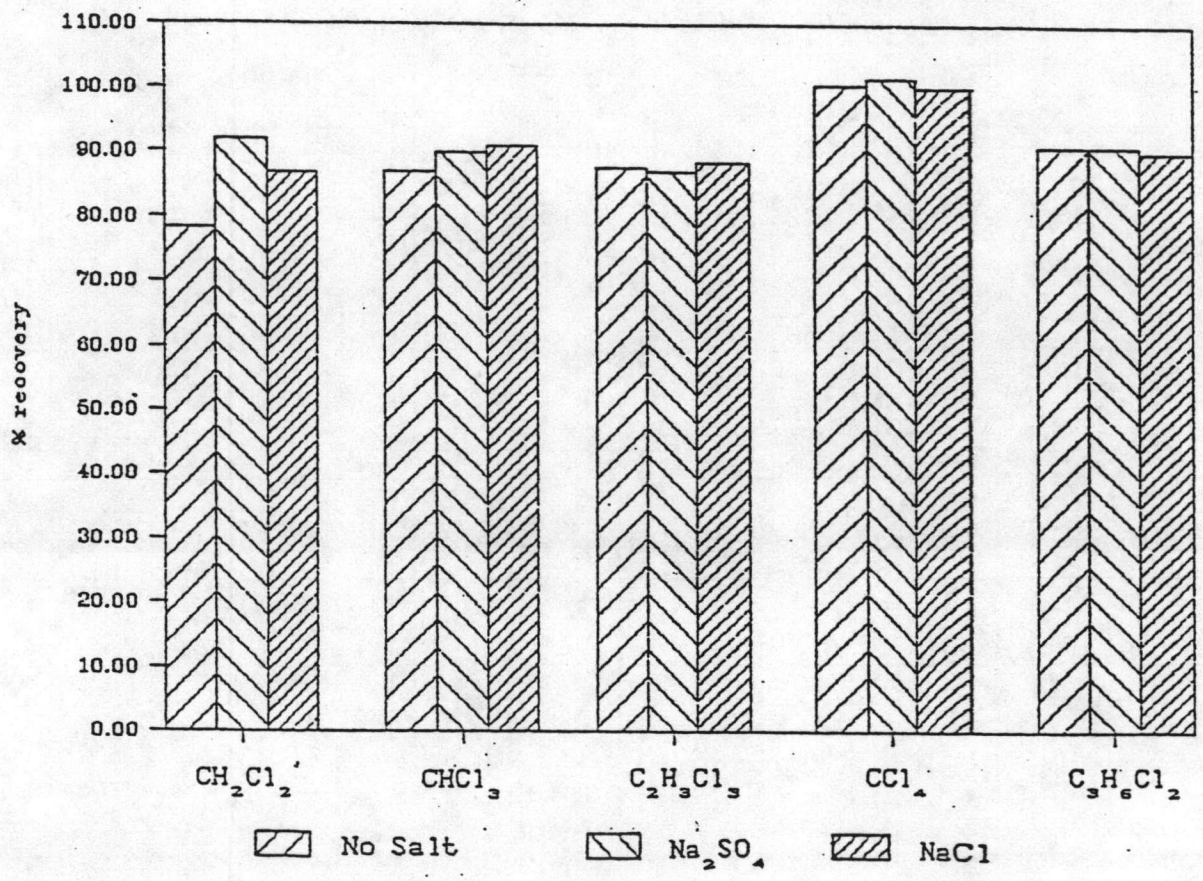

Figure 3.13 The effect of salting-out on % recovery of each halogenated alkane i.e. ,0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 5:5.

Table 3.20 The results of 2:8 extraction of halogenated alkanes (1) with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	1.67 ±0.11	0.51	67.28 ±4.79
	Na_2SO_4	1.76 ±0.11	0.61	70.84 ±4.17
	NaCl	1.79 ±0.11	0.65	72.07 ±4.36
$CHCl_3$	No Salt	2.41 ±0.05	6.38	96.24 ±1.47
	Na_2SO_4	2.42 ±0.05	6.87	96.49 ±0.98
	NaCl	2.40 ±0.05	5.76	95.84 ±0.59
$C_2H_3Cl_3$	No Salt	2.60 ±0.01	*	104.54 ±0.47
	Na_2SO_4	2.60 ±0.01	*	104.51 ±0.41
	NaCl	2.55 ±0.02	*	102.61 ±2.41
CCl_4	No Salt	2.31 ±0.06	2.93	92.15 ±1.71
	Na_2SO_4	2.33 ±0.08	3.28	92.97 ±2.33
	NaCl	2.31 ±0.07	2.87	91.98 ±2.20
$C_3H_6Cl_2$	No Salt	2.35 ±0.24	4.25	94.44 ±7.14
	Na_2SO_4	2.33 ±0.16	3.72	93.71 ±4.90
	Na Cl	2.41 ±0.27	7.37	96.72 ±8.12

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.94, 10.00 and 9.94 ppm, respectively.

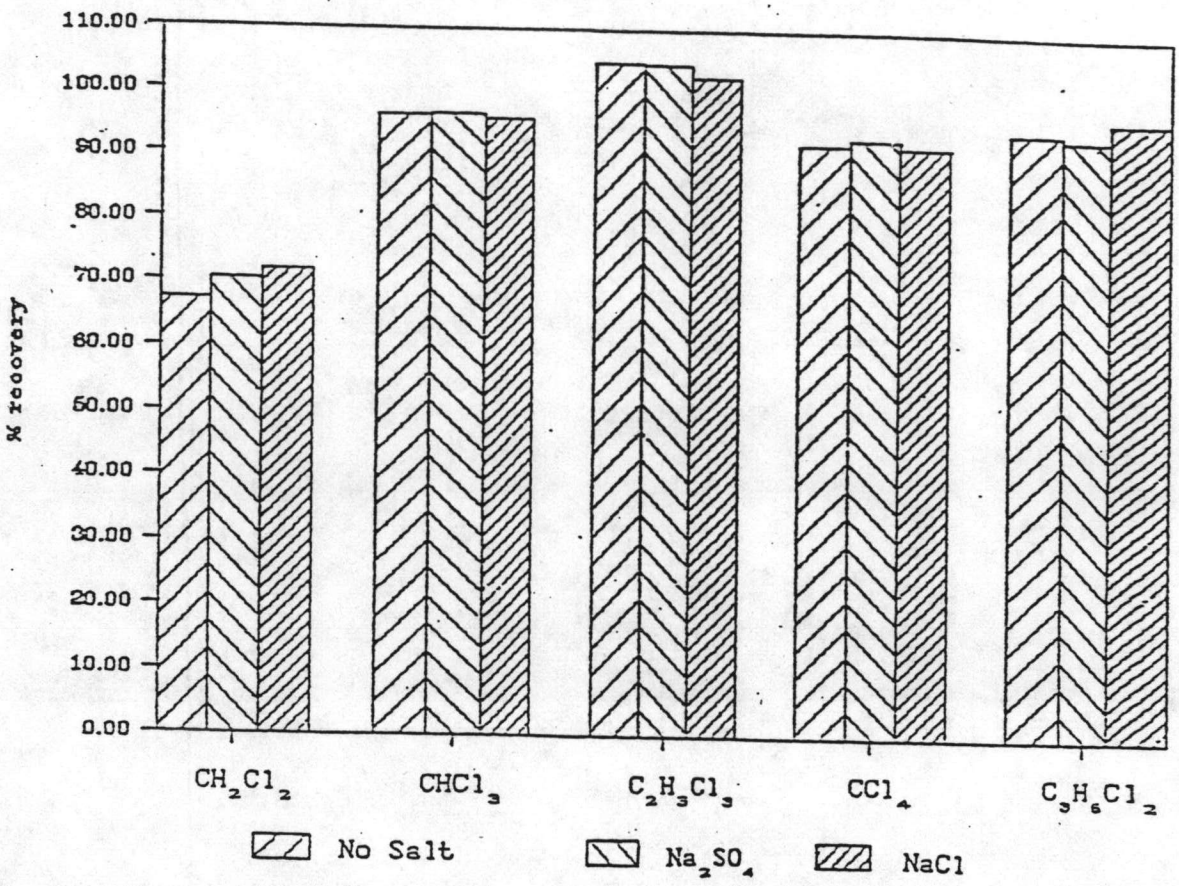

Figure 3.14 The effect of salting-out on % recovery of each halogenated alkane i.e.,9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 2:8 .

Table 3.21 The results of 2:8 extraction of halogenated alkanes (2) with hexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.19 ±0.01	0.95	79.18 ±2.53
	Na_2SO_4	0.22 ±0.02	1.25	87.29 ±10.4
	NaCl	0.22 ±0.02	1.92	85.59 ±8.45
$CHCl_3$	No Salt	0.24 ±0.01	5.88	95.92 ±3.49
	Na_2SO_4	0.26 ±0.02	*	102.73 ±4.11
	NaCl	0.26 ±0.02	*	102.21 ±4.52
$C_2H_3Cl_3$	No Salt	0.23 ±0.02	3.13	92.60 ±5.87
	Na_2SO_4	0.23 ±0.02	2.66	91.40 ±5.18
	NaCl	0.22 ±0.00	1.70	87.16 ±0.61
CCl_4	No Salt	0.24 ±0.00	9.83	97.52 ±0.89
	Na_2SO_4	0.25 ±0.01	23.56	98.95 ±0.91
	NaCl	0.25 ±0.00	54.10	99.54 ±0.05
$C_3H_6Cl_2$	No Salt	0.24 ±0.02	6.71	96.41 ±6.08
	Na_2SO_4	0.24 ±0.02	8.52	97.15 ±5.97
	Na Cl	0.24 ±0.01	7.95	96.96 ±6.12

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 0.99 ppm, respectively.

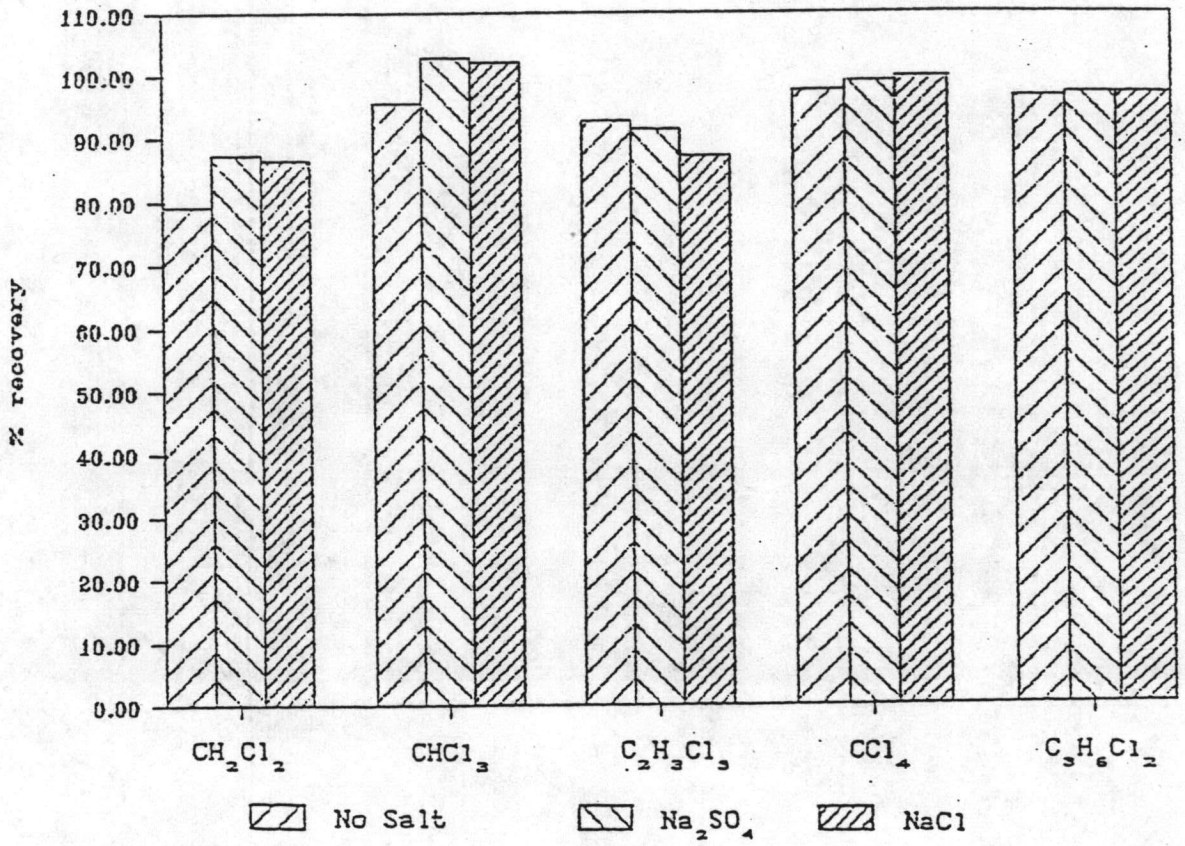

Figure 3.15 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-hexane ratio of 2:8 .

Table 3.22 The results of 9:1 extraction of halogenated alkanes with cyclohexane in single component solutions. (1)

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	32.20 ±3.60	5.50	35.96 ±2.84
	Na_2SO_4	46.79 ±8.12	9.85	52.25 ±6.41
	NaCl	42.34 ±3.37	8.07	47.27 ±2.61
$CHCl_3$	No Salt	68.66 ±1.81	28.48	75.99 ±1.83
	Na_2SO_4	73.60 ±1.39	39.52	81.45 ±1.12
	NaCl	71.45 ±2.27	34.00	79.07 ±3.21
$C_2H_3Cl_3$	No Salt	77.36 ±1.95	57.57	86.48 ±1.76
	Na_2SO_4	78.31 ±0.82	63.23	87.54 ±0.73
	NaCl	77.80 ±0.45	60.07	86.97 ±0.40
CCl_4	No Salt	73.48 ±2.22	38.97	81.24 ±2.13
	Na_2SO_4	75.33 ±1.35	44.83	83.28 ±2.66
	NaCl	76.18 ±1.13	48.03	84.22 ±1.05
$C_3H_6Cl_2$	No Salt	75.64 ±1.14	49.18	84.53 ±1.06
	Na_2SO_4	81.75 ±0.91	95.29	91.37 ±0.79
	Na Cl	80.64 ±1.77	82.18	90.13 ±1.55

Triplicate analyses

Note (1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.94, 10.00 and 9.94 ppm, respectively.

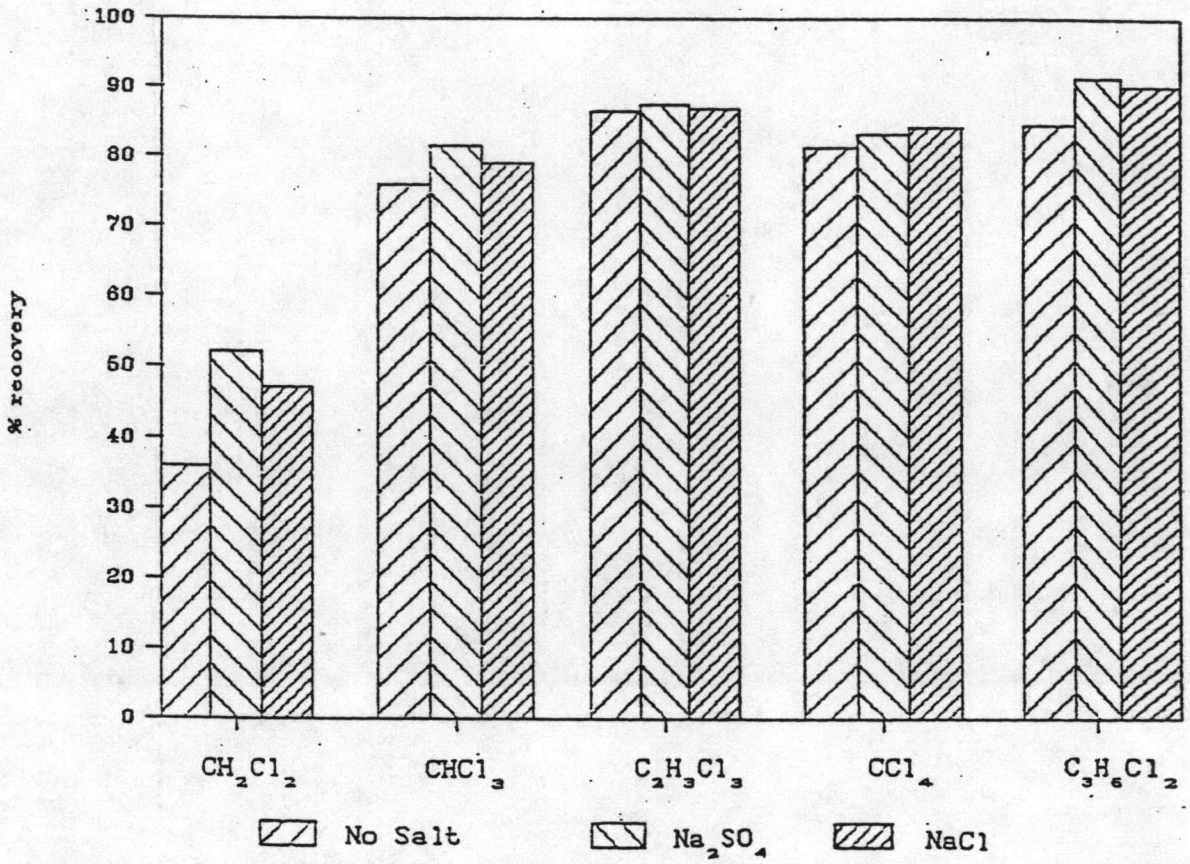

Figure 3.16 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 9:1 .

(2)

Table 3.23 The results of 9:1 extraction of halogenated alkanes with cyclohexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	3.58 ±0.22	6.05	40.21 ±3.46
	Na_2SO_4	5.81 ±0.44	16.68	64.90 ±5.30
	NaCl	5.68 ±0.37	15.82	63.74 ±4.25
$CHCl_3$	No Salt	7.23 ±0.10	36.85	80.37 ±0.96
	Na_2SO_4	7.85 ±0.29	61.26	87.19 ±2.59
	NaCl	7.52 ±0.09	45.61	83.52 ±0.89
$C_2H_3Cl_3$	No Salt	8.36 ±0.28	135.93	93.79 ±2.32
	Na_2SO_4	8.48 ±0.33	175.80	95.13 ±2.72
	NaCl	8.44 ±0.09	162.43	94.75 ±0.77
CCl_4	No Salt	7.73 ±0.13	54.74	85.88 ±1.63
	Na_2SO_4	7.67 ±0.15	51.89	85.22 ±2.06
	NaCl	7.81 ±0.34	56.18	86.80 ±4.36
$C_3H_6Cl_2$	No Salt	7.15 ±0.59	36.48	80.21 ±8.25
	Na_2SO_4	7.77 ±0.29	61.31	87.21 ±3.73
	Na Cl	7.59 ±0.29	52.02	85.25 ±3.82

Triplicate analyses

Note (2) The initial concentration of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 0.99, respectively.

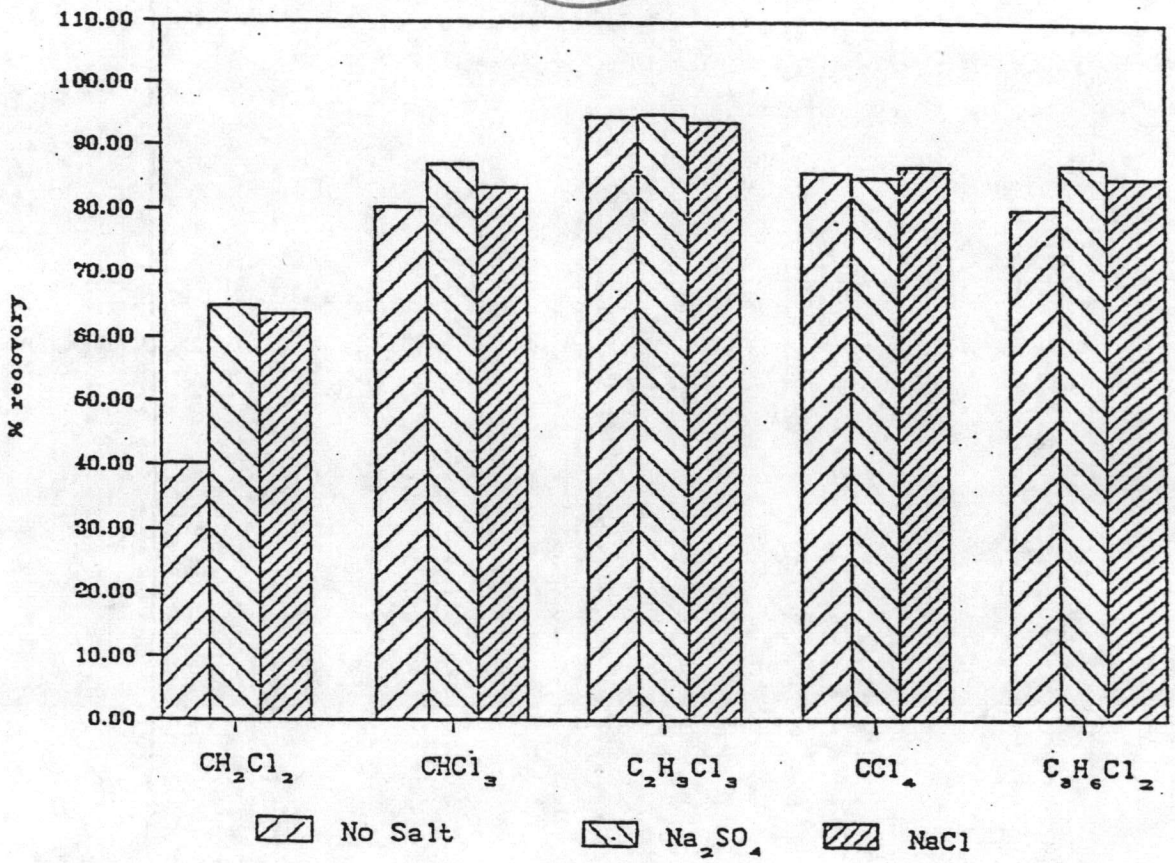

Figure 3.17 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 9:1.

(1)

Table 3.24 The results of 5:5 extraction of halogenated alkanes with cyclohexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	7.06 ±0.12	2.45	70.99 ±1.66
	Na_2SO_4	7.89 ±0.38	3.83	79.31 ±3.46
	NaCl	7.38 ±0.26	2.87	74.14 ±2.45
$CHCl_3$	No Salt	9.63 ±0.34	23.45	95.91 ±2.47
	Na_2SO_4	9.52 +0.17	18.46	94.86 ±1.22
	NaCl	9.58 ±0.32	20.98	95.45 ±2.37
$C_2H_3Cl_3$	No Salt	9.35 ±0.08	15.75	94.03 ±0.56
	Na_2SO_4	9.42 ±0.23	18.27	94.81 ±1.71
	NaCl	9.37 ±0.10	16.33	94.23 ±0.73
CCl_4	No Salt	8.92 ±7.93	7.93	88.80 ±2.47
	Na_2SO_4	9.13 ±0.17	9.93	90.85 ±0.18
	NaCl	9.12 ±0.06	10.10	90.79 ±0.47
$C_3H_6Cl_2$	No Salt	9.66 ±0.29	34.71	97.20 ±2.14
	Na_2SO_4	9.75 ±0.88	52.76	98.14 ±6.38
	Na Cl	9.63 ±0.85	30.45	96.82 ±5.87

Triplicate analyses

Note (1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane were 9.95, 10.04, 9.94, 10.00 and 9.94 ppm, respectively.

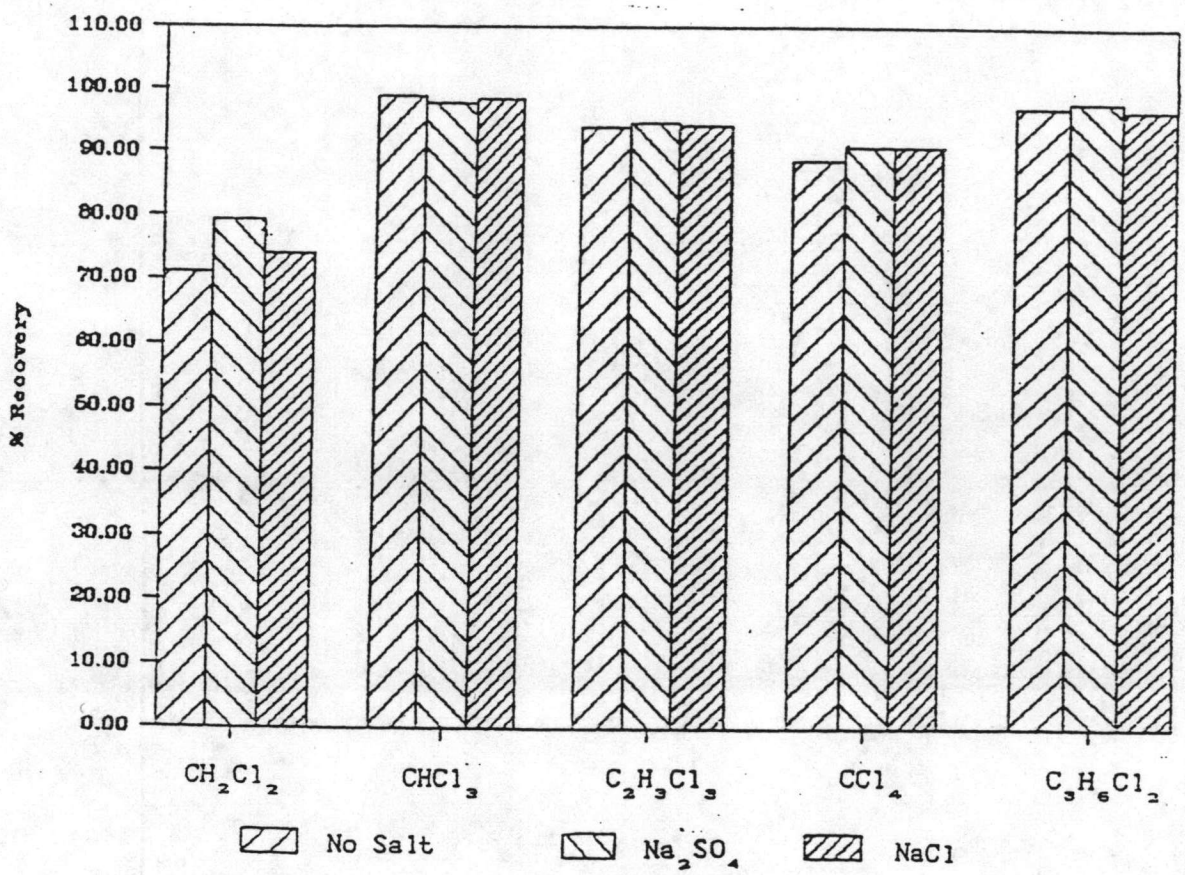

Figure 3.18 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 5:5 .

Table 3.25 The results of 5:5 extraction of halogenated alkanes (2) with cyclohexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.90 ±0.03	10.34	91.18 ±2.18
	Na_2SO_4	0.95 ±0.05	24.06	96.01 ±3.81
	NaCl	0.93 ±0.05	14.85	93.69 ±3.43
$CHCl_3$	No Salt	0.92 ±0.04	11.33	91.89 ±2.17
	Na_2SO_4	0.94 ±0.02	15.50	93.94 ±1.38
	NaCl	0.93 ±0.02	13.70	93.20 ±1.38
$C_2H_3Cl_3$	No Salt	0.99 ±0.06	1249.00	99.92 ±4.13
	Na_2SO_4	0.98 ±0.08	269.27	99.63 ±6.60
	NaCl	1.02 ±0.04	*	103.38 ±2.95
CCl_4	No Salt	1.00 ±0.02	*	100.03 ±1.13
	Na_2SO_4	1.02 ±0.02	*	101.18 ±1.66
	NaCl	1.00 ±0.01	*	100.19 ±0.89
$C_3H_6Cl_2$	No Salt	0.88 ±0.04	15.16	93.81 ±3.96
	Na_2SO_4	0.91 ±0.38	27.98	96.55 ±9.02
	Na Cl	0.90 ±0.05	22.11	95.66 ±4.76

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 0.94 ppm, respectively.

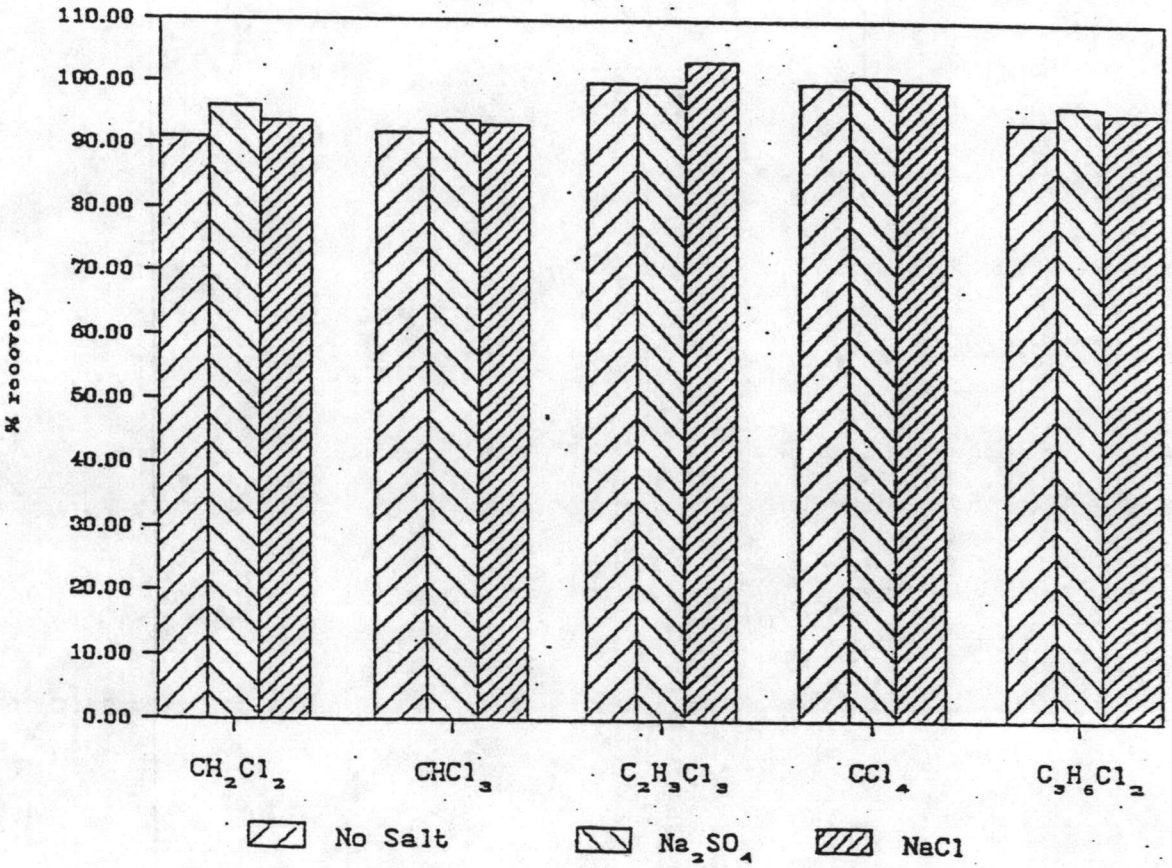

Figure 3.19 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 5:5 .

Table 3.26 The results of 2:8 extraction of halogenated alkanes (1) with cyclohexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.24 ±0.05	2.31	90.25 ±1.68
	Na_2SO_4	2.58 ±0.13	*	103.67 ±3.40
	NaCl	2.49 ±0.07	*	100.17 ±2.00
$CHCl_3$	No Salt	2.47 ±0.02	15.47	98.41 ±0.62
	Na_2SO_4	2.48 ±0.03	20.58	98.80 ±0.94
	NaCl	2.45 ±0.06	10.21	97.61 ±1.75
$C_2H_3Cl_3$	No Salt	2.37 ±0.10	4.94	95.18 ±3.02
	Na_2SO_4	2.45 ±0.08	18.98	98.70 ±2.43
	NaCl	2.44 ±0.08	14.72	98.33 ±2.15
CCl_4	No Salt	2.44 ±0.07	8.97	97.29 ±1.94
	Na_2SO_4	2.46 ±0.05	31.39	99.21 ±1.60
	NaCl	2.45 ±0.03	16.53	98.51 ±0.70
$C_3H_6Cl_2$	No Salt	2.42 ±0.17	9.95	97.55 ±5.07
	Na_2SO_4	2.45 ±0.15	18.41	98.66 ±4.73
	Na Cl	2.43 ±0.15	11.16	97.81 ±4.35

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.99, 10.05 and 9.94 ppm, respectively.

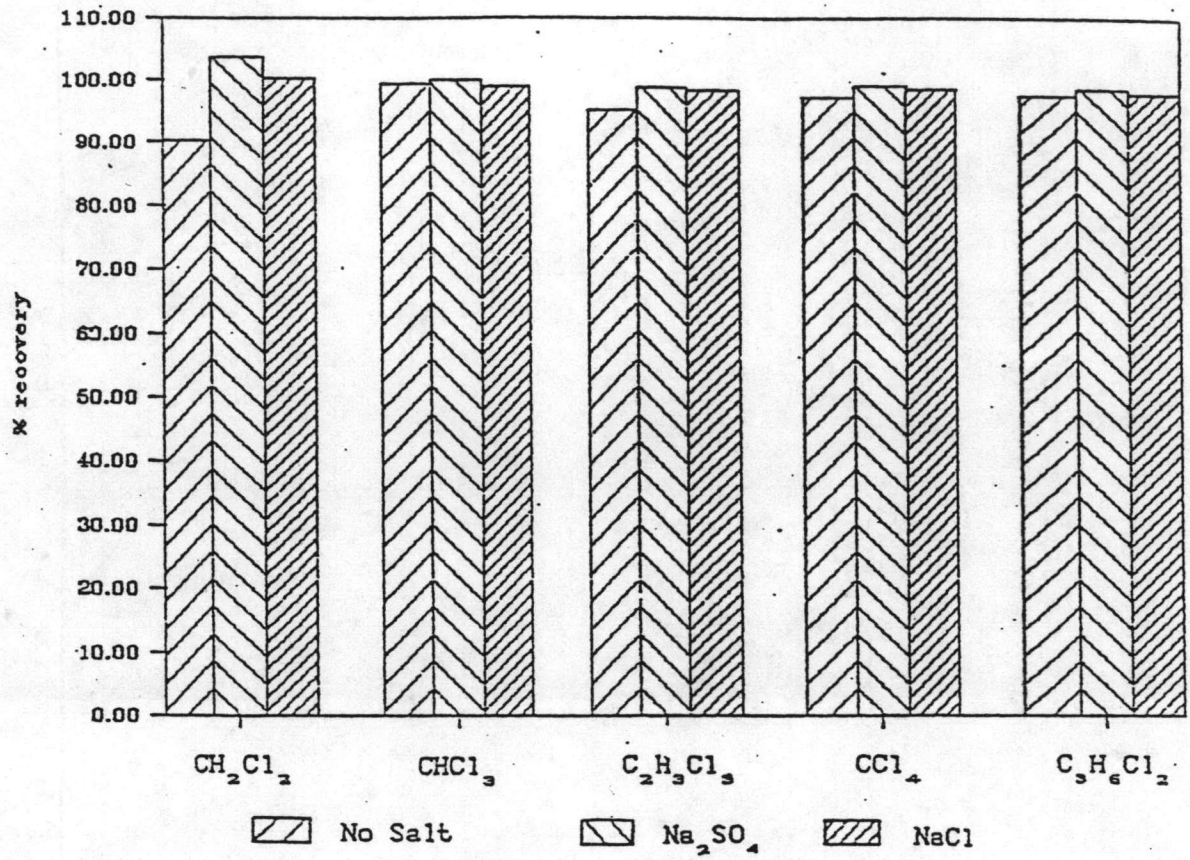

Figure 3.20 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 2:8 .

(2)

Table 3.27 The results of 2:8 extraction of halogenated alkanes with cyclohexane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.25 ±0.01	*	100.62 ±2.11
	Na_2SO_4	0.25 ±0.01	*	102.37 ±3.62
	NaCl	0.25 ±0.01	15.67	98.43 ±1.12
$CHCl_3$	No Salt	0.25 ±0.02	65.54	99.62 ±5.51
	Na_2SO_4	0.25 ±0.01	*	102.02 ±2.05
	NaCl	0.25 ±0.01	*	100.54 ±3.24
$C_2H_3Cl_3$	No Salt	0.25 ±0.01	*	101.20 ±4.60
	Na_2SO_4	0.25 ±0.01	*	101.37 ±5.38
	NaCl	0.25 ±0.01	*	101.35 ±6.99
CCl_4	No Salt	0.25 ±0.01	*	102.33 ±2.66
	Na_2SO_4	0.26 ±0.01	*	104.76 ±3.26
	NaCl	0.26 ±0.01	*	103.83 ±2.15
$C_3H_6Cl_2$	No Salt	0.23 ±0.02	3.04	92.40 ±3.80
	Na_2SO_4	0.24 ±0.01	5.83	95.89 ±4.75
	Na Cl	0.24 ±0.03	6.97	96.54 ±6.95

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99, 1.00 and 0.99 ppm, respectively.

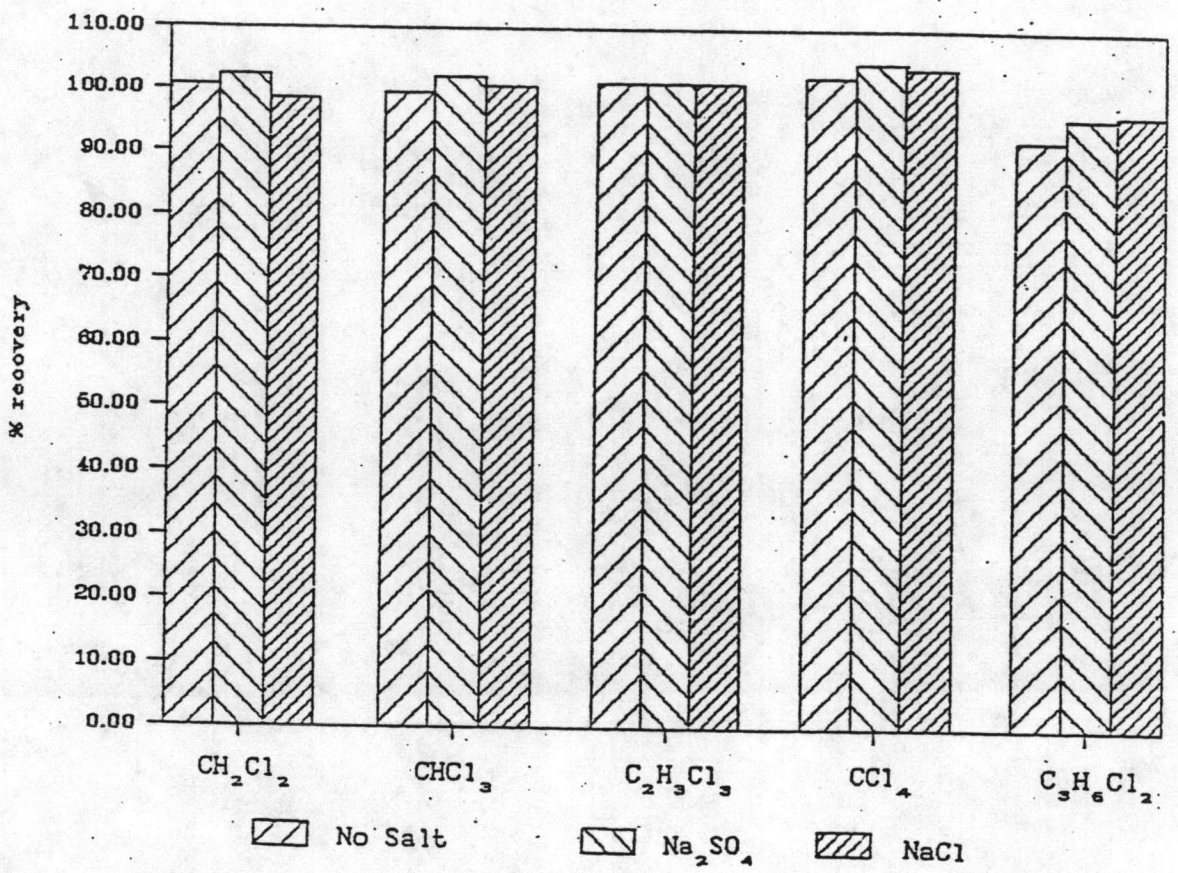

Figure 3.21 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-cyclohexane ratio of 2:8.

(1)

Table 3.28 The results of 9:1 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	33.89 ±2.17	5.48	37.85 ±4.46
	Na_2SO_4	47.97 ±1.38	10.38	53.57 ±2.04
	NaCl	42.44 ±1.60	8.11	47.40 ±2.13
$CHCl_3$	No Salt	55.46 ±3.29	14.30	61.38 ±0.84
	Na_2SO_4	62.15 ±3.73	19.83	68.78 ±2.89
	NaCl	60.12 ±2.80	17.89	66.53 ±2.67
$C_2H_3Cl_3$	No Salt	73.54 ±3.05	41.56	82.20 ±2.91
	Na_2SO_4	75.97 ±4.54	50.68	84.92 ±4.55
	NaCl	74.12 ±1.63	43.48	82.85 ±1.55
CCl_4	No Salt	68.41 ±2.93	27.93	75.63 ±4.29
	Na_2SO_4	68.84 ±2.10	28.67	76.11 ±3.04
	NaCl	68.46 ±0.50	28.02	75.69 ±0.73
$C_3H_6Cl_2$	No Salt	79.77 ±1.90	74.10	89.17 ±2.20
	Na_2SO_4	90.77 ±2.23	*	101.46 ±1.26
	NaCl	89.10 ±2.58	2241.00	99.60 ±1.30

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane were 9.95, 10.04, 9.94, 10.05 and 9.94 ppm, respectively.

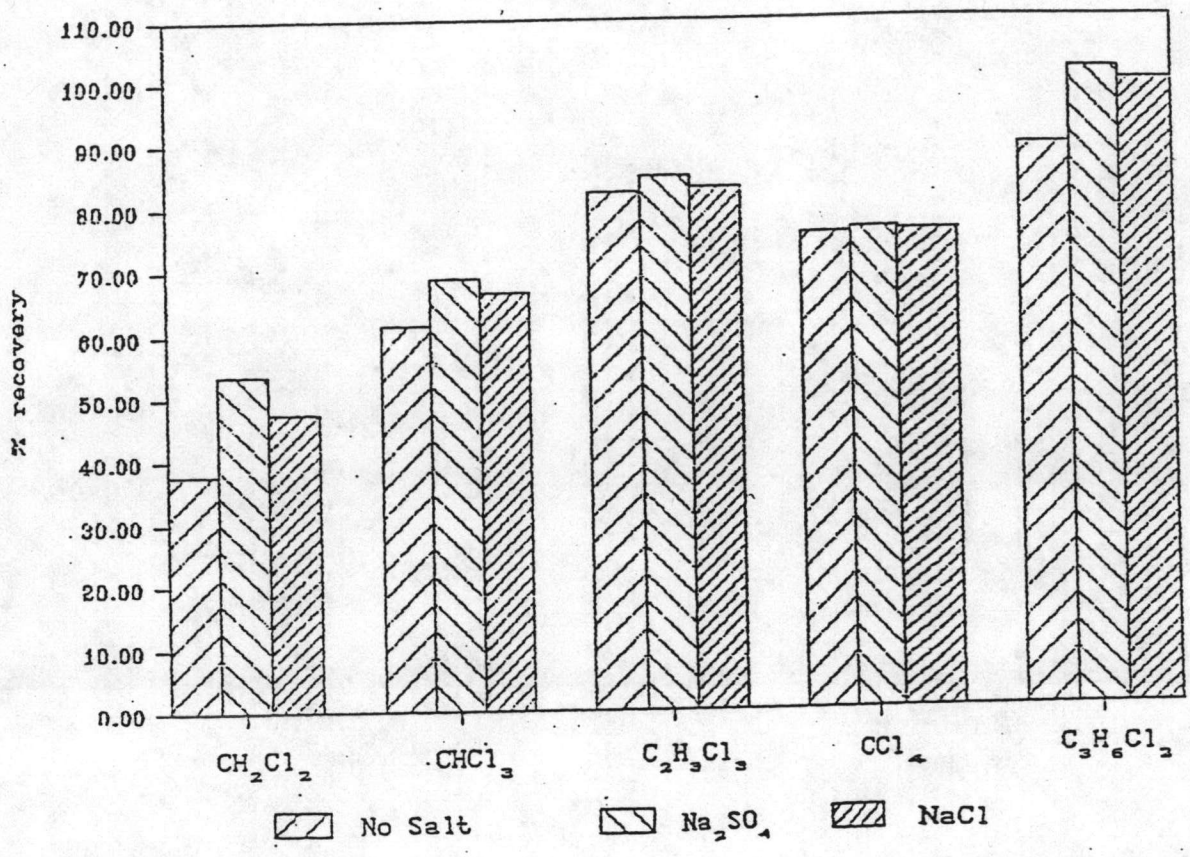

Figure 3.22 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 9:1 .

(2)

Table 3.29 The results of 9:1 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	3.09 ±0.32	4.77	34.65 ± 4.33
	Na_2SO_4	5.24 ±0.28	13.98	60.84 ± 3.86
	NaCl	5.21 ±0.32	12.66	58.45 ± 4.13
$CHCl_3$	No Salt	6.34 ±0.25	21.41	70.41 ± 2.25
	Na_2SO_4	6.63 ±0.20	25.12	73.62 ± 1.84
	NaCl	6.54 ±0.29	23.98	72.71 ± 2.25
$C_2H_3Cl_3$	No Salt	7.53 ±0.29	49.25	84.55 ± 4.42
	Na_2SO_4	8.10 ±0.05	89.79	90.89 ± 0.45
	NaCl	7.99 ±0.26	78.29	89.69 ± 2.34
CCl_4	No Salt	6.81 ±0.23	27.96	75.65 ± 2.44
	Na_2SO_4	7.14 ±0.28	34.60	79.36 ± 2.27
	NaCl	6.99 ±0.29	31.39	77.72 ± 2.93
$C_3H_6Cl_2$	No Salt	7.87 ±0.35	68.59	88.40 ± 3.16
	Na_2SO_4	8.80 ±0.10	760.23	98.83 ± 1.30
	Na Cl	8.64 ±0.16	292.00	97.01 ± 1.26

Triplicate analyses

Note (2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99,1.00,0.99,1.00 and 0.99 ppm, respectively.

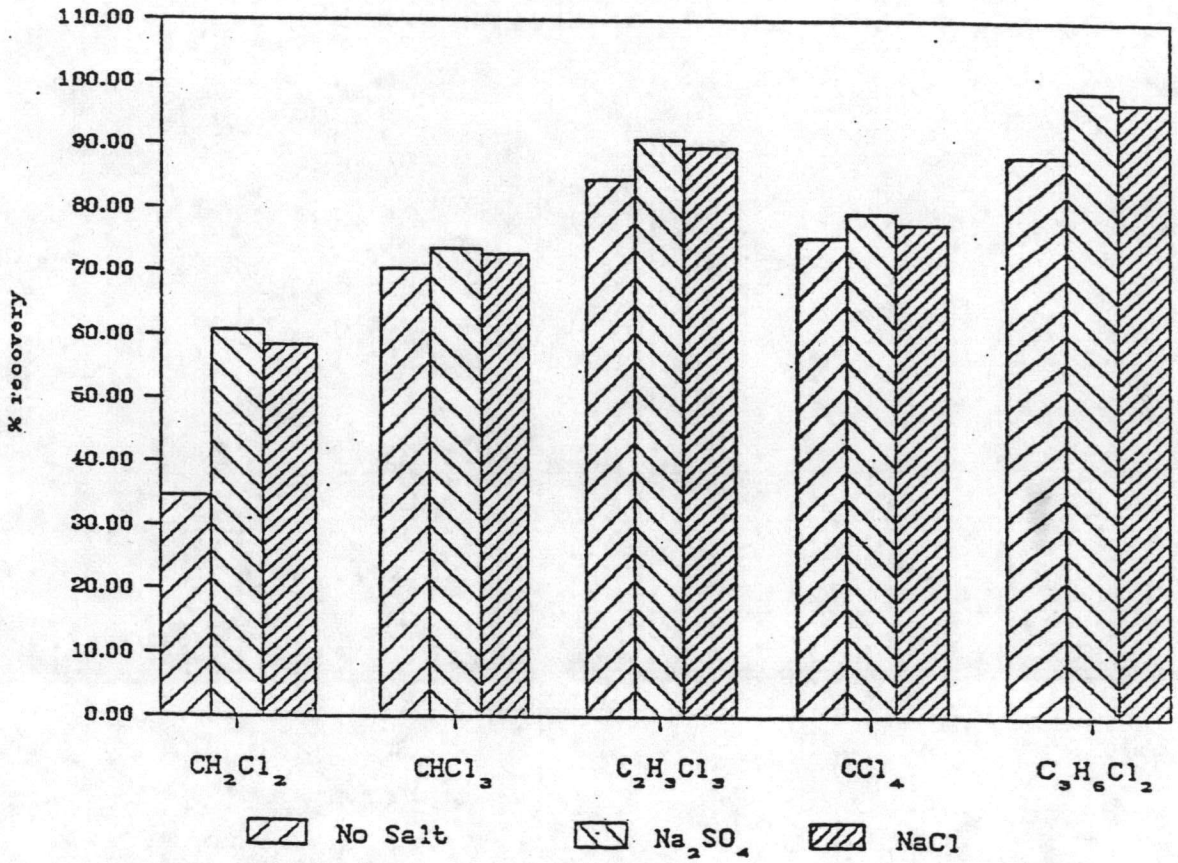

Figure 3.23 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 9:1 .

(1)

Table 3.30 The results of 5:5 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	6.29 ±0.08	1.72	63.21 ±1.53
	Na_2SO_4	6.94 ±0.43	2.31	69.80 ±4.39
	NaCl	6.82 ±0.10	2.18	68.57 ±0.68
$CHCl_3$	No Salt	9.15 ±0.16	10.25	91.11 ±1.27
	Na_2SO_4	9.17 ±0.20	10.59	91.37 ±1.53
	NaCl	9.29 ±0.36	12.49	92.57 ±2.71
$C_2H_3Cl_3$	No Salt	10.02 ±0.26	*	100.85 ±1.82
	Na_2SO_4	10.09 ±0.27	*	101.56 ±1.89
	NaCl	10.09 ±0.04	*	101.53 ±0.30
CCl_4	No Salt	8.85 ±0.36	7.40	88.10 ±4.06
	Na_2SO_4	8.70 ±0.40	6.46	86.60 ±4.54
	NaCl	8.84 ±0.17	7.33	87.99 ±1.94
$C_3H_6Cl_2$	No Salt	10.41 ±0.42	*	104.71 ±2.88
	Na_2SO_4	10.54 ±0.31	*	105.04 ±2.05
	Na Cl	10.38 ±0.23	*	104.42 ±1.58

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene chloride, chloroform 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.44, 10.05 and 9.94 ppm, respectively.

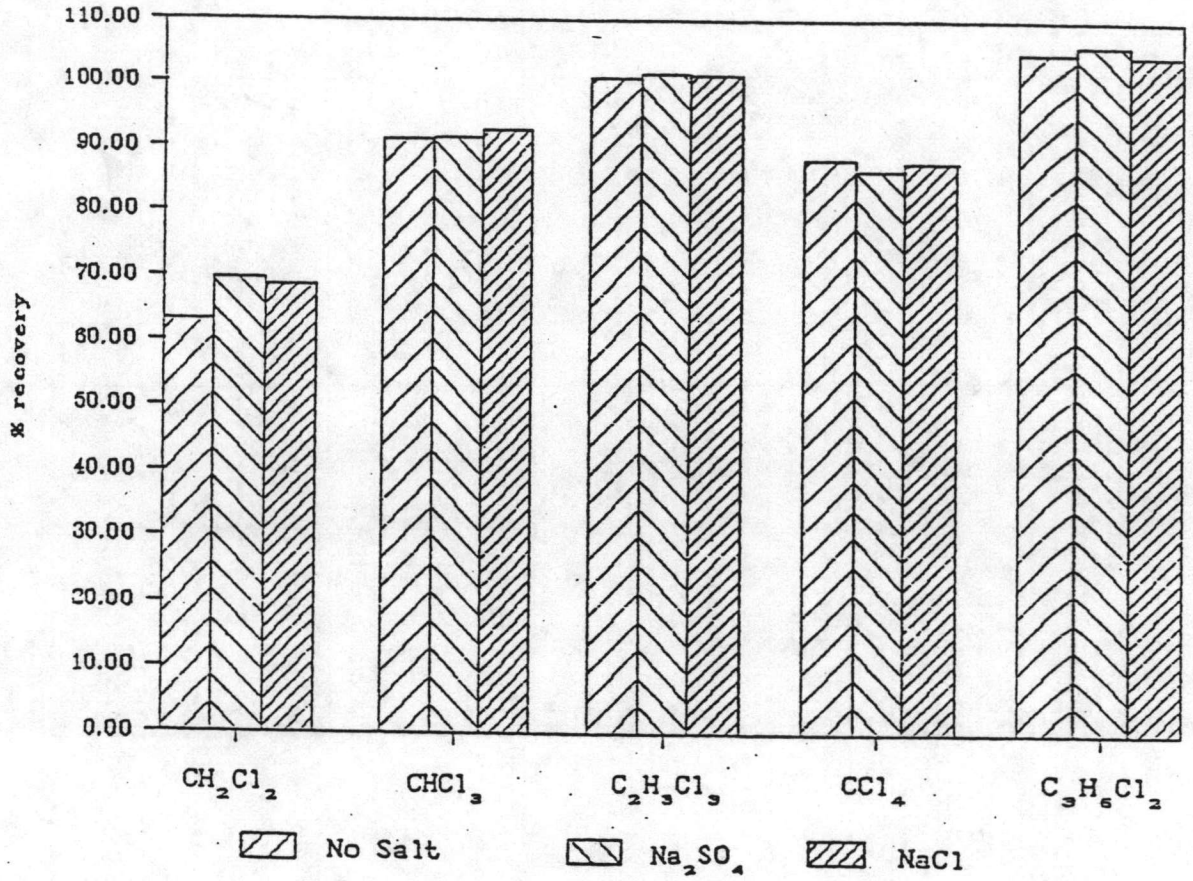

Figure 3.24 The effect of salting-out on % recovery of halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 5:5 .

(2)

Table 3.31 The results of 5:5 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.72 ±0.02	2.63	72.46 ±1.62
	Na_2SO_4	0.79 ±0.04	3.85	79.40 ±2.95
	NaCl	0.77 ±0.03	3.41	77.31 ±3.47
$CHCl_3$	No Salt	0.92 ±0.01	11.94	92.27 ±0.76
	Na_2SO_4	0.92 ±0.02	11.97	92.29 ±1.45
	NaCl	0.92 ±0.04	12.39	92.53 ±3.33
$C_2H_3Cl_3$	No Salt	0.95 ±0.02	26.40	96.35 ±1.43
	Na_2SO_4	0.99 ±0.04	*	100.30 ±2.24
	NaCl	0.96 ±0.02	36.04	97.30 ±1.62
CCl_4	No Salt	0.87 ±0.03	6.94	87.41 ±2.42
	Na_2SO_4	0.91 ±0.03	10.19	91.06 ±2.24
	NaCl	0.87 ±0.02	7.02	87.53 ±2.14
$C_3H_6Cl_2$	No Salt	0.76 ±0.02	4.14	80.53 ±1.90
	Na_2SO_4	0.93 ±0.01	15.45	97.92 ±0.84
	Na Cl	0.97 ±0.02	50.81	98.07 ±1.93

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99,1.00,0.99,1.00 and 0.99 ppm, respectively.

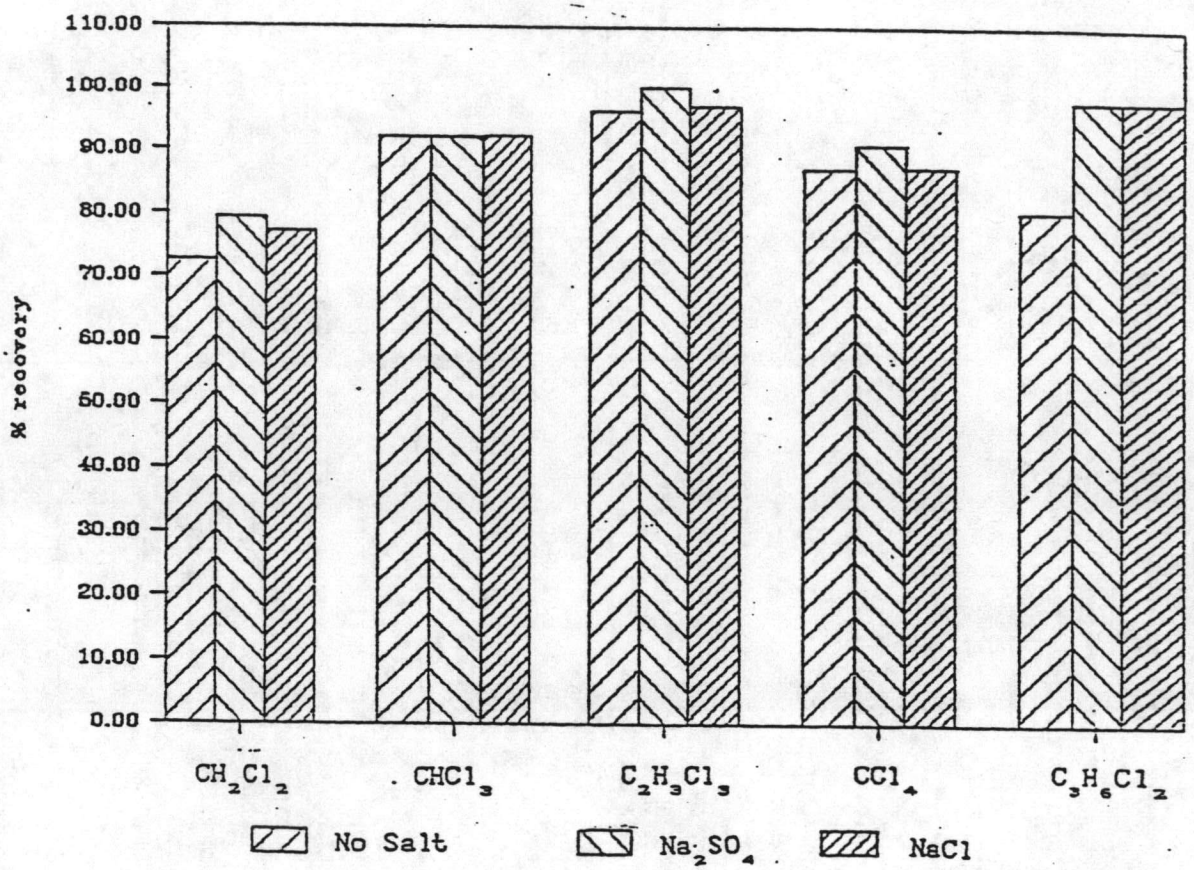

Figure 3.25 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 5:5.

(1)

Table 3.32 The results of 2:8 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.04 ±0.11	1.14	82.02 ±3.94
	Na_2SO_4	2.11 ±0.09	1.50	85.69 ±1.98
	NaCl	2.02 ±0.26	1.08	81.21 ±8.94
$CHCl_3$	No Salt	2.52 ±0.04	*	100.57 ±1.36
	Na_2SO_4	2.55 ±0.04	*	101.56 ±1.12
	NaCl	2.58 ±0.03	*	103.22 ±1.42
$C_2H_3Cl_3$	No Salt	2.48 ±0.10	83.08	99.70 ±3.01
	Na_2SO_4	2.51 ±0.12	*	100.89 ±3.46
	NaCl	2.57 ±0.06	*	103.30 ±1.53
CCl_4	No Salt	2.37 ±0.05	4.99	95.23 ±2.60
	Na_2SO_4	2.44 ±0.06	8.19	97.04 ±1.13
	NaCl	2.41 ±0.05	5.95	95.97 ±1.34
$C_3H_6Cl_2$	No Salt	2.64 ±0.02	*	106.35 ±0.53
	Na_2SO_4	2.48 ±0.10	83.08	99.70 ±2.89
	Na Cl	2.51 ±0.10	*	101.06 ±2.85

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(1) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.95, 10.04, 9.94,10.05 and 9.94 ppm, respectively.

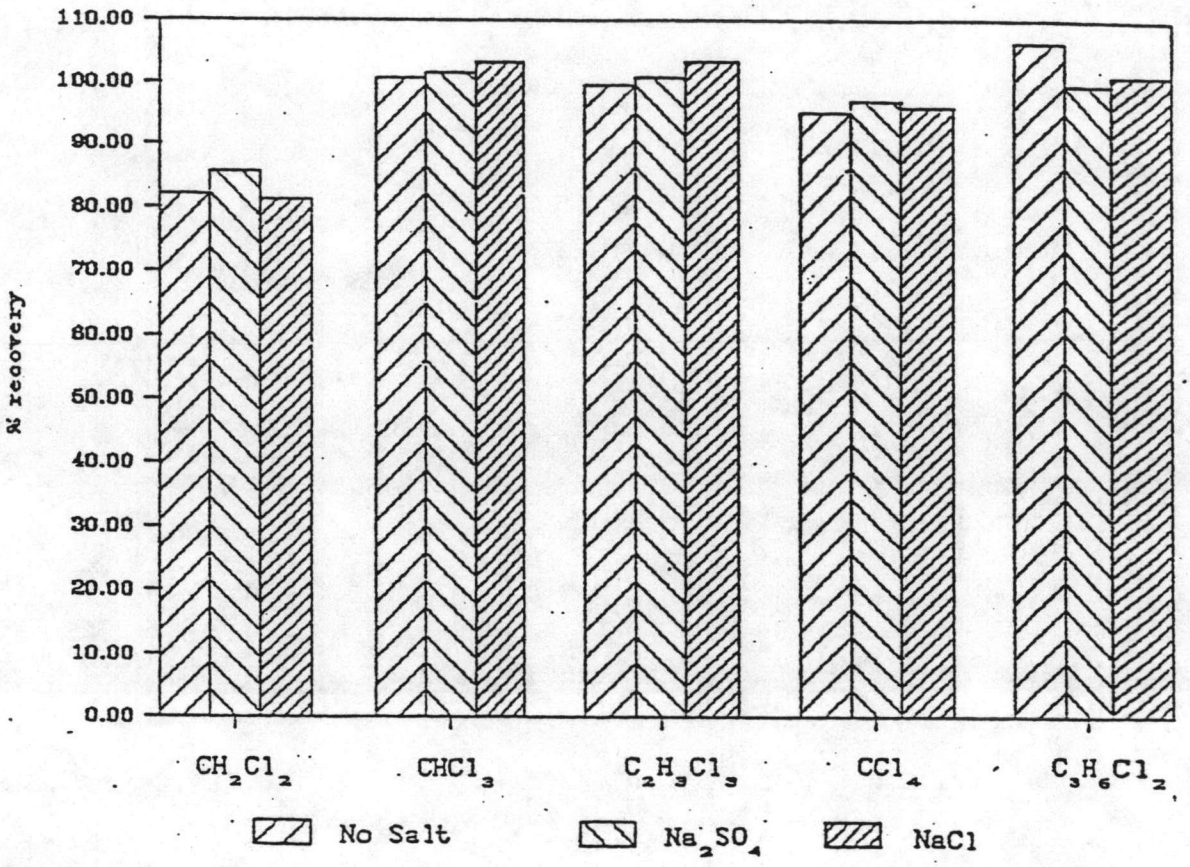

Figure 3.26 The effect of salting-out on % recovery of each halogenated alkane i.e., 9.95 ppm of methylene chloride, 10.04 ppm of chloroform, 9.94 ppm of 1,1,1-trichloroethane, 10.00 ppm of carbontetrachloride and 9.94 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 2:8.

(2)

Table 3.33 The results of 2:8 extraction of halogenated alkanes with isooctane in single component solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.20 ±0.01	1.12	81.71 ±4.12
	Na_2SO_4	0.21 ±0.01	1.59	86.41 ±3.19
	NaCl	0.20 ±0.01	1.20	82.79 ±0.62
$CHCl_3$	No Salt	0.25 ±0.01	*	101.33 ±2.51
	Na_2SO_4	0.25 ±0.01	*	102.02 ±1.55
	NaCl	0.25 ±0.01	*	101.58 ±2.28
$C_2H_3Cl_3$	No Salt	0.24 ±0.00	16.09	98.47 ±0.68
	Na_2SO_4	0.24 ±0.00	21.68	98.86 ±1.01
	NaCl	0.24 ±0.00	7.02	96.56 ±1.03
CCl_4	No Salt	0.22 ±0.01	1.89	88.31 ±2.14
	Na_2SO_4	0.23 ±0.01	2.42	90.63 ±4.31
	NaCl	0.22 ±0.01	1.96	88.70 ±3.76
$C_3H_6Cl_2$	No Salt	0.25 ±0.01	37.63	99.34 ±2.81
	Na_2SO_4	0.27 ±0.01	*	107.99 ±1.41
	Na Cl	0.25 ±0.02	*	100.67 ±5.28

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(2) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.99, 1.00, 0.99,1.00 and 0.99 ppm, respectively.

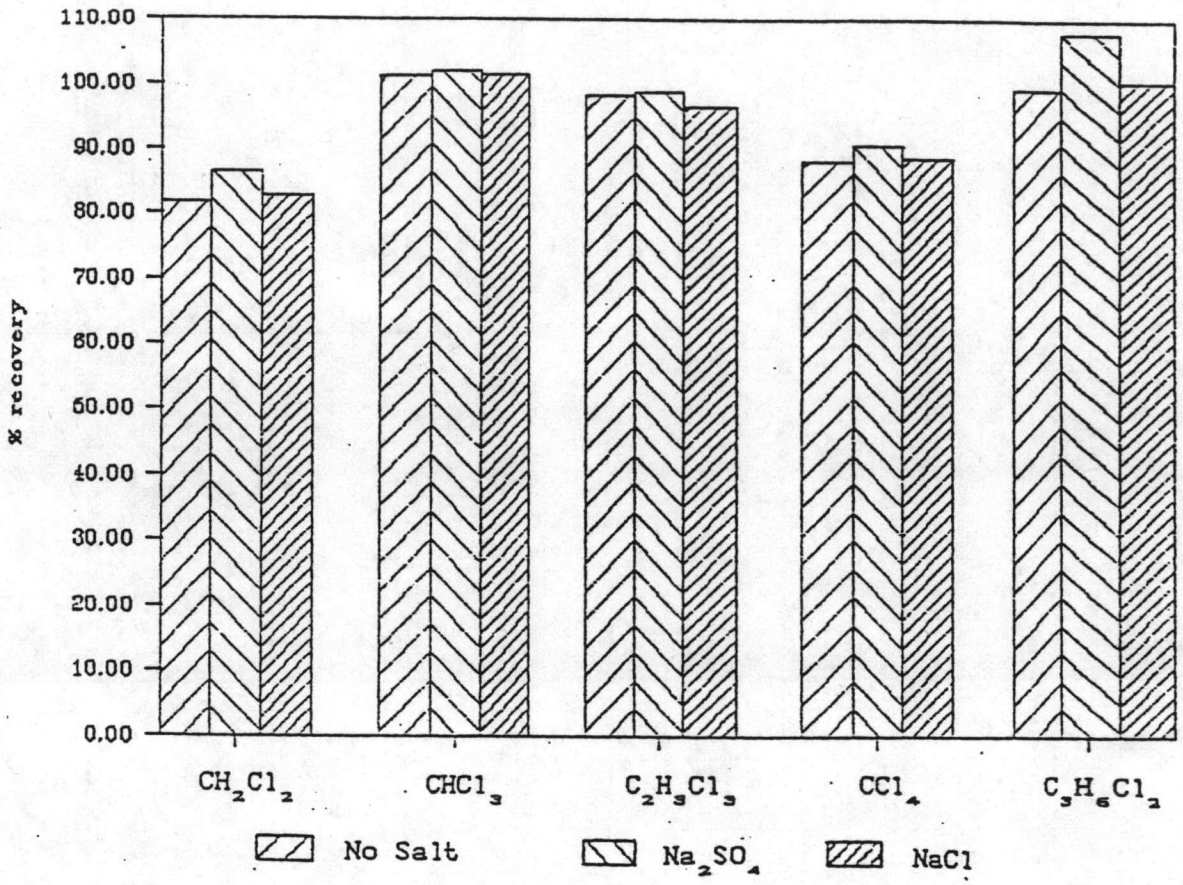

Figure 3.27 The effect of salting-out on % recovery of each halogenated alkane i.e., 0.99 ppm of methylene chloride, 1.00 ppm of chloroform, 0.99 ppm of 1,1,1-trichloroethane, 1.00 ppm of carbontetrachloride and 0.99 ppm of 1,2-dichloropropane in single component solution for sample-to-isooctane ratio of 2:8 .

including methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane with each extracting solvent including hexane, cyclohexane and isooctane for each sample-to-solvent ratio i.e., 9:1, 5:5 and 2:8 are shown in Table 3.34-3.51. It is found that the percent recovery of each halogenated alkane would be increased as in the following order of sample-to-solvent ratio : 9:1, 5:5 and 2:8. The percent recoveries of halogenated alkanes for the sample-to-solvent ratio of 9:1 shown in Table 3.34-3.35, 3.40-3.41 and 3.46-3.47 are in the range of 31.05-101.46 % with the percent RSD in the range of 0.16-8.73. The percent recoveries of halogenated alkanes for the sample-to-solvent ratio of 5:5 shown in Table 3.36-3.37, 3.42-3.43 and 3.48-3.49 and 2:8 as shown in Table 3.38-3.39, 3.44-3.45 and 3.50-3.51 are in the ranges of 44.14-104.72 % and 72.24-106.11 %, respectively with percent RSD in the ranges of 0.12-9.45 % and 0.44-10.67 % ,respectively. The sample-to-solvent ratio of 9:1 is chosen to be the suitable ratio for the analysis of halogenated alkanes due to the percent RSD of sample-to-solvent ratio is lower than those of the other sample-to-solvent ratios and in addition the compounds of interest are concentrated into organic solvents by this sample-to-solvent ratio.

The effect of solvents on percent recoveries of halogenated alkanes can be seen from Table 3.34-3.51. They indicate that the percent recoveries of halogenated alkanes in each extracting solvent differ insignificantly . However cyclohexane seems to have an effect on percent recoveries of carbontetrachloride in the study of mixture solution due to the separation between carbontetrachloride and cyclohexane peaks do not come out as good as other peaks,

especially, when the sensitivity of ECD is increased. Moreover, the percent recovery of carbontetrachloride in the mixture solution with the cyclohexane used as solvent seems to be lower than it would be in the single component solution. The reason of this is that the separation of carbontetrachloride and cyclohexane is not good enough for the peak area to be integrated accurately by integrator, especially, for the sample-to-solvent ratios of 5:5 and 2:8.

The effect of adding salt on percent recoveries of halogenated alkanes are shown in Table 3.34-3.51 and can also be seen in Figure 3.28-3.35 . As same as the results in the extraction of halogenated alkanes in single component solution, the sodium sulfate would be the suitable salt which can be used to increase the percent recoveries of halogenated alkanes in the mixture solutions.

The effect of concentration of halogenated alkanes on percent recoveries was studied. The results of percent recoveries of these compounds are shown in Table 3.34-3.51. The percent recovery of each halogenated alkane for the two different concentrations is insignificantly differente. In the study of mixture solution, all halogenated alkanes except carbontetrachloride were studied in the same concentration level. The reason of this is that response factor of carbontetrachloride with ECD was much higher than the response factor of other halogenated alkanes and it could not be separated from the 1,1,1-trichloroethane peak which was the adjacent peak of carbontetrachloride. Thus, the concentration of carbontetrachloride had to be reduced to the level which these two peaks could be separated.

Table 3.34 The results of 9:1 extraction of halogenated alkanes[3] with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	30.46 ±7.04	4.73	34.46 ±5.09
	Na_2SO_4	42.70 ±1.49	8.41	48.31 ±2.75
	NaCl	39.56 ±2.25	7.29	44.76 ±4.09
$CHCl_3$	No Salt	43.86 ±1.75	8.71	49.18 ±2.46
	Na_2SO_4	51.33 ±1.95	12.20	57.55 ±2.73
	NaCl	50.17 ±1.91	11.57	56.25 ±2.82
$C_2H_3Cl_3$	No Salt	60.26 ±1.01	19.35	68.25 ±2.10
	Na_2SO_4	68.34 ±1.82	30.84	77.41 ±4.11
	NaCl	65.69 ±1.54	26.16	74.40 ±1.94
CCl_4	No Salt	6.08 ±0.32	22.19	71.15 ±3.68
	Na_2SO_4	6.59 ±0.18	30.39	77.15 ±1.94
	NaCl	6.34 ±0.26	25.76	74.11 ±2.91
$C_3H_6Cl_2$	No Salt	73.77 ±2.10	45.71	83.55 ±2.05
	Na_2SO_4	77.39 ±1.03	63.87	87.65 ±1.94
	Na Cl	75.52 ±2.05	53.24	85.54 ±2.03

Triplicate analyses

Note (3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

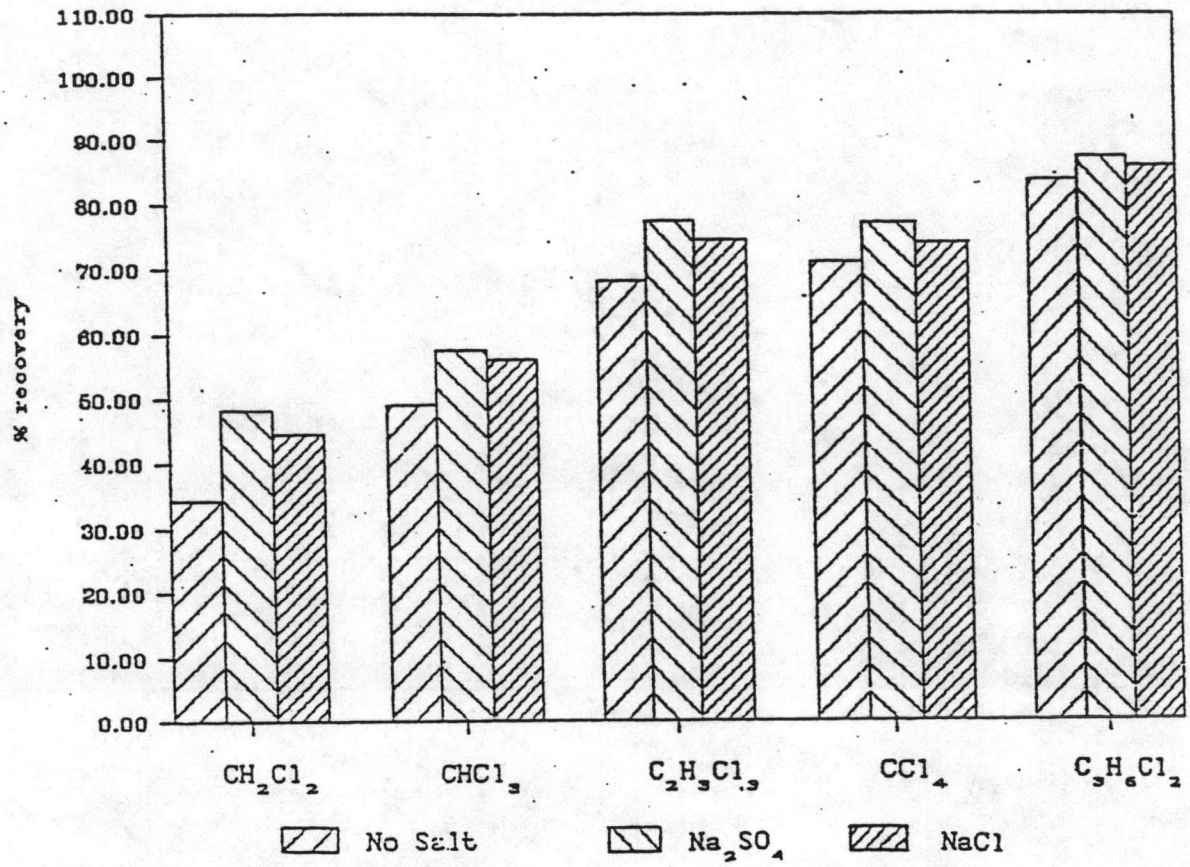

Figure 3.28 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 9:1

Table 3.35 The results of 9:1 extraction of halogenated alkanes[4] with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	3.75 ±0.21	6.65	42.50 ±6.80
	Na_2SO_4	5.19 ±0.49	12.86	58.84 ±6.74
	NaCl	5.09 ±0.38	12.29	57.72 ±5.52
$CHCl_3$	No Salt	5.61 ±0.26	15.30	62.97 ±3.27
	Na_2SO_4	5.95 ±0.39	18.01	66.68 ±4.64
	NaCl	5.79 ±0.52	16.67	64.94 ±6.39
$C_2H_3Cl_3$	No Salt	7.22 ±0.53	40.72	81.90 ±5.14
	Na_2SO_4	7.34 ±0.31	44.73	83.25 ±2.99
	NaCl	7.07 ±0.43	36.32	80.14 ±2.52
CCl_4	No Salt	0.59 ±0.02	24.31	72.98 ±3.38
	Na_2SO_4	0.60 ±0.02	25.10	73.61 ±3.23
	NaCl	0.57 ±0.02	21.57	70.56 ±3.49
$C_3H_6Cl_2$	No Salt	7.57 ±0.58	54.56	85.94 ±7.50
	Na_2SO_4	7.86 ±0.52	73.49	89.09 ±6.82
	Na Cl	7.90 ±0.58	77.12	89.55 ±7.19

Triplicate analyses

Note (4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

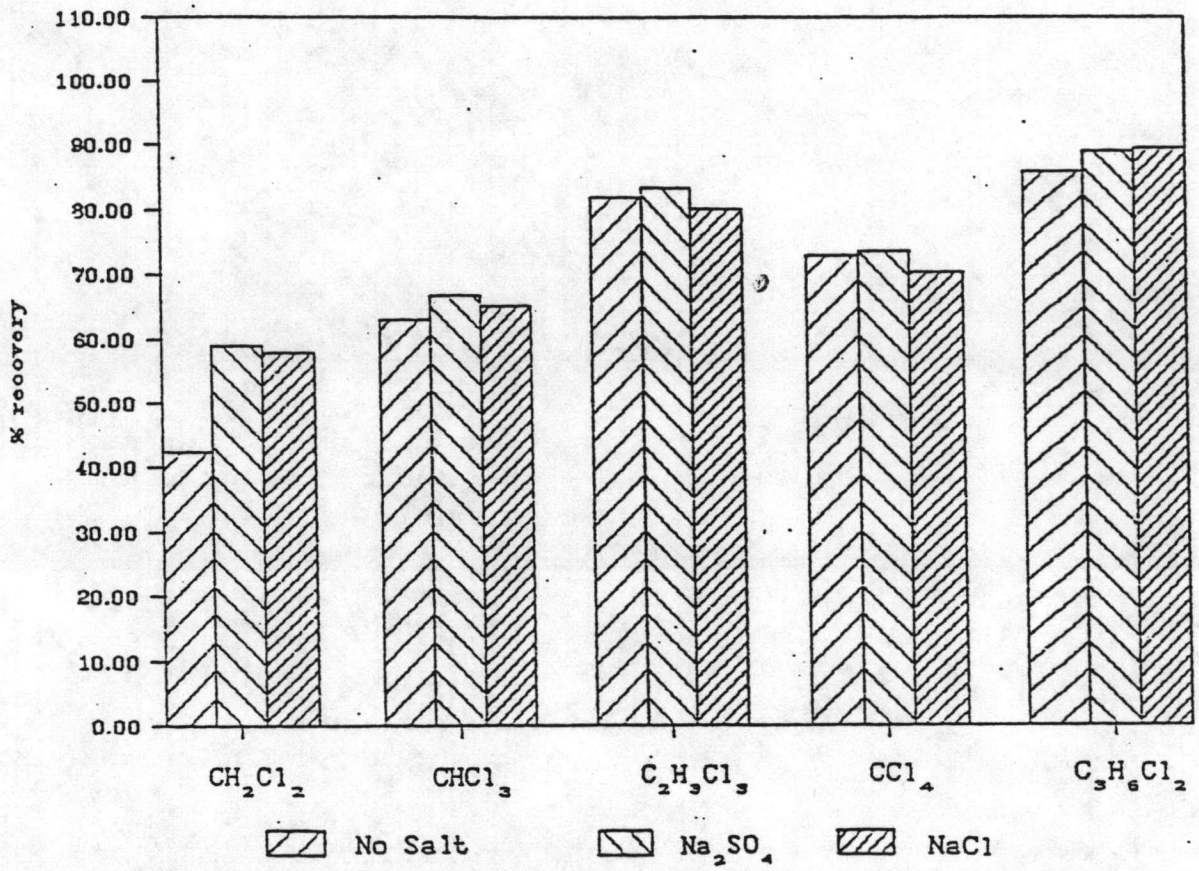

Figure 3.29 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 9:1.

Table 3.36 The results of 5:5 extraction of halogenated alkanes[3] with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	7.34 ±0.72	2.96	74.75 ±9.45
	Na_2SO_4	7.80 ±0.55	3.87	79.49 ±7.20
	NaCl	7.40 ±0.69	3.06	75.36 ±9.40
$CHCl_3$	No Salt	8.69 ±0.70	7.12	87.69 ±5.74
	Na_2SO_4	8.90 ±0.42	8.80	89.80 ±3.37
	NaCl	8.79 ±0.13	7.76	88.58 ±1.10
$C_2H_3Cl_3$	No Salt	9.16 ±0.75	14.17	93.41 ±5.90
	Na_2SO_4	9.22 ±0.40	15.75	94.03 ±3.16
	NaCl	9.20 ±0.29	15.21	93.83 ±2.31
CCl_4	No Salt	0.85 ±0.01	8.26	89.20 ±0.45
	Na_2SO_4	0.91 ±0.06	22.31	95.71 ±6.54
	NaCl	0.90 ±0.08	19.20	95.05 ±8.78
$C_3H_6Cl_2$	No Salt	9.60 ±0.11	45.95	97.87 ±3.28
	Na_2SO_4	9.83 ±0.11	*	100.26 ±3.27
	Na Cl	9.59 ±0.10	45.90	97.76 ±4.03

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

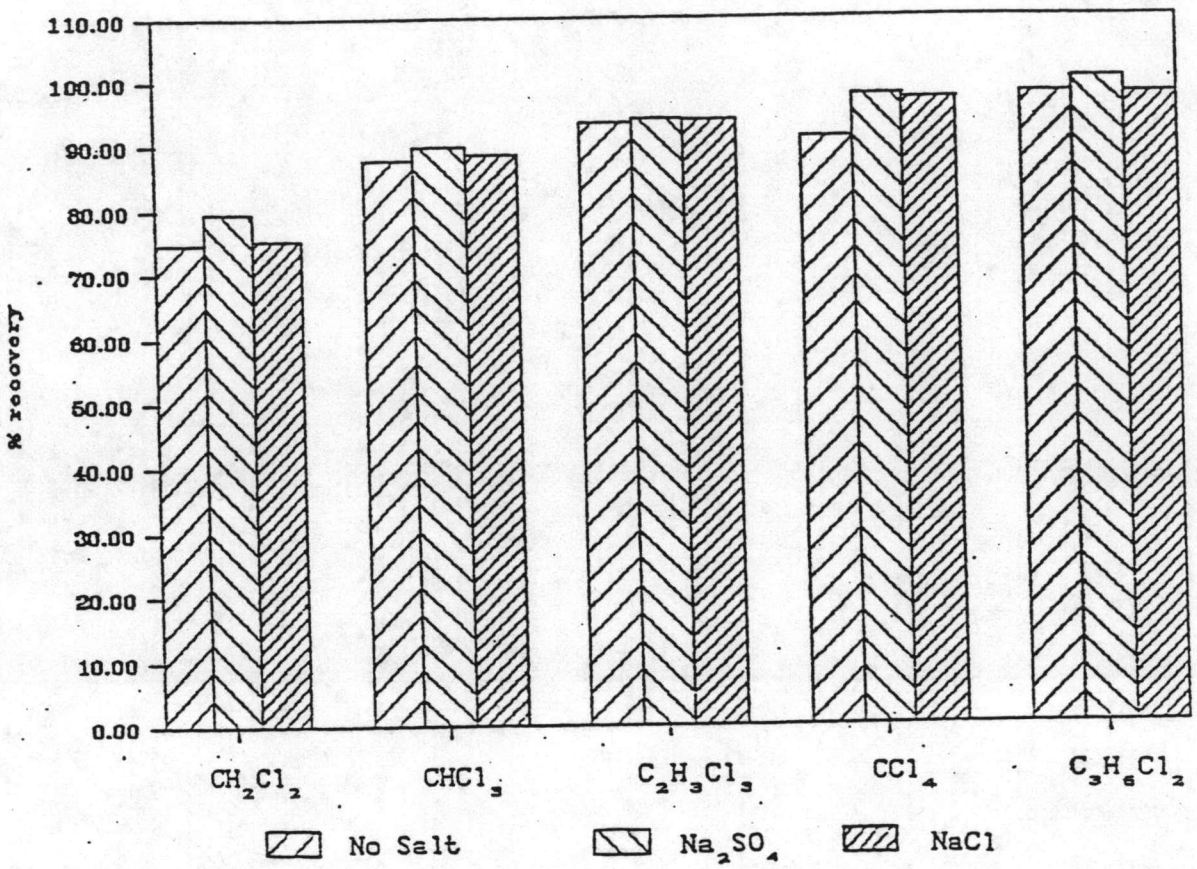

Figure 3.30 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 5:5.

Table 3.37 The results of 5:5 extraction of halogenated alkanes[4] with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.74 ±0.22	3.05	75.30 ±5.41
	Na_2SO_4	0.77 ±0.02	3.61	78.33 ±0.42
	NaCl	0.76 ±0.22	3.45	77.55 ±4.02
$CHCl_3$	No Salt	0.94 ±0.01	17.94	94.71 ±1.39
	Na_2SO_4	0.97 ±0.02	50.81	98.07 ±1.54
	NaCl	0.98 ±0.04	70.94	98.61 ±3.56
$C_2H_3Cl_3$	No Salt	0.90 ±0.02	11.36	91.91 ±1.76
	Na_2SO_4	0.89 ±0.01	10.74	91.48 ±0.75
	NaCl	0.81 ±0.15	10.21	91.07 ±2.26
CCl_4	No Salt	0.09 ±0.00	30.06	96.78 ±0.12
	Na_2SO_4	0.09 ±0.00	19.83	95.20 ±2.13
	NaCl	0.09 ±0.00	24.25	96.04 ±0.22
$C_3H_6Cl_2$	No Salt	0.81 ±0.03	4.90	83.05 ±2.63
	Na_2SO_4	0.87 ±0.04	7.82	88.66 ±3.85
	Na Cl	0.87 ±0.03	7.70	88.50 ±1.88

Triplicate analyses

Note (4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.99 and 0.98 ppm, respectively.

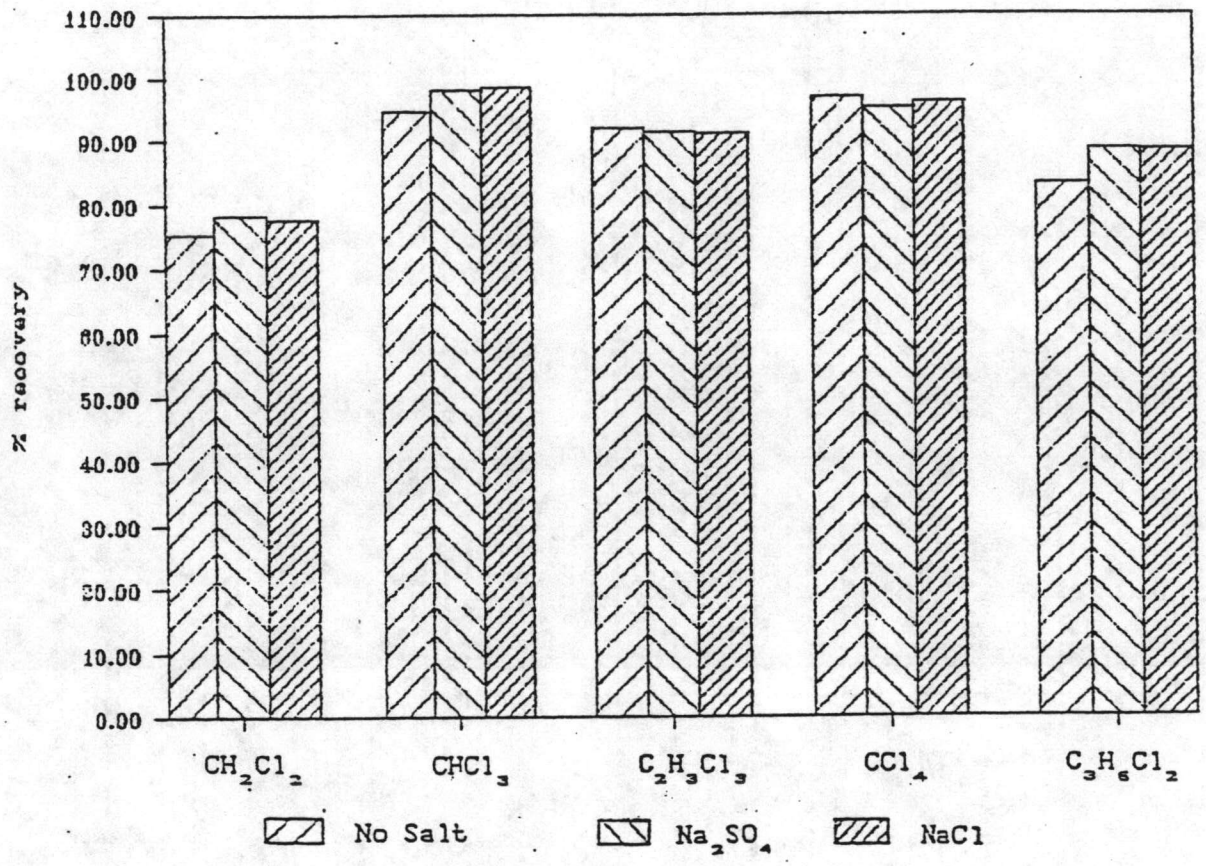

Figure 3.31 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 5:5 .

Table 3.38 The results of 2:8 extraction halogenated alkanes (3) with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.28 ±0.08	3.36	93.08 ±6.99
	Na_2SO_4	2.35 ±0.16	3.47	95.98 ±7.01
	NaCl	2.31 ±0.09	4.10	94.26 ±5.10
$CHCl_3$	No Salt	2.19 ±0.11	1.37	88.24 ±5.44
	Na_2SO_4	2.34 ±0.03	4.15	94.32 ±1.12
	NaCl	2.29 ±0.02	2.13	92.64 ±1.12
$C_2H_3Cl_3$	No Salt	2.25 ±0.12	2.77	91.71 ±3.99
	Na_2SO_4	2.43 ±0.03	71.18	99.65 ±0.87
	NaCl	2.39 ±0.14	9.67	97.48 ±4.13
CCl_4	No Salt	0.21 ±0.01	2.93	92.14 ±5.34
	Na_2SO_4	0.22 ±0.01	4.26	94.46 ±5.05
	NaCl	0.22 ±0.01	4.81	95.06 ±2.16
$C_3H_6Cl_2$	No Salt	2.51 ±0.11	*	102.28 ±3.08
	Na_2SO_4	2.54 +0.11	*	103.93 ±3.27
	Na Cl	2.51 ±0.10	*	102.29 ±2.89

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

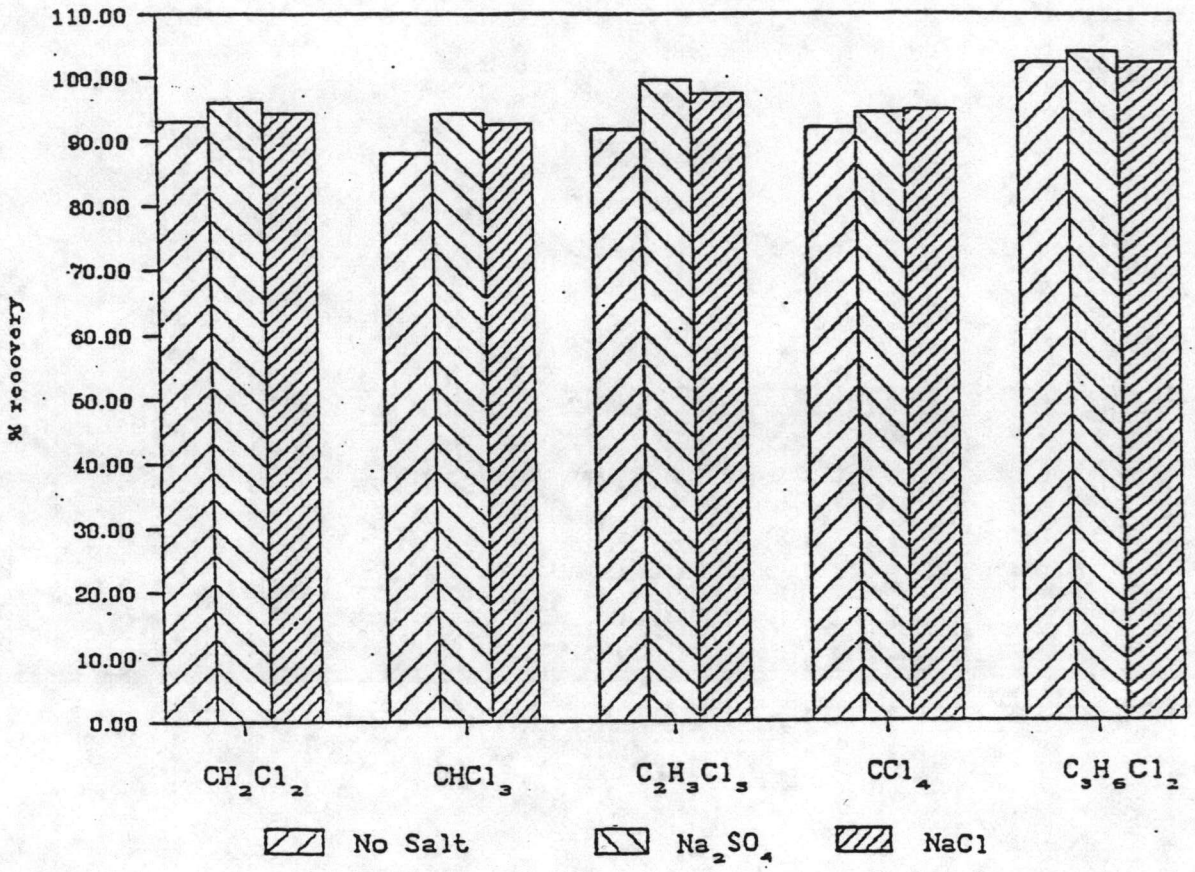

Figure 3.32 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 2:8.

Table 3.39 The results of 2:8 extraction halogenated alkane[4] with hexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.22 ±0.01	2.14	89.55 ±5.56
	Na_2SO_4	0.23 ±0.02	3.42	93.19 ±0.13
	NaCl	0.23 ±0.01	3.29	92.93 ±6.26
$CHCl_3$	No Salt	0.23 ±0.02	5.09	95.32 ±6.25
	Na_2SO_4	0.25 ±0.02	51.83	99.52 +7.68
	NaCl	0.25 ±0.01	40.73	99.39 ±7.33
$C_2H_3Cl_3$	No Salt	0.25 ±0.01	*	103.05 ±2.43
	Na_2SO_4	0.24 ±0.01	*	101.85 ±3.13
	NaCl	0.25 ±0.01	*	103.65 ±3.19
CCl_4	No Salt	0.02 ±0.00	*	101.97 ±0.62
	Na_2SO_4	0.02 ±0.00	*	104.58 ±3.71
	NaCl	0.02 ±0.00	17.74	98.61 ±0.44
$C_3H_6Cl_2$	No Salt	0.22 ±0.02	2.58	91.16 ±6.97
	Na_2SO_4	0.22 ±0.03	2.59	91.19 ±7.43
	Na Cl	0.22 +0.01	1.93	88.55 ±3.78

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.99 and 0.98 ppm, respectively.

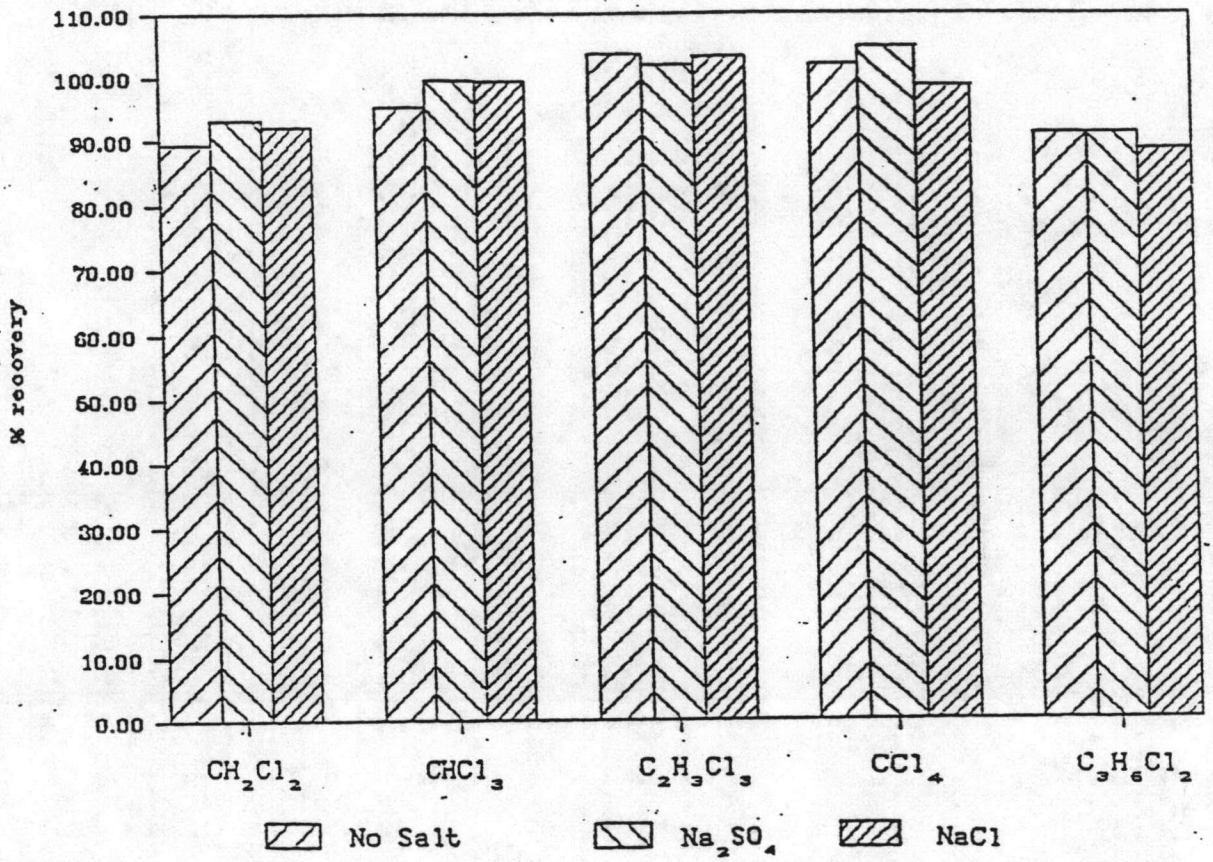

Figure 3.33 The effect of salting-out on % recoveries of halogenated alkanes i.e. ,0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-hexane ratio of 2:8 .

Table 3.40 The results of 9:1 extraction of halogenated alkanes(3) with cyclohexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	30.31 ±3.24	4.70	34.30 ±7.71
	Na_2SO_4	46.89 ±4.55	10.17	53.05 ±7.87
	NaCl	42.48 ±3.52	8.52	48.64 ±5.89
$CHCl_3$	No Salt	65.35 ±2.79	24.67	73.27 ±3.09
	Na_2SO_4	72.02 ±4.28	37.75	80.75 ±6.04
	NaCl	70.45 ±3.57	33.84	78.99 ±3.56
$C_2H_3Cl_3$	No Salt	75.14 ±1.06	51.44	85.11 ±1.02
	Na_2SO_4	76.18 ±2.31	56.64	86.29 ±2.18
	NaCl	76.69 ±1.01	59.49	86.86 ±0.94
CCl_4	No Salt	7.22 ±0.17	48.84	84.44 ±1.59
	Na_2SO_4	7.27 ±0.23	51.00	85.00 ±2.14
	NaCl	7.22 ±0.17	48.84	84.44 ±1.60
$C_3H_6Cl_2$	No Salt	77.13 ±2.28	62.20	87.36 ±3.26
	Na_2SO_4	79.74 ±1.42	83.98	90.32 ±1.78
	Na Cl	77.16 ±2.74	62.43	87.40 ±3.68

Triplicate analyses

Note (3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm respectively.

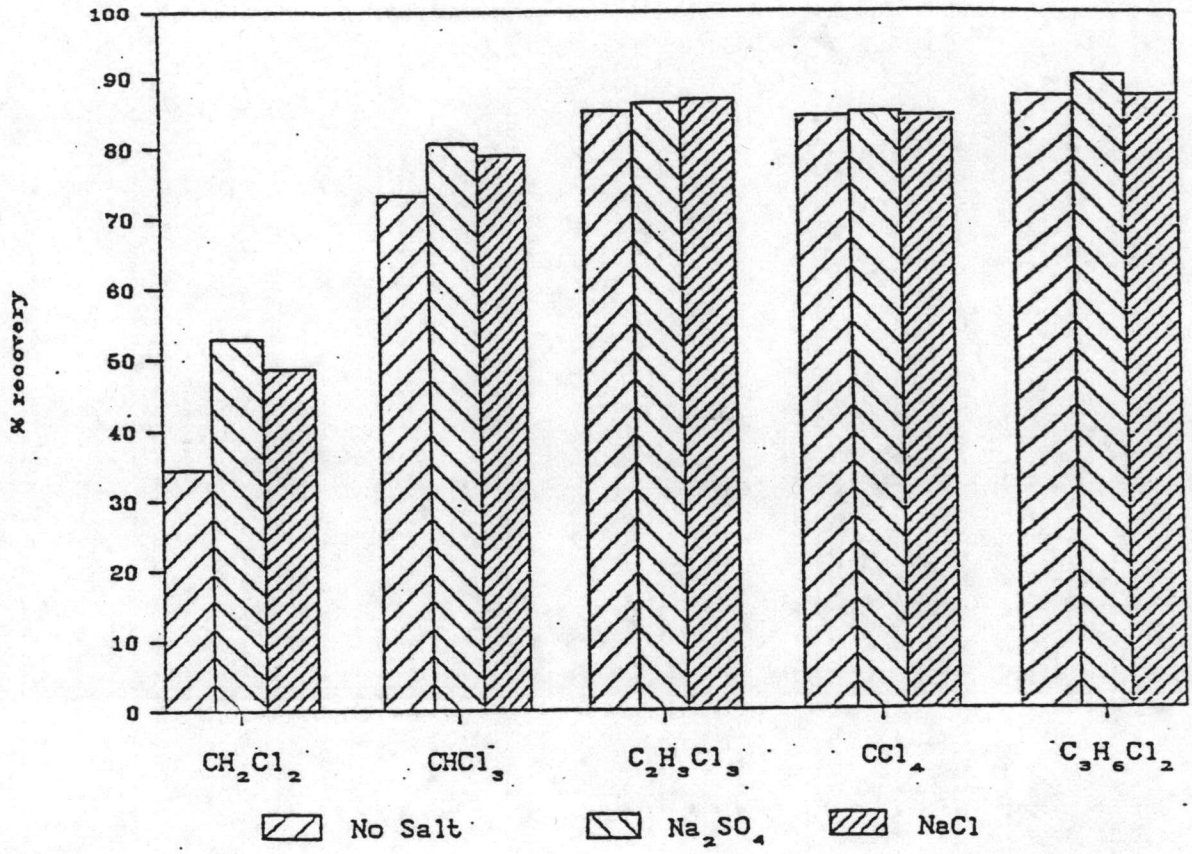

Figure 3.34 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 9:1 .

Table 3.41 The results of 9:1 extraction of halogenated alkanes(4) with cyclohexane in mixture solutions.

alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	3.29 ±0.85	5.36	37.33 ±8.73
	Na_2SO_4	4.57 ±0.79	9.66	51.77 ±6.87
	NaCl	3.72 ±0.69	6.57	42.21 ±7.80
$CHCl_3$	No Salt	6.76 ±0.98	28.30	75.87 ±5.48
	Na_2SO_4	7.39 ±0.27	43.72	82.93 ±2.37
	NaCl	7.19 ±0.21	37.56	80.67 ±1.82
$C_2H_3Cl_3$	No Salt	7.20 ±0.69	40.19	81.69 ±6.18
	Na_2SO_4	7.47 ±0.38	49.67	84.66 ±3.28
	NaCl	7.46 ±0.14	49.37	84.58 ±1.23
CCl_4	No Salt	0.69 ±0.14	52.64	85.40 ±5.03
	Na2SO4	0.70 ±0.08	60.60	87.07 ±3.58
	NaCl	0.71 ±0.02	62.83	87.47 ±0.16
$C_3H_6Cl_2$	No Salt	7.65 ±0.91	59.13	86.79 ±7.76
	Na_2SO_4	8.23 ±0.30	176.18	93.34 ±2.31
	Na Cl	7.89 ±0.73	79.55	89.48 ±6.01

Triplicate analyses

Note (4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

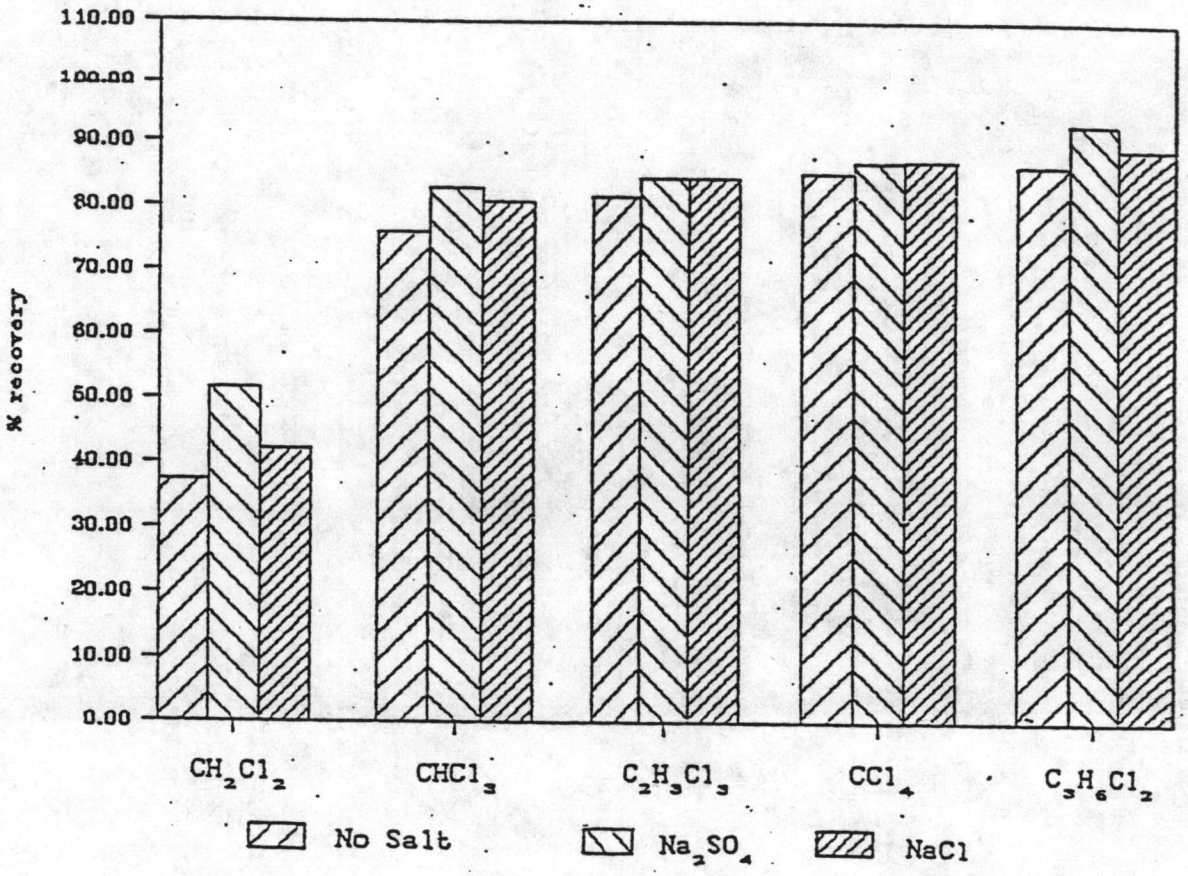

Figure 3.35 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 9:1 .

Table 3.42 The results of 5:5 extraction of halogenated alkanes(3) with cyclohexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	7.57 ±0.78	3.37	77.11 ±7.35
	Na_2SO_4	8.09 ±0.32	4.70	82.46 ±2.50
	NaCl	7.71 ±0.73	3.66	78.55 ±6.80
$CHCl_3$	No Salt	7.77 ±0.78	3.63	78.40 ±7.23
	Na_2SO_4	8.10 ±1.07	4.48	81.75 ±9.88
	NaCl	7.87 ±1.04	3.86	79.41 ±9.56
$C_2H_3Cl_3$	No Salt	8.14 ±0.47	4.89	83.02 ±4.16
	Na_2SO_4	8.30 ±0.62	5.50	84.61 ±7.55
	NaCl	8.20 ±0.63	5.09	83.58 ±5.56
CCl_4	No Salt	0.78 ±0.12	4.71	82.49 ±4.39
	Na_2SO_4	0.81 ±0.02	5.74	85.16 ±2.59
	NaCl	0.80 ±0.03	5.26	84.03 ±6.64
$C_3H_6Cl_2$	No Salt	9.35 ±0.60	20.41	95.33 ±4.64
	Na_2SO_4	9.60 ±1.99	47.08	97.92 ±1.41
	Na Cl	9.51 ±0.13	31.79	96.95 ±1.41

Triplicate analyses

Note (3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

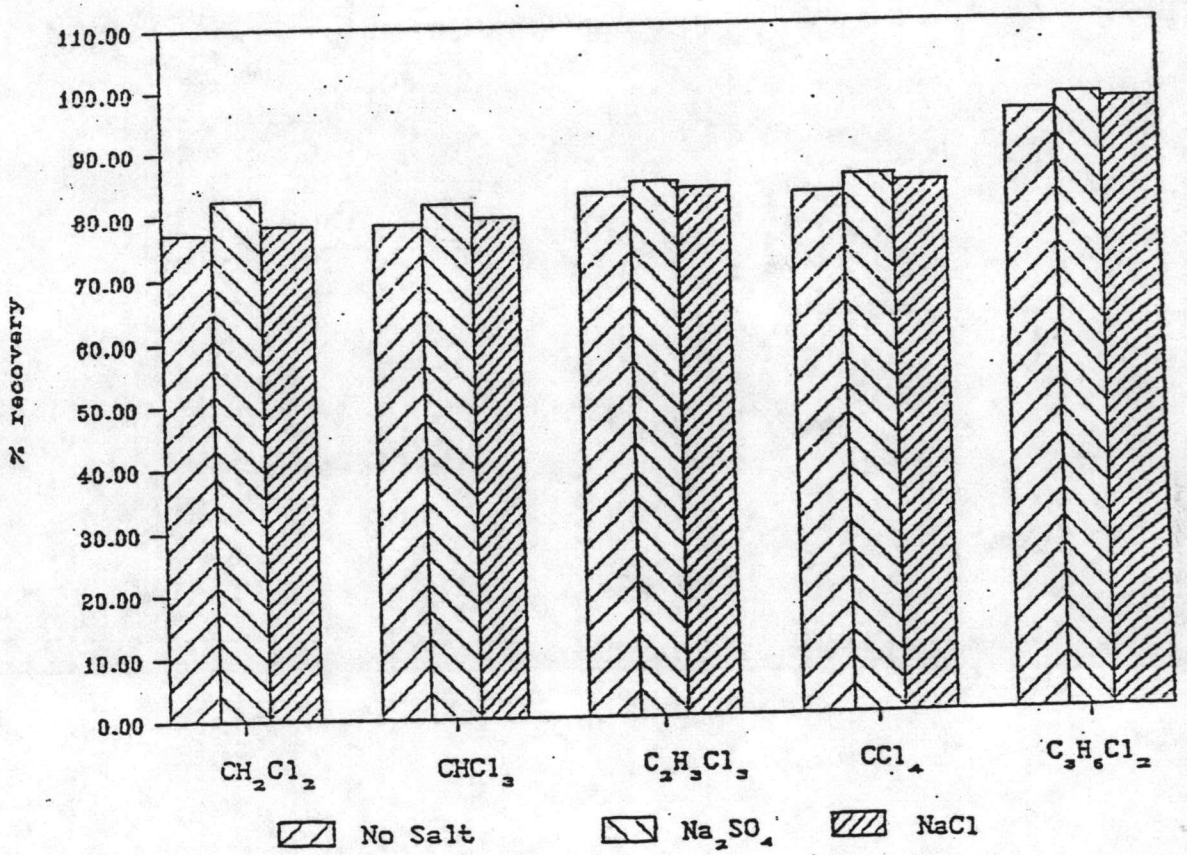

Figure 3.36 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 5:5 .

Table 3.43 The results of 5:5 extraction of halogenated alkanes[4] with cyclohexane in the mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.80 ±0.06	4.45	81.65 ±7.25
	Na_2SO_4	0.90 ±0.06	11.16	91.78 ±5.81
	NaCl	0.88 ±0.12	8.82	89.82 +9.13
$CHCl_3$	No Salt	0.89 +0.03	9.21	90.21 +3.19
	Na_2SO_4	0.94 ±0.02	20.32	95.31 ±2.30
	NaCl	0.89 ±0.03	9.05	90.05 ±3.18
$C_2H_3Cl_3$	No Salt	0.85 ±0.03	6.26	86.22 ±2.91
	Na_2SO_4	0.85 ±0.02	6.51	86.68 ±1.91
	NaCl	0.86 ±0.03	7.45	88.17 ±3.08
CCl_4	No Salt	0.07 ±0.0	4.89	83.02 ±6.54
	Na_2SO_4	0.08 ±0.00	5.50	84.61 ±4.26
	NaCl	0.08 ±0.00	5.09	83.58 ±4.18
$C_3H_6Cl_2$	No Salt	0.84 ±0.06	6.15	86.02 ±8.43
	Na_2SO_4	0.86 ±0.04	7.55	88.31 ±2.40
	Na Cl	0.88 ±0.04	8.55	89.53 ±1.12

Triplicate analyses

Note (4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

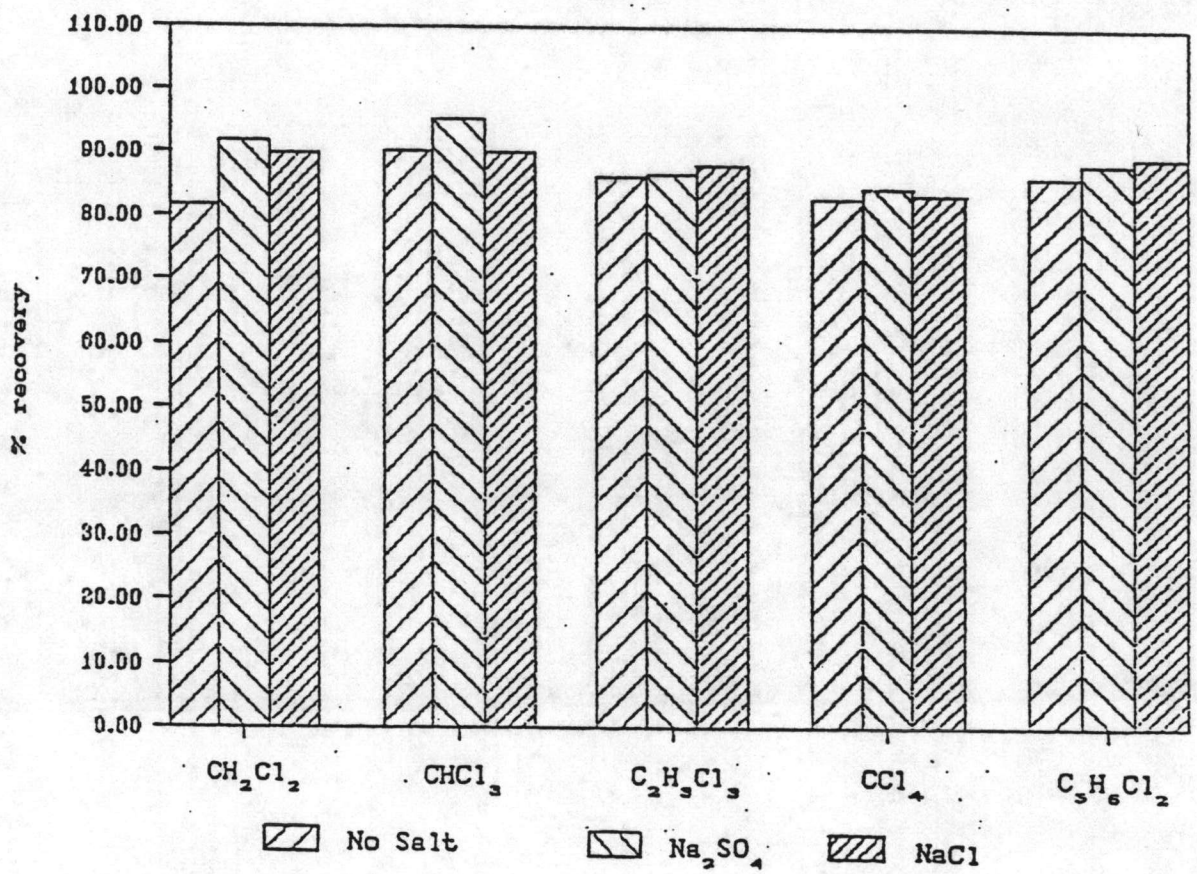

Figure 3.37 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 5:5 .

Table 3.44 The results of 2:8 extractions of halogenated alkanes(3) with cyclohexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.26 ±0.23	2.99	92.30 ± 5.63
	Na_2SO_4	2.27 ±0.09	3.12	92.58 ±2.91
	NaCl	2.28 ±0.18	3.23	92.81 ±4.97
$CHCl_3$	No Salt	2.30 ±0.04	3.20	92.76 ±1.92
	Na_2SO_4	2.34 ±0.03	4.39	94.61 ±1.08
	NaCl	2.28 ±0.14	2.93	92.14 ±4.44
$C_2H_3Cl_3$	No Salt	2.43 ±0.17	23.33	98.94 ±4.79
	Na_2SO_4	2.51 ±0.06	*	102.48 ±2.44
	NaCl	2.47 ±0.02	*	100.62 ±0.81
CCl_4	No Salt	0.19 ±0.01	1.13	81.90 ±3.15
	Na_2SO_4	0.20 ±0.04	1.26	83.40 ±0.79
	NaCl	0.19 ±0.01	1.21	82.86 ±1.12
$C_3H_6Cl_2$	No Salt	2.37 ±0.27	7.17	96.63 ±4.20
	Na_2SO_4	2.54 ±0.05	*	103.51 ±1.83
	Na Cl	2.51 ±0.09	*	102.42 ±3.80

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81ppm, respectively.

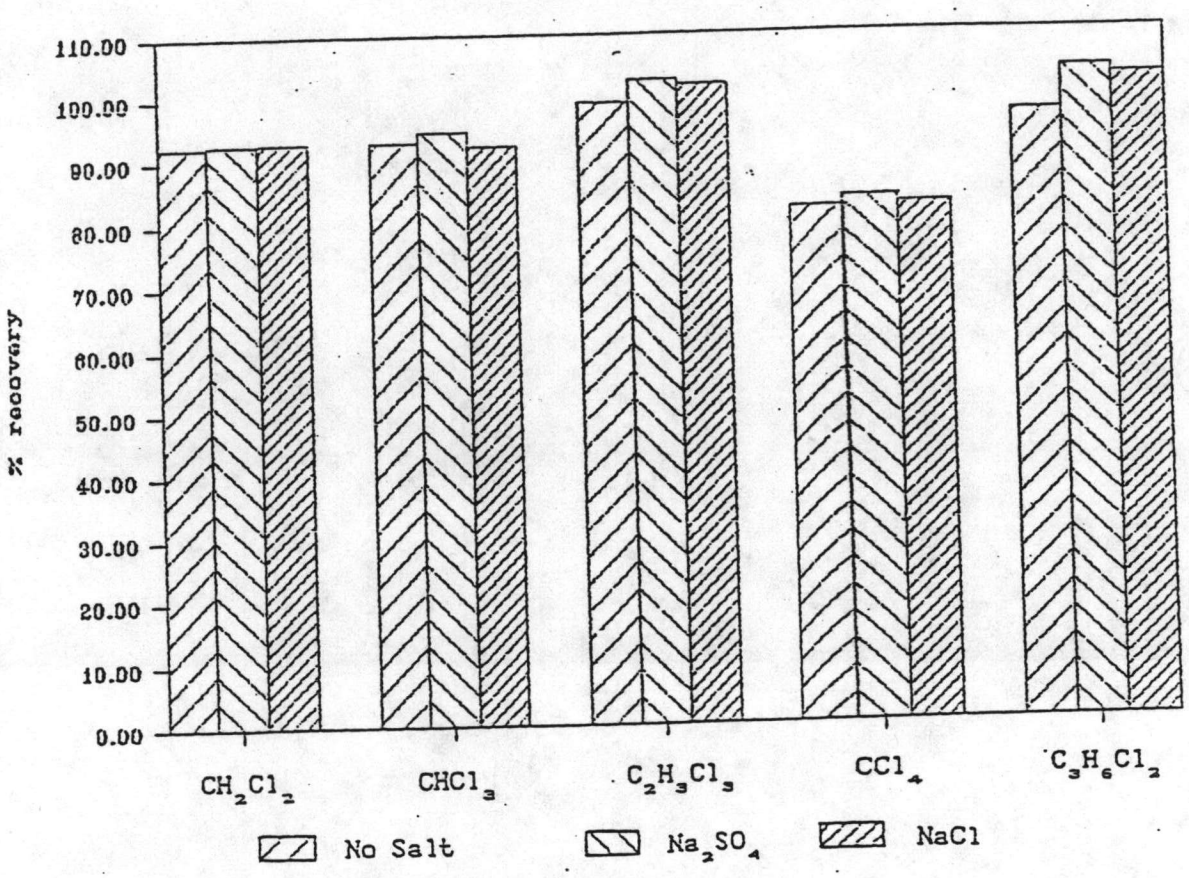

Figure 3.38 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 2:8 .

Table 3.45 The results of 2:8 extraction of halogenated alkanes[4] with cyclohexane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.22 ±0.01	2.02	88.98 ±5.20
	Na_2SO_4	0.23 ±0.01	7.42	96.74 ±6.59
	NaCl	0.23 ±0.02	4.23	94.42 ±9.46
$CHCl_3$	No Salt	0.22 ±0.02	2.28	90.14 ±6.49
	Na_2SO_4	0.25 ±0.06	*	102.00 ±9.12
	NaCl	0.24 ±0.03	19.91	98.76 ±6.89
$C_2H_3Cl_3$	No Salt	0.23 ±0.18	3.85	93.90 ±8.87
	Na_2SO_4	0.23 ±0.05	5.98	95.99 ±2.41
	NaCl	0.22 ±0.07	2.05	89.13 ±3.64
CCl_4	No Salt	0.02 ±0.01	1.58	86.34 ±3.72
	Na_2SO_4	0.02 ±0.01	1.96	88.67 ±2.28
	NaCl	0.02 ±0.01	1.85	88.11 ±0.55
$C_3H_6Cl_2$	No Salt	0.25 ±0.01	*	100.62 ±2.90
	Na_2SO_4	0.25 ±0.01	*	100.08 ±3.37
	Na Cl	0.25 ±0.01	*	100.97 ±3.84

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

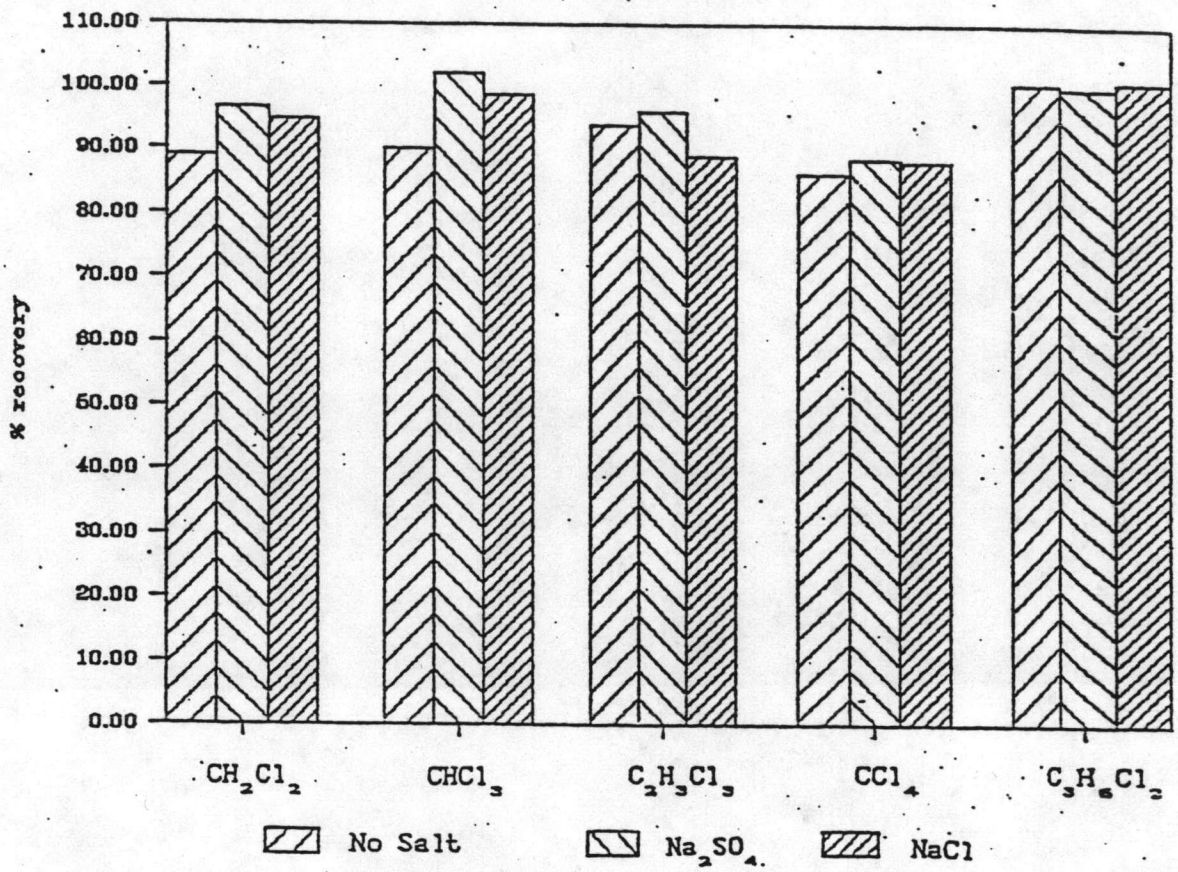

Figure 3.39 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-cyclohexane ratio of 2:8 .

Table 3.46 The results of 9:1 extraction of halogenated alkanes(3) with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	27.45 ± 1.28	4.05	31.05 ±3.38
	Na_2SO_4	41.54 ± 2.21	7.98	47.00 ±4.29
	NaCl	36.50 ± 2.48	6.33	41.30 ±4.90
$CHCl_3$	No Salt	56.41 ± 2.84	15.49	63.25 ±3.62
	Na_2SO_4	60.36 ± 2.04	18.84	67.68 ±2.39
	NaCl	58.98 ± 2.11	17.57	66.13 ±2.57
$C_2H_3Cl_3$	No Salt	65.55 ± 1.03	25.95	74.25 ±2.23
	Na_2SO_4	70.27 ± 1.67	35.10	79.59 ±5.56
	NaCl	68.14 ± 1.00	30.44	77.18 ±1.10
CCl_4	No Salt	6.47 ± 0.24	28.02	75.69 ±4.32
	Na_2SO_4	6.60 ± 0.24	30.54	77.24 ±2.66
	NaCl	6.55 ± 0.26	29.44	76.59 ±2.82
$C_3H_6Cl_2$	No Salt	67.19 ± 0.98	28.66	76.10 ±1.74
	Na_2SO_4	73.93 ± 4.24	46.49	83.74 ±4.12
	Na Cl	71.66 ± 1.96	38.80	81.17 ±1.97

Triplicate analyses

Note *K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard compound in the standard solution used in this study.

(3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.55 and 9.81 ppm, respectively.

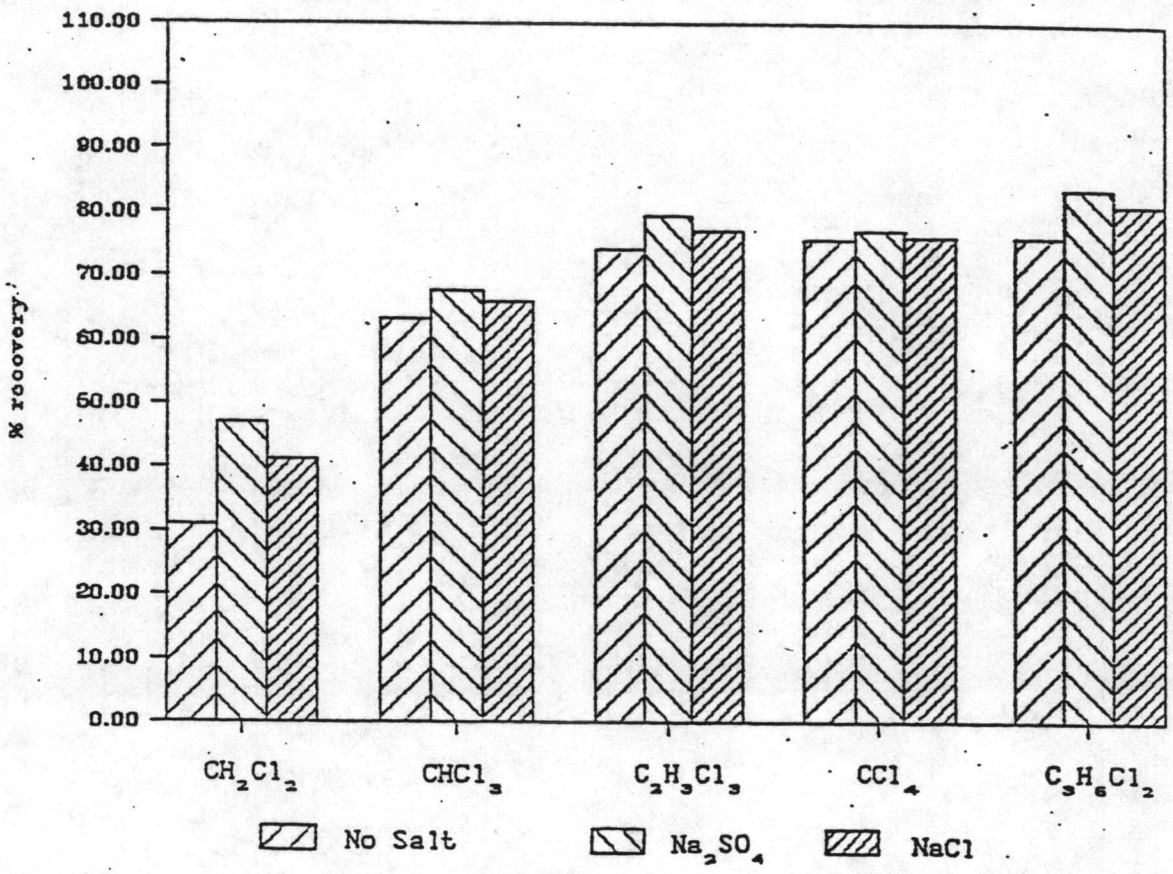

Figure 3.40 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 9:1 .

Table 3.47 The results of 9:1 extraction of halogenated alkanes[4] with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	2.94 ±0.28	4.50	33.33 ±4.10
	Na_2SO_4	4.51 ±0.21	9.48	51.29 ±4.42
	NaCl	4.04 ±0.17	7.61	45.82 ±3.04
$CHCl_3$	No Salt	4.66 ±0.13	7.88	52.33 ±2.12
	Na_2SO_4	6.03 ±0.20	18.89	67.73 ±5.64
	NaCl	5.66 ±0.10	15.71	63.58 ±1.28
$C_2H_3Cl_3$	No Salt	6.57 ±0.26	26.31	74.51 ±2.82
	Na_2SO_4	7.69 ±0.60	61.26	87.19 ±5.51
	NaCl	7.00 ±0.38	34.25	79.32 ±3.87
CCl_4	No Salt	0.65 ±0.01	37.25	80.54 ±0.74
	Na_2SO_4	0.69 ±0.03	52.98	85.48 ±2.51
	NaCl	0.69 ±0.03	50.25	84.81 ±2.86
$C_3H_6Cl_2$	No Salt	7.31 ±1.21	43.54	82.87 ±2.00
	Na_2SO_4	7.55 ±1.18	53.54	85.61 ±7.54
	Na Cl	7.36 ±0.29	45.38	83.45 ±3.40

Triplicate analyses

Note (4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98 ,0.09 and 0.98 ppm, respectively.

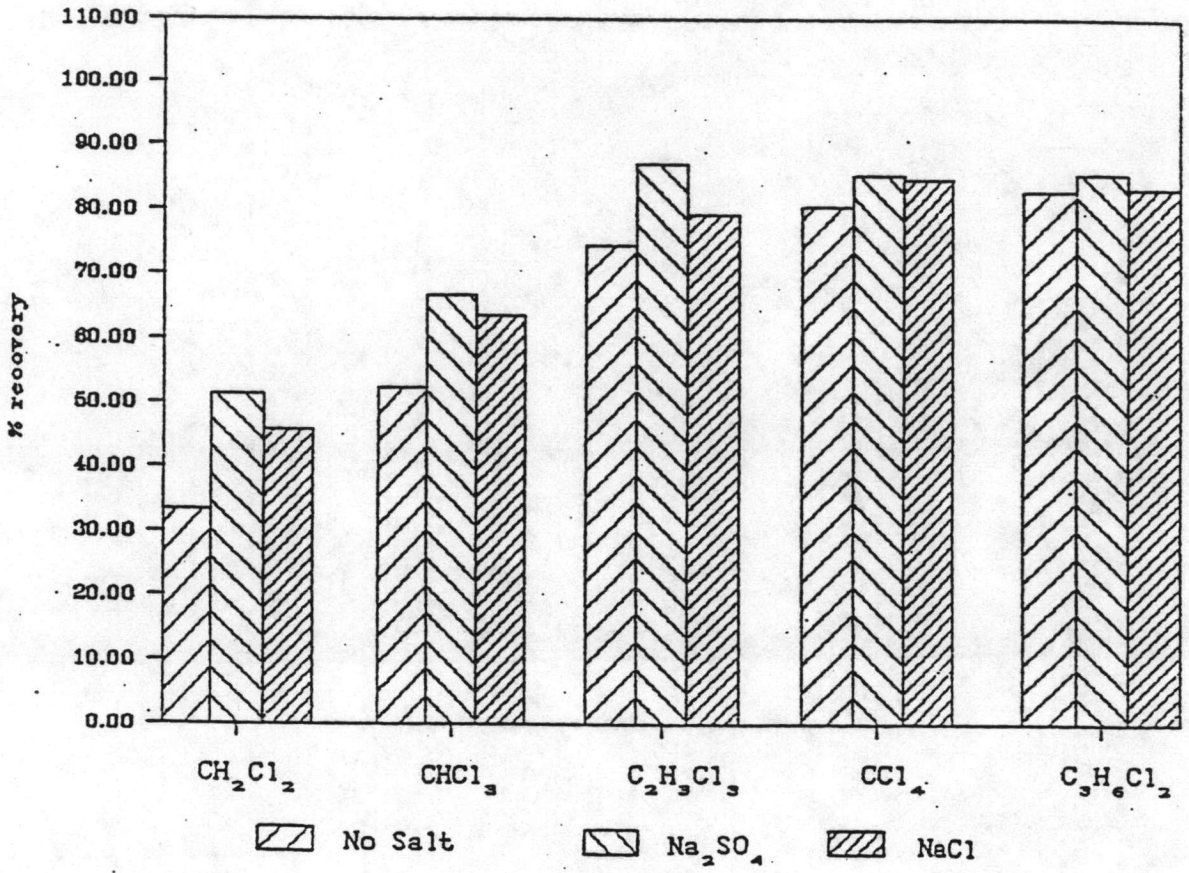

Figure 3.41 The effect of salting-out on % recoveries of halogenated alkanes i.e.,0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 9:1

Table 3.48 The results of 5:5 extraction of halogenated alkanes (3) with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	5.83 ±0.25	1.45	59.20 ± 4.56
	Na_2SO_4	6.45 ±0.84	1.87	65.11 ±10.76
	NaCl	6.30 ±0.44	1.79	64.17 ± 6.65
$CHCl_3$	No Salt	9.22 ±0.28	13.31	93.01 ± 6.65
	Na_2SO_4	9.38 ±0.78	17.62	94.63 ± 6.02
	NaCl	9.37 ±0.62	17.48	94.59 ± 6.73
$C_2H_3Cl_3$	No Salt	10.10 ±0.12	*	102.95 ± 1.65
	Na_2SO_4	9.79 ±0.06	62.40	99.83 ± 0.58
	NaCl	9.92 ±0.31	*	101.18 ± 1.94
CCl_4	No Salt	0.94 ±0.01	90.74	98.70 ± 5.08
	Na_2SO_4	0.95 ±0.02	332.33	99.70 ± 1.37
	NaCl	0.94 ±0.02	19.31	99.48 ± 2.72
$C_3H_6Cl_2$	No Salt	8.75 ±0.93	8.26	89.20 ±10.20
	Na_2SO_4	9.29 ±1.16	17.90	94.71 ± 8.16
	Na Cl	8.76 ±0.80	8.35	89.30 ± 2.76

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane ,carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

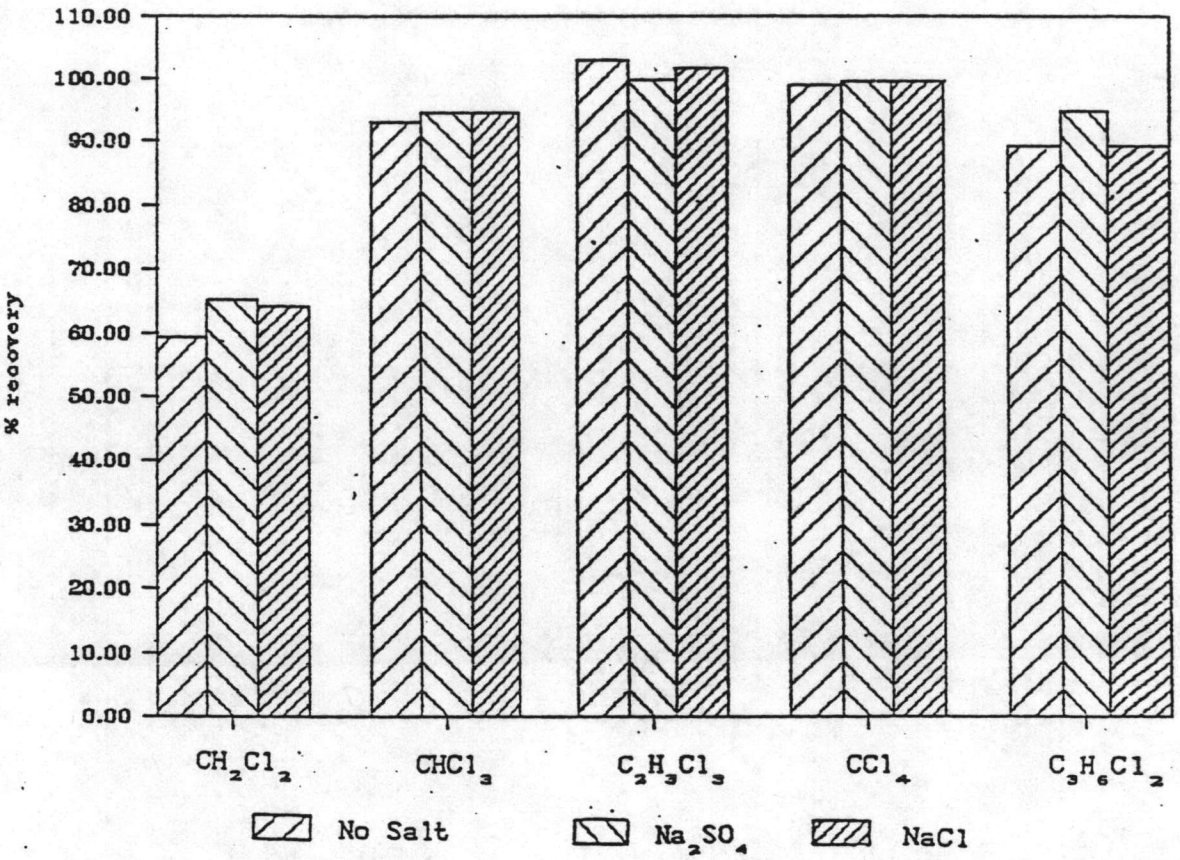

Figure 3.42 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 5:5 .

Table 3.49 The results of 5:5 extraction of halogenated alkanes (4) with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.43 ±0.05	0.79	44.14 ±5.03
	Na_2SO_4	0.59 ±0.19	1.49	59.91 ±9.33
	NaCl	0.47 ±0.04	0.93	48.23 ±5.93
$CHCl_3$	No Salt	0.96 ±0.05	24.58	96.94 ±3.82
	Na_2SO_4	0.95 ±0.02	39.82	96.35 ±1.54
	NaCl	0.99 ±2.86	157.73	99.67 ±2.02
$C_2H_3Cl_3$	No Salt	0.94 ±0.03	20.83	95.42 ±2.28
	Na_2SO_4	0.94 ±0.03	17.28	94.54 ±2.05
	NaCl	0.95 ±0.01	24.00	96.00 ±0.71
CCl_4	No Salt	0.09 ±0.00	*	103.34 ±2.05
	Na_2SO_4	0.09 ±0.00	*	102.04 ±2.07
	NaCl	0.09 ±0.00	*	104.72 ±0.49
$C_3H_6Cl_2$	No Salt	0.83 ±0.05	5.71	85.11 ±5.94
	Na_2SO_4	0.86 ±0.01	7.11	87.67 ±0.34
	Na Cl	0.82 ±0.03	5.13	83.68 ±2.39

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

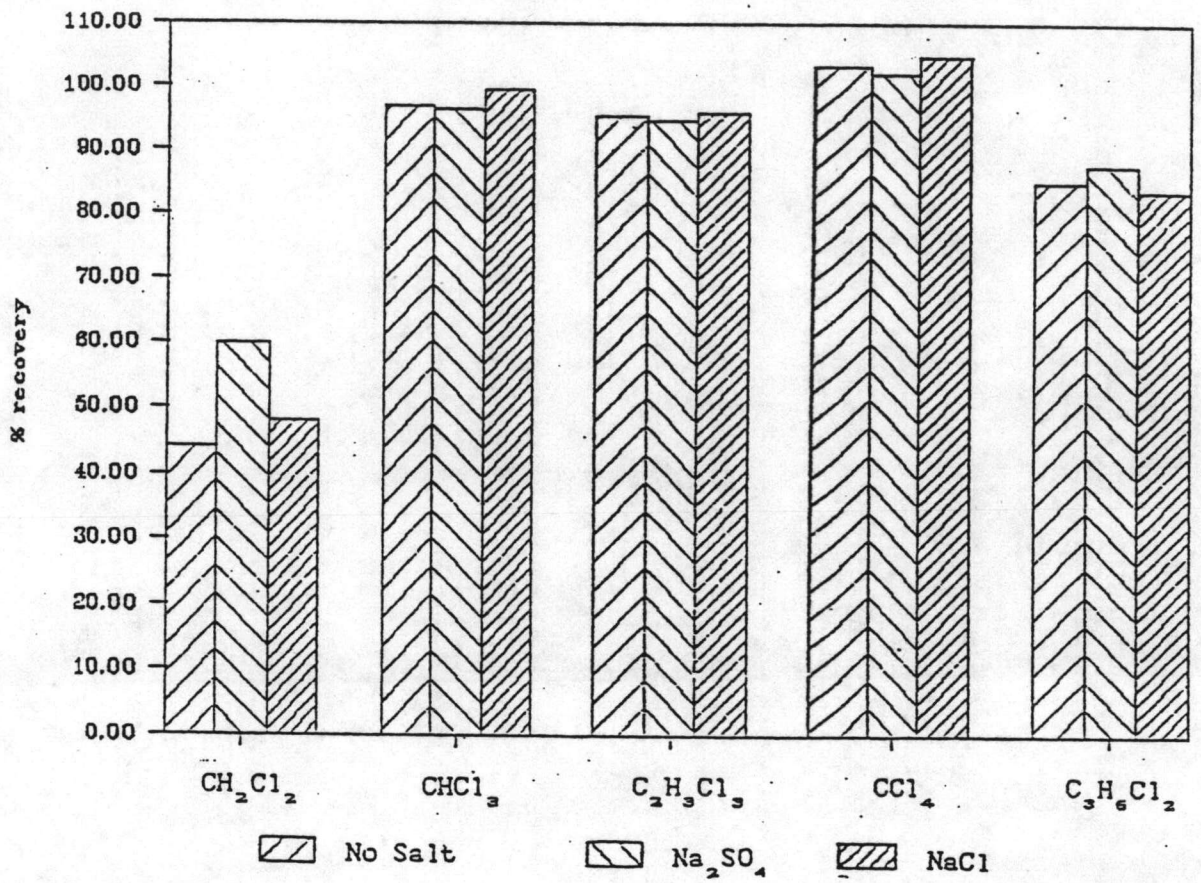

Figure 3.43 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 5:5 .

Table 3.50 The results of 2:8 extraction of halogenated alkanes (3) with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	1.77 ±0.18	0.65	72.24 ±7.28
	Na_2SO_4	2.10 ±0.21	1.51	85.78 ±7.05
	NaCl	2.06 ±0.14	1.32	84.10 ±5.39
$CHCl_3$	No Salt	2.22 ±0.14	2.21	89.82 ±6.51
	Na_2SO_4	2.28 ±0.01	2.88	92.01 ±0.48
	NaCl	2.33 ±0.06	3.88	93.95 ±2.80
$C_2H_3Cl_3$	No Salt	2.24 ±0.16	2.63	91.31 ±7.60
	Na_2SO_4	2.33 ±0.11	4.70	94.95 ±5.09
	NaCl	2.30 ±0.16	3.87	93.94 ±5.10
CCl_4	No Salt	0.22 ±0.01	4.56	94.80 ±0.90
	Na_2SO_4	0.22 ±0.02	3.55	93.42 ±5.06
	NaCl	0.22 ±0.01	3.79	93.82 ±1.91
$C_3H_6Cl_2$	No Salt	2.24 ±0.31	2.63	91.32 ±10.26
	Na_2SO_4	2.39 ±0.39	10.39	97.65 ±5.26
	Na Cl	2.41 ±0.26	15.47	98.41 ±8.88

Triplicate analyses

Note (3) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane solutions were 9.82, 9.91, 9.81, 0.95 and 9.81 ppm, respectively.

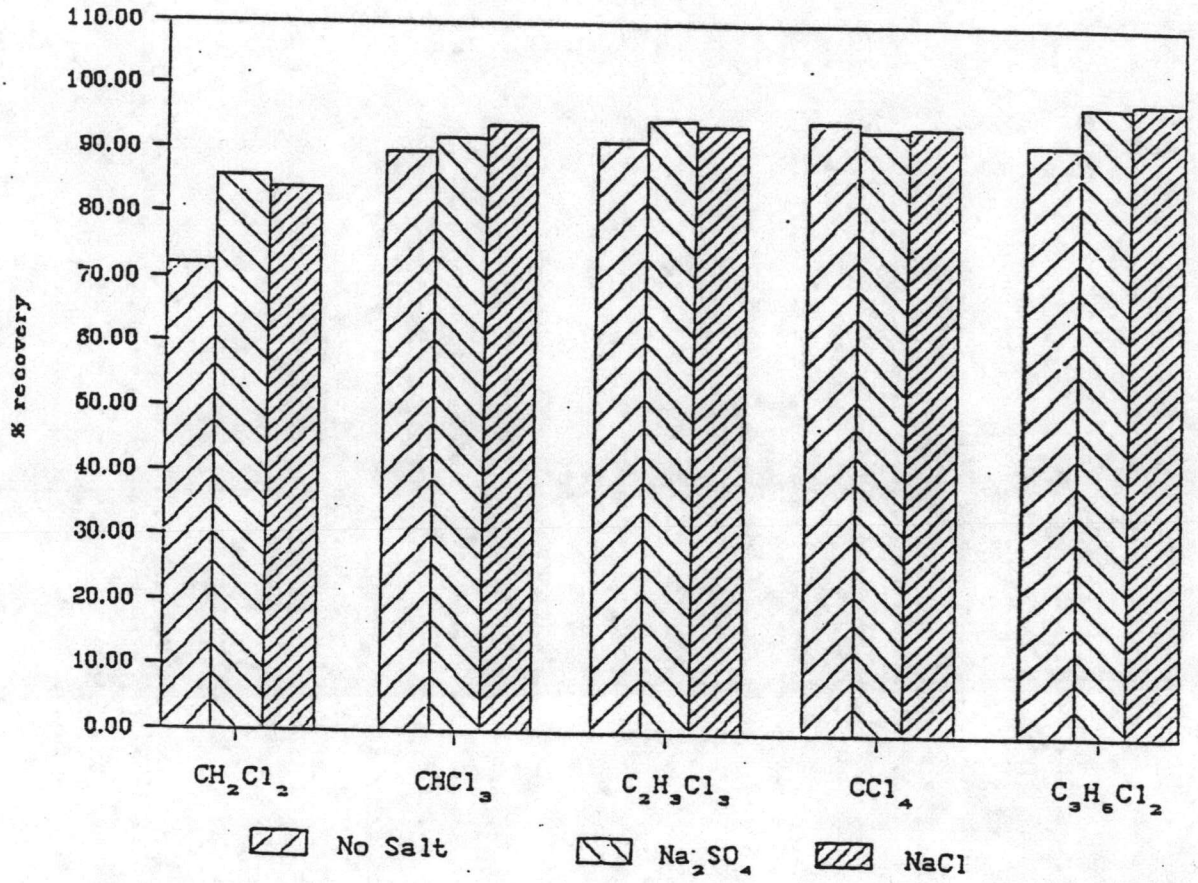

Figure 3.44 The effect of salting-out on % recoveries of halogenated alkanes i.e., 9.82 ppm of methylene chloride, 9.91 ppm of chloroform, 9.81 ppm of 1,1,1-trichloroethane, 0.95 ppm of carbontetrachloride and 9.81 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 2:8 .

(4)

Table 3.51 The results of 2:8 extraction of halogenated alkanes with isooctane in mixture solutions.

Halogenated alkanes	Type of extraction	Concentration (ppm)	K_d	%E ± %RSD
CH_2Cl_2	No Salt	0.20 ±0.01	1.09	81.37 ±4.80
	Na_2SO_4	0.22 ±0.01	2.09	89.31 ±2.45
	NaCl	0.21 ±0.02	1.34	84.24 ±7.52
$CHCl_3$	No Salt	0.25 ±0.01	227.02	99.89 ±1.84
	Na_2SO_4	0.25 ±0.01	*	101.00 ±1.68
	NaCl	0.26 ±0.01	*	103.67 ±3.09
$C_2H_3Cl_3$	No Salt	0.23 ±0.01	4.14	94.30 ±2.65
	Na_2SO_4	0.23 ±0.01	6.47	96.28 ±5.32
	NaCl	0.23 ±0.00	4.64	94.89 ±1.05
CCl_4	No Salt	0.02 ±0.00	*	102.90 ±2.34
	Na_2SO_4	0.02 ±0.00	*	106.11 ±3.03
	NaCl	0.02 ±0.00	*	103.08 ±3.92
$C_3H_6Cl_2$	No Salt	0.25 ±0.04	*	101.63 ±10.67
	Na_2SO_4	0.26 ±0.02	*	105.67 ±5.93
	Na Cl	0.26 ±0.02	*	104.93 ±7.93

Triplicate analyses

Note * K_d cannot be calculated due to the concentration of the component was higher than the initial concentration of the standard solution used in this study.

(4) The initial concentrations of methylene chloride, chloroform, 1,1,1-trichloroethane, carbontetrachloride and 1,2-dichloropropane were 0.98, 0.99, 0.98, 0.09 and 0.98 ppm, respectively.

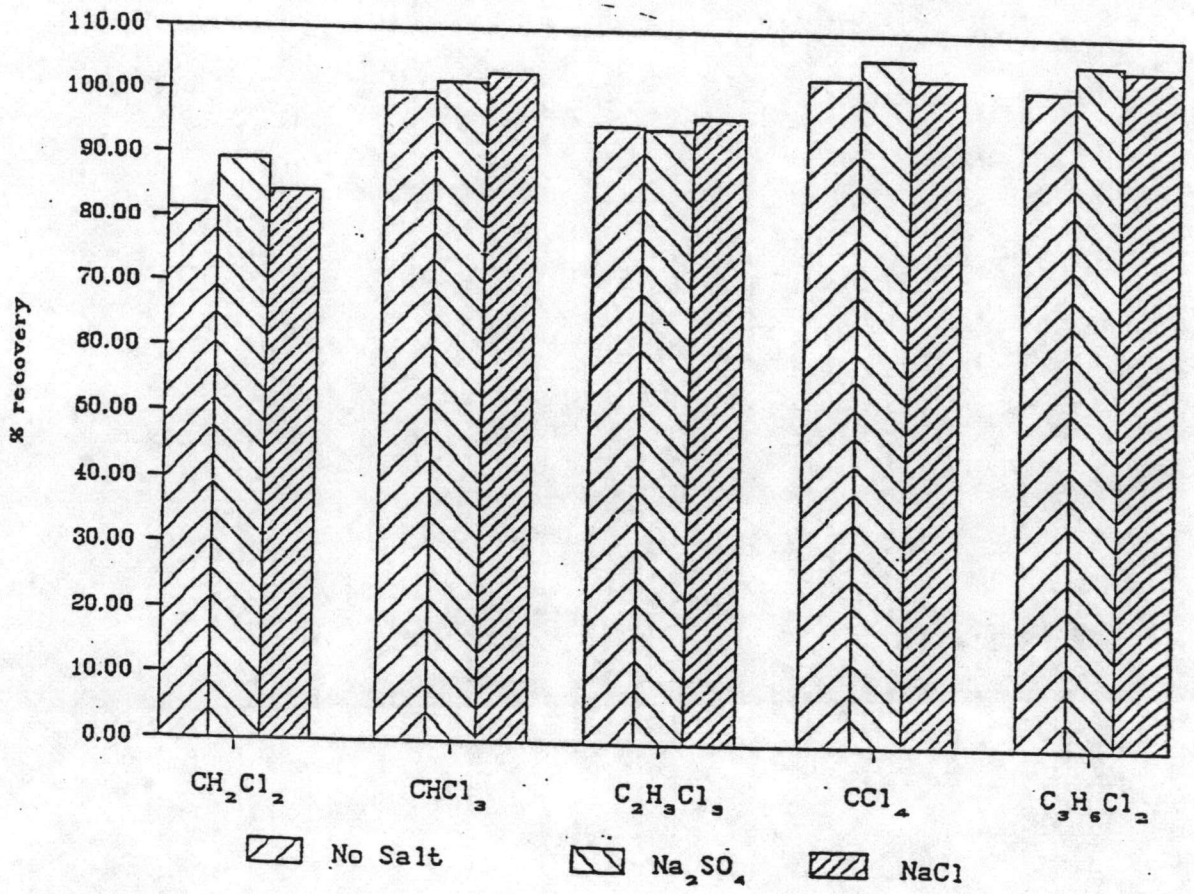

Figure 3.45 The effect of salting-out on % recoveries of halogenated alkanes i.e., 0.98 ppm of methylene chloride, 0.99 ppm of chloroform, 0.98 ppm of 1,1,1-trichloroethane, 0.09 ppm of carbontetrachloride and 0.98 ppm of 1,2-dichloropropane in mixture solution for sample-to-isooctane ratio of 2:8 .

The percent recoveries of halogenated alkanes in single component solutions and in the mixture solutions in Table 3.16-3.51 show that the percent recoveries of the halogenated alkanes of the single component solutions for the sample-to-solvent ratios of 9:1, 5:5 and 2:8 which are in the range of 31.31-101.46%, 63.21-106.04% and 67.28-107.99%, respectively, are not much different from the % recoveries of the halogenated alkanes of the mixture solutions for the sample-to-solvent ratios of 9:1, 5:5 and 2:8 which are in the range of 31.05-101.46 %, 44.14-104.72 % and 72.24-106.11 %, respectively. This means that for the range of concentrations studied, the percent recovery of an individual halogenated alkane is not affected by the presence of other halogenated alkanes in the solution.

3.4 Minimum Detectable Level (MDL)

The minimum detectable level is defined as the smallest amount of solute required to produce a signal that is twice the noise level.(52)

The minumum detectable level of each halogenated alkane in each extracting solvent is shown in Table 3.52. It is found that the MDL of the halogenated alkanes is lowest in isooctane with the range of 0.01-100.00 ppb.

Table 3.52 The minumum detectable level (MDL) of halogenated alkanes in various solvents.

Halogenated alkanes	Minumum Detectable Level (MDL)(ppb)		
	Hexane	Cyclohexane	Isooctane
CH_2Cl_2	35.00	35.00	30.00
$CHCl_3$	4.00	4.00	1.00
$C_2H_3Cl_3$	4.00	4.00	1.00
CCl_4	0.05	0.05	0.01
$C_3H_6Cl_2$	150.00	150.00	100.00

3.5 The Determination of Halogenated Alkanes in Synthetic Unknown Mixture

The halogenated alkanes in the synthetic unknown mixture was determined by microextraction technique, as the procedure in section 2.5.2. The suitable combination used in the analysis of halogenated alkanes is 9:1 ratio, 2.00g sodium sulfate and isooctane and the organic extract obtained from the microextraction was studied by GC/ECD.

The results obtained from the study are shown in Table 3.53. The percent error in the determination of halogenated alkanes in the synthetic unknown mixture is in the range of 1.68-5.46%. The peak of 1,2-dichloropropane is broad ,illustrated in Fig. 2.3 , and the minimum detectable level is high as shown in Table 3.52 ,thus, the peak area obtained from the intregration would be inconsistency. This is the reason that the percent error in the determination of 1,2-dichloropropane is higher than those of the other compounds.

Table 3.53 The concentration of halogenated alkanes in synthetic unknown mixture

Halogenated alkane	Concentration in water (ppb)	Concentration founded (ppb)	% Error
CH_2Cl_2	120.28	122.30	1.68
$CHCl_3$	44.82	43.46	3.03
$C_2H_3Cl_3$	60.70	59.10	2.64
CCl_4	12.04	11.92	1.00
$C_3H_6Cl_2$	338.84	320.32	5.46

3.6 The Determination of Halogenated Alkanes in Water Sample.

The water samples from 5 locations of water reservior in the canal used for water supplies and from 5 locations of tap water were collected and were analyzed by the microextraction technique as the procedure used in analysis of halogenated alkanes in the synthetic unknown mixture. The chromatograms of the unknown compounds are shown in Figure 3.46-3.55. The retention times of the unknown peaks were compared to the retention times of the known mixture of halogenated alkanes which is shown in figure 2.3 and it is found that the halogenated alkanes in the water reservoir seem to be a chloroform and a carbontetrachloride and the halogenated compounds in tap water seem to be a chloroform and other compounds which were not interested. Then, the concentrations of the identified halogenated alkanes are determined by internal standardization method and the results are shown in Table 3.54. It is found that the concentration of chloroform in tap water samples is in the range of

102.48-129.83 ppb and the concentrations of chloroform and carbontetrachloride in reservoir water samples are in the ranges of 12.06-25.72 ppb and 1.57-3.76 ppb, respectively.

Table 3.54 The concentration of halogenated alkanes in water samples.

Source of water	Concentration (ppb)				
	methylene chloride	chloroform	1,1,1-trichloro ethane	carbontetra chloride	1,2-dichloro propane
Tap water 1	-	127.83	-	-	-
2	-	129.87	-	-	-
3	-	113.76	-	-	-
4	-	102.48	-	-	-
5	-	129.31	-	-	-
Reservoir 1	-	14.77	-	-	-
2	-	12.38	-	1.57	-
3	-	25.72	-	2.30	-
4	-	12.06	-	3.76	-
5	-	20.81	-	1.87	-

Note Tap water 1. The water sample was collected from a house on Rama V Road, Dusit ,Bangkok. (October 10th 1987, 7:00 a.m.)

2. The water sample collected from drinking water for public opposite to the Water Supplies Plant on Rama VI Road ,Samsaen, Bangkok. (October 10th 1987, 7:15 a.m.)

3. The water sample was collected from the faucet outside the Biology 2 Building ,Faculty of Science , Chulalongkorn University. (October 10th 1987, 8:45 a.m.)

4. The water sample collected from the house opposite to the Sowabha Institute on Rama IV Road, Bangruk, Bangkok. (October 10th 1987, 17th 1987, 8:25 a.m.)

5. The water sample was collected from the faucet outside the Chemistry Building 3, Faculty of Science ,Chulalongkorn University. (October 10th 1987, 6:00 p.m.)

Reservoir Water

1. The water sample was collected from the canal on Rama VI Road, Samsaen ,Bangkok. (October 10th 1987, 7:25 a.m.)

2. The water sample was collected from the canal near Bangsue Bridge ,Bang sue ,Bangkok. (October 10th 1987, 7:45 a.m.)

3. The water sample was collected from the canal in front of Vimon Commerce School, on Prachachoen Road, Prachachoen, Bangkok. (October 10th 1987, 8:00 a.m.)

4. The water sample was collected from the canal in front of the Bangkaen Water Supplies Plant, Bangkaen, Bangkok. (October 10th 1987, 8:25 a.m.)

5. The water sample collected from the canal opposite to the Samsaen School on Rama VI Road, Samsaen, Bangkok. (October 10th 1987, 7:10 a.m.)

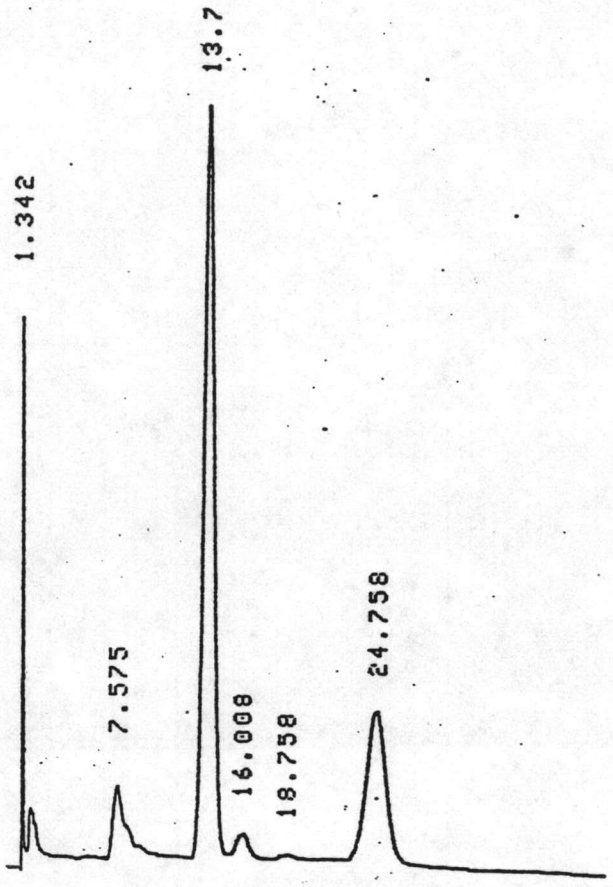

Figure 3.46 The Ni^{63} ECD gas chromatogram of the extract from tap water sample 1 and 577.43 ppb of 1,2-dichloroethane (internal standard) using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120 °C ;injection port temperture 200 °C; detector temperature 200 °C and N_2 flowrate 30 mL/min.

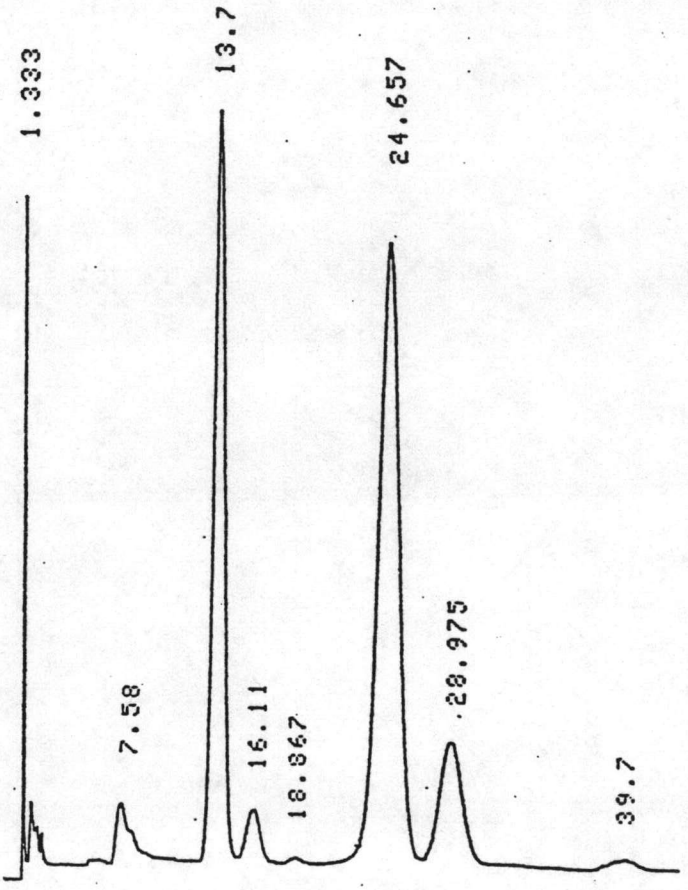

Figure 3.47 The Ni^{63} ECD gas chromatogram of the extract from tap water sample 2 and 1154.85 ppb of 1,2-dichloroethane (internal standard) using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port temperture 200°C ; detector temperature 200°C and N_2 flowrate 30 mL/min.

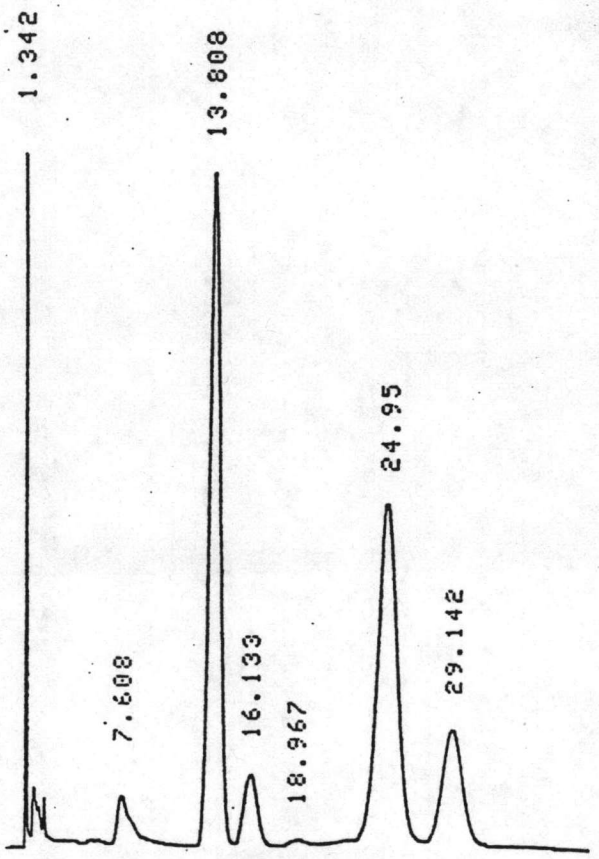

Figure 3.48 The Ni^{63} ECD gas chromatogram of the extract from tap water sample 3 and 1154.85 ppb of 1,2-dichloroethane (internal standard) using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120 °C ;injection port temperature 200 °C ; detector temperature 200 °C and N_2 flowrate 30 mL/min.

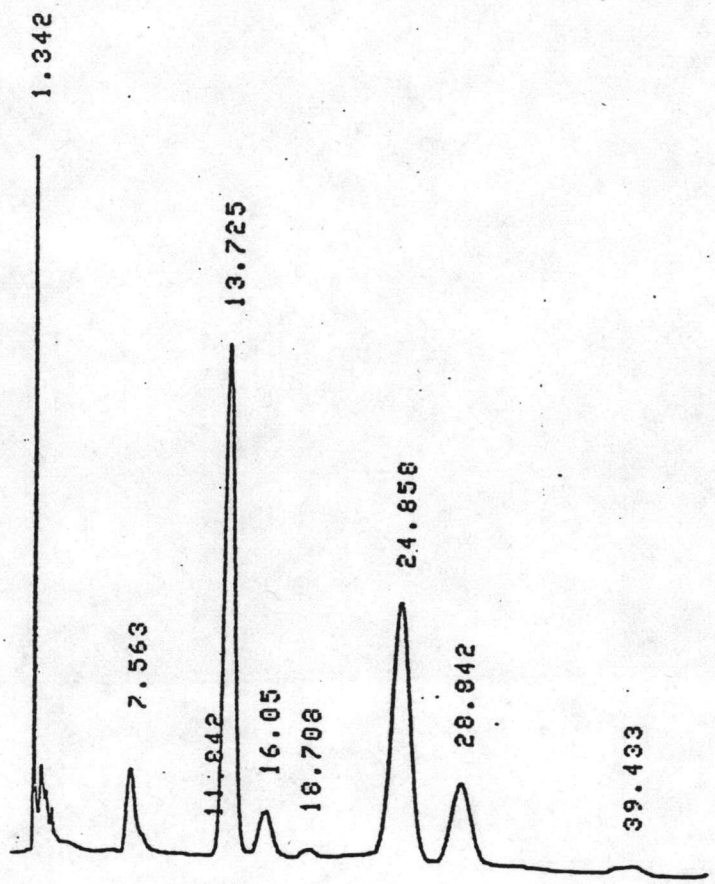

Figure 3.49 The Ni^{63} ECD gas chromatogram of the extract from tap water sample 4 and 1154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120 °C ;injection port temperature 200 °C ; detector temperature 200 °C and N_2 flowrate 30 mL/min.

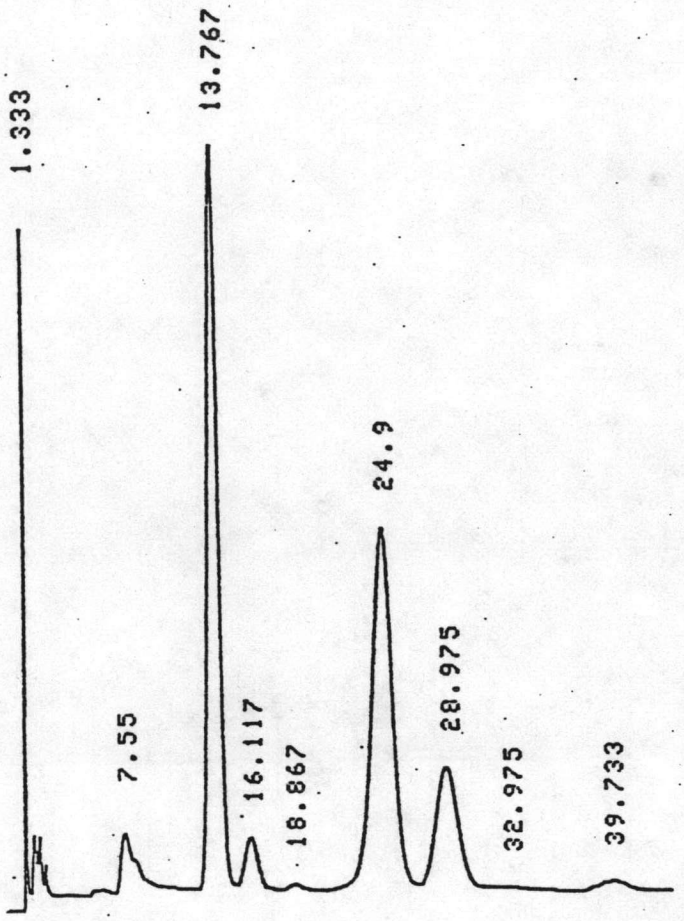

Figure 3.50 The Ni^{63} ECD gas chromatogram of the extract from tap water sample 5 and 1.154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120 °C ;injection port temperature 200 °C; detector temperature 200 °C and N_2 flowrate 30 mL/min.

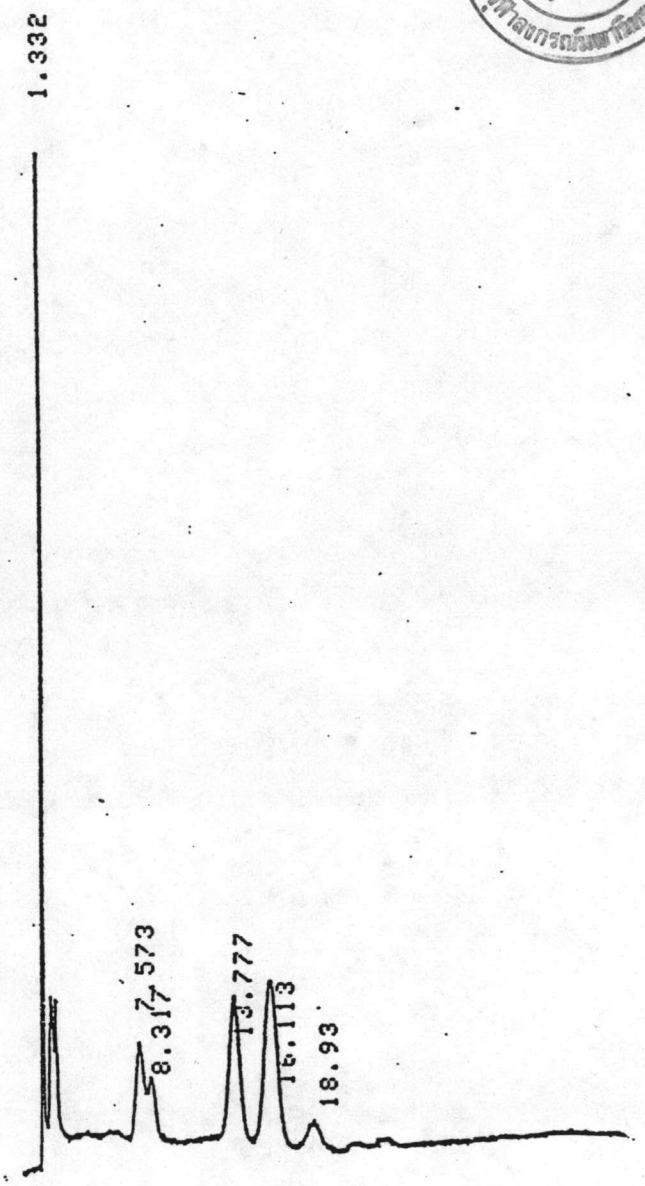

Figure 3.51 The Ni^{63} ECD gas chromatogram of the extract from reservoir water sample 1 and 1154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port temperature 200°C ; detector temperature 200°C and N_2 flowrate 30 mL/min.

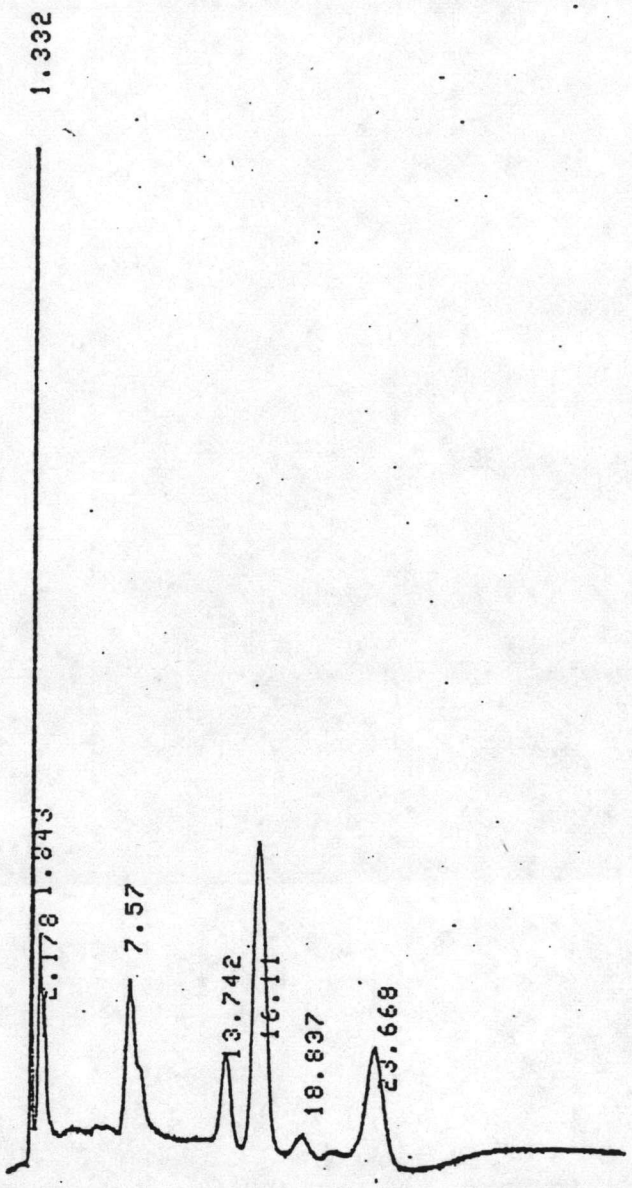

Figure 3.52 The Ni^{63} ECD gas chromatogram of the extract from reservoir water sample 2 and 2309.70 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port temperature 200°C; detector temperature 200°C and N_2 flowrate 30 mL/min.

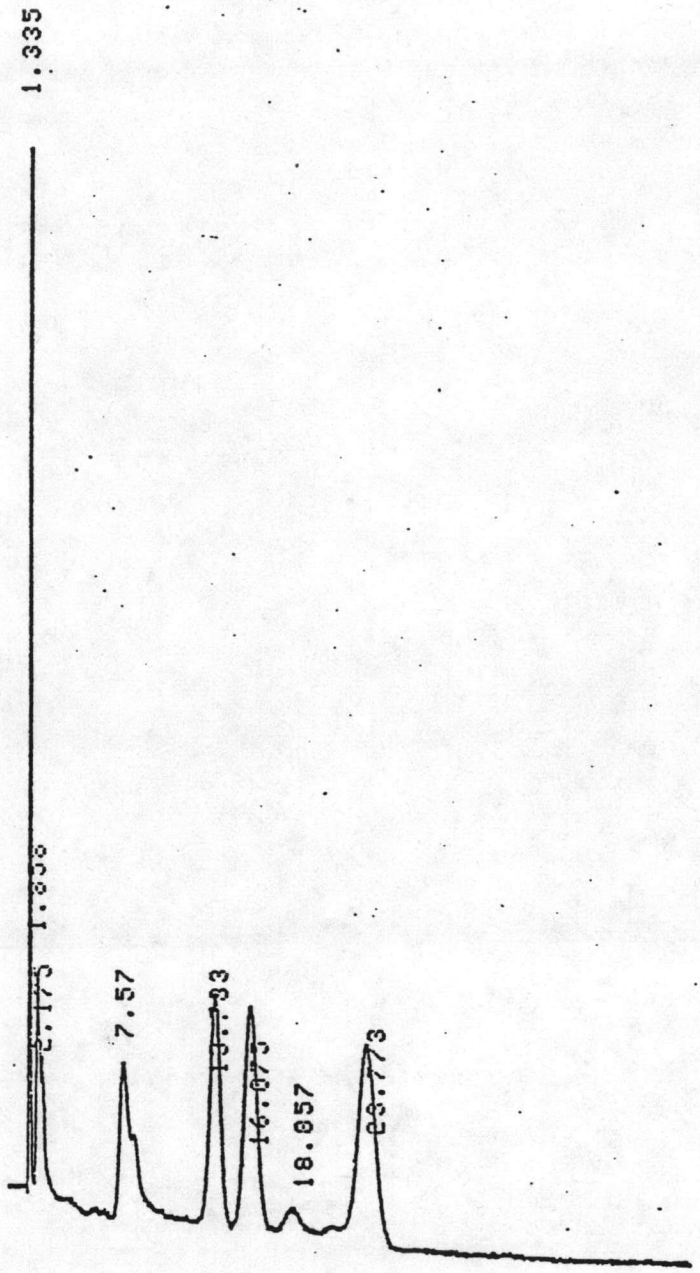

Figure 3.53 The Ni^{63} ECD gas chromatogram of the extract from reservoir water sample 3 and 1154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port temperature 200°C ; detector temperature 200°C and N_2 flowrate 30 mL/min.

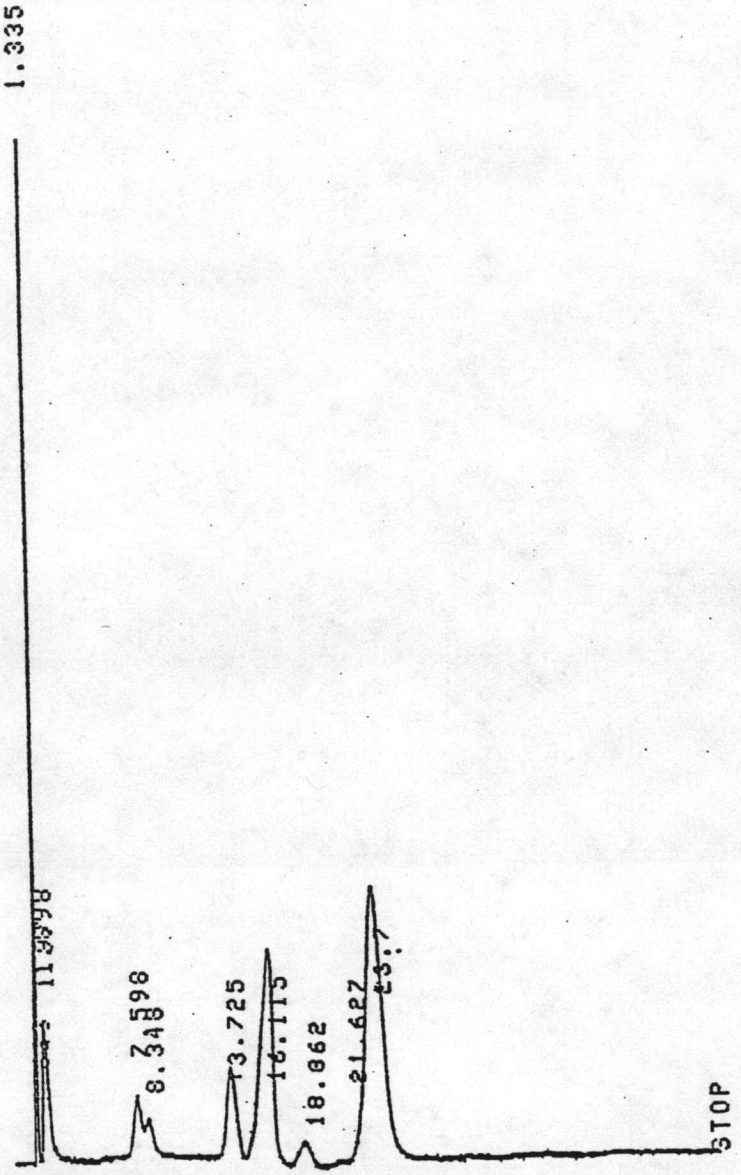

Figure 3.54 The Ni^{63} ECD gas chromatogram of the extract from reservoir water sample 4 and 1154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port 200°C ; detector temperature 200°C and N_2 flowrate 30 mL/min.

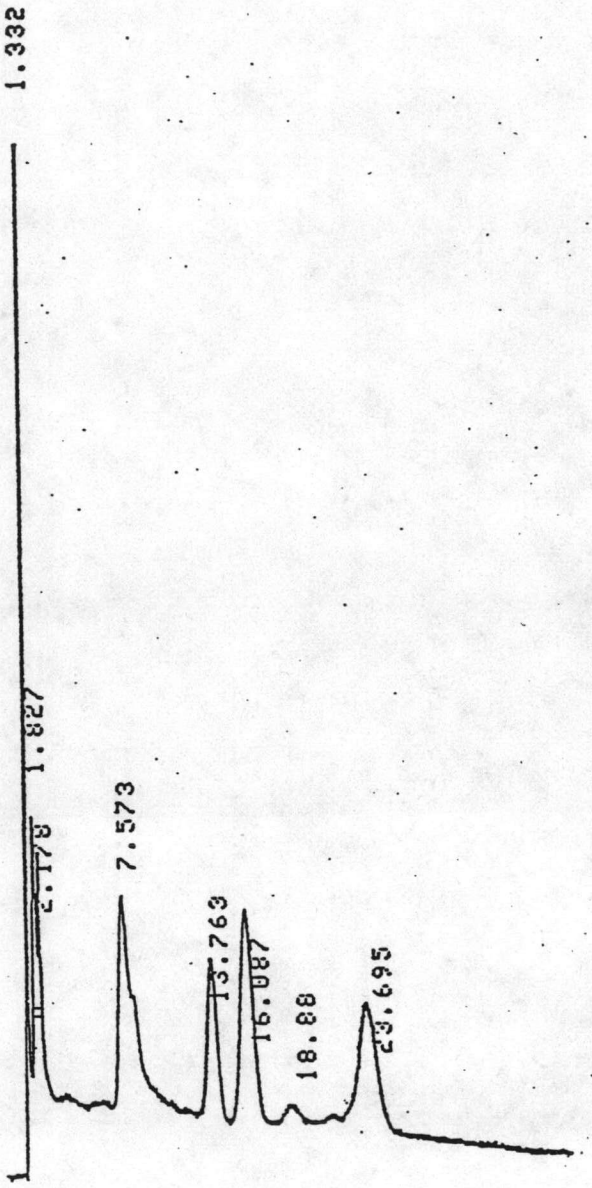

Figure 3.55 The Ni^{63} ECD gas chromatogram of the extract from reservoir water sample 5 and 1154.85 ppb of 1,2-dichloroethane (internal standard) ,using 6'x 3/8" O.D. glass column with 1% AT1000 on Graphpac GB 60/80 mesh ; oven temperature 120°C ;injection port temperature 200°C ; detector temperature 200°C and N_2 flowrate 30 mL/min.