PNNL-11123
UC-810
Project Technical Information

Equilibrium Data for Cesium Ion Exchange of Hanford CC and NCAW Tank Waste

L. A. Bray
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April 1996

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest National Laboratory
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SUMMARY

At the request of Westinghouse Hanford Co. (WHC), the Pacific Northwest Laboratory (PNL) has studied several ion exchange materials for the recovery of cesium from Hanford waste tanks. The WHC program was divided into two main tasks, 1) to obtain equilibrium data for cesium ion exchange, and 2) to evaluate ion exchange column performance. The subject of this letter report is the measurement of batch distribution coefficients for several ion exchange media for a range of operating conditions for two types of waste; complexant concentrate (CC) and neutralized current acid waste (NCAW).

Equilibrium data was obtained for the ion exchange materials IONSIV IE-96 (a zeolite produced by UOP), CS-100 (an organic resin produced by Rohm and Haas) and SRL-DJ (a new resorcinol-formaldehyde organic resin produced by Boulder Scientific). Five hundred (500) cesium batch distribution coefficients (Cs K_d) were obtained at temperatures of 10°C, 25°C and 40°C using simulated NCAW and CC wastes. Results obtained for the SRL-DJ exchanger were inconsistent with previous PNL results with material sent from the Savannah River Laboratory (SRL). Dr. Jane Bibler (SRL) provided new material from a 50 lb lot that was prepared by Boulder Scientific (BIB-DJ). Excellent results were obtained using the BIB-DJ resin. The following conclusions were developed after completion of the batch distribution study:

- The cesium ion exchange capacity of IE-96 and CS-100 doubles as the temperature is varied from 40°C to 10°C. The temperature effect was not as pronounced for the BIB-DJ resin.
- The initial volume of feed that can be processed using IE-96 increases ≈ 50% with a 3X feed dilution (6$\underline{M}$ Na^+ diluted to 2$\underline{M}$ Na^+). The initial feed volume with the BIB-DJ resin decreases by ≈10% with a 3X feed dilution, and >30% with CS-100.
- The λ values ($\lambda = Cs\ K_d \times \rho_b$) for cesium ion exchange at 5$\underline{M}$ Na^+ for NCAW and CC waste were similar; 45-57, 65-80 and 240 for CS-100, IE-96, and BIB-DJ, respectively, at an equilibrium Na/Cs mole ratio of 10^4, at 10°C. From these results, it is postulated that basic ion exchange data can be applied to a broad range of tank waste types.

- Potassium (K^+) was found to exert an effect on λ, over a Na/K range of 11 to 200. An increasing amount of K was found to decrease the cesium λ as the K^+ competes with the cesium for ion exchange sites.

- Rubidium was found to have a negligible effect on λ over a Na/Rb range of 1.15E4 - 4.6E4 (Cs/Rb = 0.2 to 92). While rubidium can be expected to compete with the cesium for ion exchange sites, the Cs/Rb ratios tested were not small enough to be significant.

CONTENTS

FIGURES

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1.0 INTRODUCTION

Hanford alkaline waste storage-tank contents will be processed to remove the alkaline solutions followed by salt cake and sludge washing to dissolve the soluble salts. A major fraction of these solutions will require cesium (^{137}Cs) recovery to produce a Class A LLW waste. The technology for decontamination of high-level alkaline wastes and sludge wash waters is being developed at Hanford (WHC), at the Westinghouse Savannah River Co. (WSRC), Aiken SC, and at the West Valley Nuclear Services Co., Inc. (WVNS) in West Valley, NY. (See 5.0 REFERENCE Section). Using this technology as a starting point, experimental studies are being conducted to examine the performance of these ion exchange processes using simulated and actual Hanford wastes.

2.0 OBJECTIVES

The objective of the overall Westinghouse Hanford Co. (WHC) program is, 1) to evaluate ion exchangers for the recovery of cesium from alkaline wastes, 2) to determine ion exchange column loading and elution characteristics, 3) to determine the physical life cycle (including radiation and chemical stability) for selected ion exchangers, 4) to determine if basic ion exchange data can be applied to a broad range of tank waste compositions, and 5) to provide credible laboratory data for engineering-scale evaluation and ion exchange media selection. The overall goal is to provide the technology to produce a Class A waste. The program has been divided into two main tasks, 1) to determine batch distribution data, and 2) to evaluate ion exchange column performance and to obtain engineering data. This report summarizes the results for the measurement of batch distribution coefficient values for three ion exchange media under a range of conditions.

3.0 EXPERIMENTAL

Planned FY 1992 experimental work for cesium recovery included the determination of batch distribution coefficients and ion exchange column studies. Ion exchange processes to be investigated may apply over a wide range of tank waste compositions. Complexant Concentrate (CC) and Neutralized Current Acid Waste (NCAW) were selected for the initial investigation. Complexant Concentrate represents a high sodium waste containing organic complexants (complexants selected represent those assumed to be added to the initial tank contents). NCAW represents a high sodium waste containing a low organic content. Because of the limited availability of actual waste, simulated solutions were used to perform the parametric studies. Actual wastes will only be used in future tests to obtain reference points and to verify that cesium ion exchange behavior for simulated and actual wastes are equivalent. Actual wastes may be used after engineering-scale evaluation and ion exchange media selection has been completed.

3.1 ION EXCHANGE SELECTION

Rohm and Haas CS-100, a granular phenol-formaldehyde condensate polymer ion exchange resin with carboxylic acid functional groups, the Savannah River Laboratory resorcinol-formaldehyde (SRL-DJ) ion exchange resin, and the UOP Co. IONSIV IE-96 zeolite exchanger were selected by WHC for the initial investigation. Zeolite IE-96 was investigated as a once-through process and storage method. Cooperation and coordination between Hanford and the Savannah River Laboratory was obtained during the testing and verification of the SRL/BIB-DJ resin.

3.2 VARIABLES TO BE CONSIDERED TO OBTAIN BATCH DISTRIBUTION DATA

The effect of the following parameters on cesium batch distribution coefficients were measured during this study; 1) Na^+ concentration, 2) temperature, 3) Na to Cs mole ratio, 4) K^+ and Rb^+ concentration, and 5) dilution effects. The effect of varying the hydroxide concentration and the effect of time-dependent variables (superficial velocity or bed volumes per hour) will be studied in subsequent batch contact and ion exchange column studies.

3.3 EQUIPMENT DESCRIPTION

The equipment to obtain batch distribution data consists of a constant temperature shaker table, an analytical balance, and gamma counting equipment. The equipment and procedures are described in the latest revision of test procedure WTC-006-21, "Determination of Batch Sorption Ratios for Ion Exchange Materials Using Radionuclide Tracer Techniques", as part of the Hanford Waste Vitrification Program.

3.4 PREPARATION OF SYNTHETIC WASTES

Complexant Concentrate (CC) and Neutralized Current Acid Waste (NCAW) were selected for the initial investigation. CC wastes represents a high sodium waste containing organic complexants. NCAW represents a high sodium waste containing a low organic content. Simulated solutions were prepared as part of this study and used to initiate the parametric studies, APPENDIX A.

3.5 PREPARATION OF ION EXCHANGE MATERIALS

To effect an accurate and reproducible determination of the cesium distribution coefficient for various organic and inorganic exchangers, it is essential that a uniform basis be used for the mass and that accurate determinations of the mass be obtained. The most reproducible basis for the mass is that of a completely dry material (i.e., 85 - 105°C for 24 h). A dry material is also much easier to weigh because damp material tends to clump together. However, the exchange capacity of some ion exchange materials may be destroyed on drying. In that case, the material is used as is and a correction factor is applied using a separate dried sample.

The drying behavior of the organic ion exchange resin was investigated as follows. Samples of the two organic resins were converted to the sodium form by contact with sodium hydroxide and washed with water. These samples were then air dried for two hours and the sample was weighed at various times. The air drying was accomplished by using a vacuum to draw an air stream past the wet resin. A reasonable estimate of the amount of water in organic resins was determined by drying a sample in an oven at elevated temperatures (24 hrs @ 85°C).

The resulting data was used to produce the drying curve, shown in Figure 1, as density of the material versus the drying time. The dry basis was taken to be the mass of the material after drying in the oven at 85°C. Based on the curve, is was decided that air drying the material for an hour would provide a uniform basis (i.e. a point on the flat portion of the curve) for determination of the mass and that a sample of each material could be dried in an oven at 85°C so the anhydrous mass could be determined.

3.6 BATCH DISTRIBUTION RATIO MEASUREMENTS

The procedure to measure a batch distribution ratio or coefficient for ion exchange materials is found in a separate document[3]. This procedure describes a method to determine the batch distribution coefficient for specific radionuclides. For ion exchange research and testing, the batch distribution measurement methodology provides a rapid and cost-effective method of comparing a wide variety of ion exchange conditions for their selectivity of specific radionuclides.

A batch distribution ratio is a measure of the overall ability of the solid phase to remove an ion from solution. The data in this report are reported as radionuclide distribution coefficients (K_d) and/or λ. K_d has units of ml/g (volume of solution/mass of dry exchanger) and represents a theoretical volume of solution that can be processed per mass of exchanger. To convert to (λ), the K_d value can be multiplied by the bed density of the exchanger ρ_b to obtain a value which is equivalent to the volume of the solution per volume of exchanger. The formula for the determination of K_d is:

$$K_d = C_s \div C_l, \text{ mL/g; where,}$$

C_s - the concentration of the radionuclide exchanged on the solid phase (Ci or g of radionuclide/g of anhydrous material)

C_l - the concentration of the radionuclide remaining in the liquid phase after batch contact (Ci or g of radionuclide/mL).

The formula for the determination of λ is:

$$\lambda = K_d \times \rho_b\text{; where,}$$

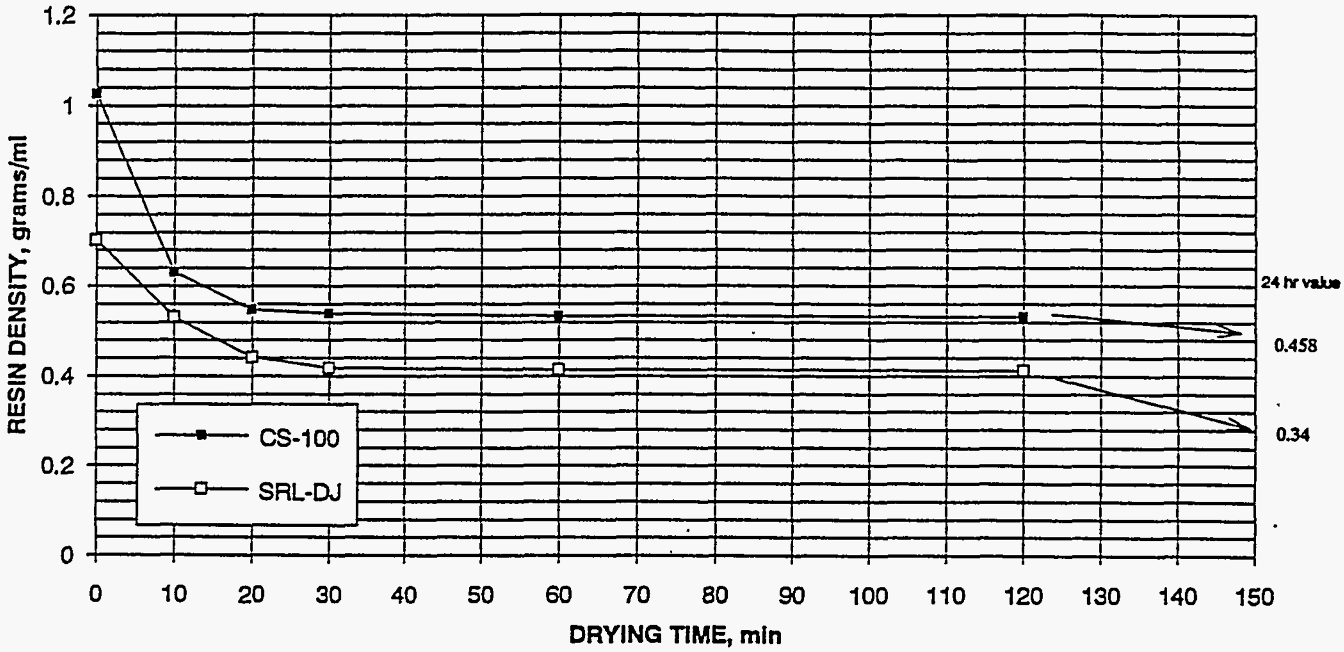

FIGURE 1. Ion Exchange Resin Drying

λ represents the number of exchanger bed volumes of feed that can be loaded on an exchanger (column volumes). This is an artificial number because it is difficult in practice to achieve 100% loading of a column. Under certain conditions λ is approximated by the bed volumes processed when 50% breakthrough is achieved during column loading.

A summary of the data collected during this study is found in Appendix B. As part of the summary, a reference λ (λ_{ref}) was determined for each λ and is defined as follows;

$$\lambda_{ref} = \lambda \frac{[Na,\ actual]}{[Na,\ reference]}$$

where:

$[Na^+$, actual] = the sodium concentration at the experimental conditions, and

$[Na^+$, reference] = the reference sodium concentration which was chosen as 5M Na^+ for this study.

A value of 5M Na^+ was chosen because it corresponds to the reference grout feed concentration. Since λ represents the number of exchanger bed volumes of feed that can be loaded on an exchanger, λ_{ref} represents the volume of grout feed that can be processed per volume of exchanger. In general the λ_{ref} is a function of the sodium concentration because of the influence of the total ionic concentration on the equilibrium behavior. For example dilution has a favorable impact on the cesium loading capacity of IE-96 in that more waste can be processed if it is first diluted. For example, λ_{ref} = 65 (NCA waste, [Na] = 1M , T = 25°C) and λ_{ref} = 44 (NCA waste, [Na] = 5 M, T = 25°C). This means more grout feed can be processed per volume of exchanger by processing feed diluted to [Na] = 1 M. Ion exchange column loading data and engineering analysis will be required to determine if there is an incentive for processing dilute feed instead of more concentrated feed.

4.0 RESULTS AND DISCUSSION

Laboratory studies were completed to determine the batch distribution coefficient values (K_d) for four ion exchangers: IONSIV IE-96 (UOP), CS-100 (Rohm and Haas), BIB-DJ and SRL-DJ (Boulder Scientific). Greater than five hundred (500) batch distribution values were obtained at temperatures of 10°C, 25°C and 40°C using simulated NCAW and CC wastes. Results obtained for the SRL-DJ exchanger did not equal previous results (Bray 1990b) with material (BIB-DJ) sent from the Savannah River Laboratory (SRL). Dr. Jane Bibler (SRL) provided new material for testing from a 50 lb lot that had been prepared by Boulder Scientific (BIB-DJ).

Stock solutions of NCAW and CC waste were prepared (Appendix A). Precipitates of iron oxide in the CC waste were dissolved with the addition of sodium gluconate to the feed composition. Sodium gluconate is the only known chelating agent effective for iron in the pH 14-free caustic region. This complexant may have been used in B-Plant to wash the cesium phosphotungstate precipitate free of iron and aluminum.

Cesium batch distribution coefficient results are summarized in Appendix B, pp. B-3 through B-8. The raw data results are reported in Appendix B, pp. B-10 through B-41. The resorcinol-formaledhyde batch distribution tests were run with material purchased directly from Boulder Scientific Co., Boulder, CO (SRL-DJ), and with material sent from SRL that has been prepared by Boulder Scientific on a large scale for SRL (BIB-DJ). The new exchanger (BIB-DJ) performed as expected based on previous work (Bray 1990b and Bibler 1989b).

After completion of the distribution studies, the λ (Cs $K_d \times \rho_b$) values were plotted as a function of the equilibrium sodium to cesium mole ratio at several sodium ion values. The graphical presentation of the distribution data is reported in Appendix C. The results for NCAW waste are shown on pp. C-3 through C-11. The results for CC waste are shown on pp. C-12 through C-20.

The batch tests were run at 10°C, 25°C and 40°C to determine the effect of temperature on the cesium distribution values. Selected results (Na/Cs mole ratio = 10^4) were plotted as a function of the reciprocal temperature (10^3/T) to determine the effect of temperature on the Cs K_d, Figures 2 and 3.

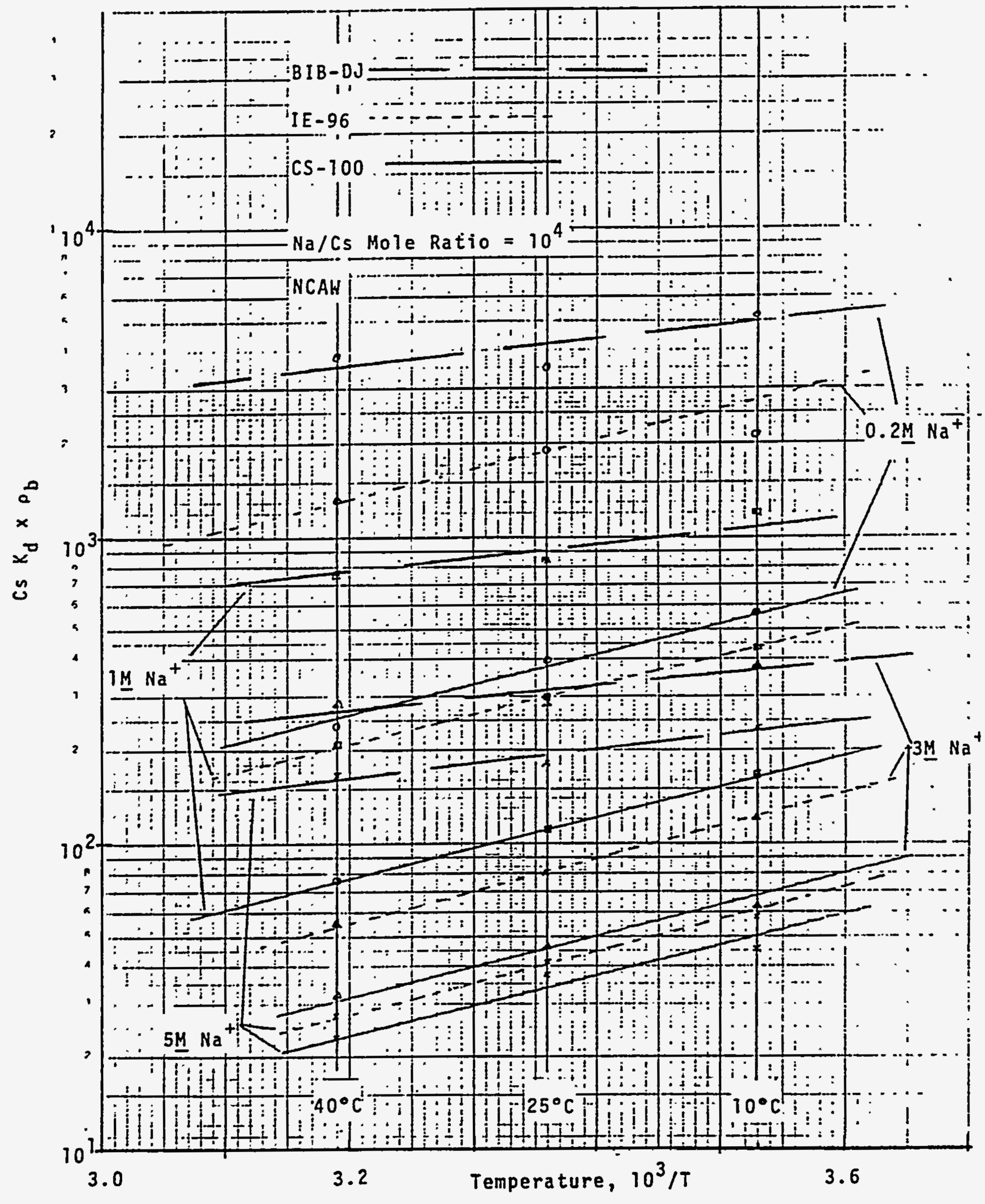

FIGURE 2. Performance of Ion Exchangers Using NCAW as a Function of Temperature

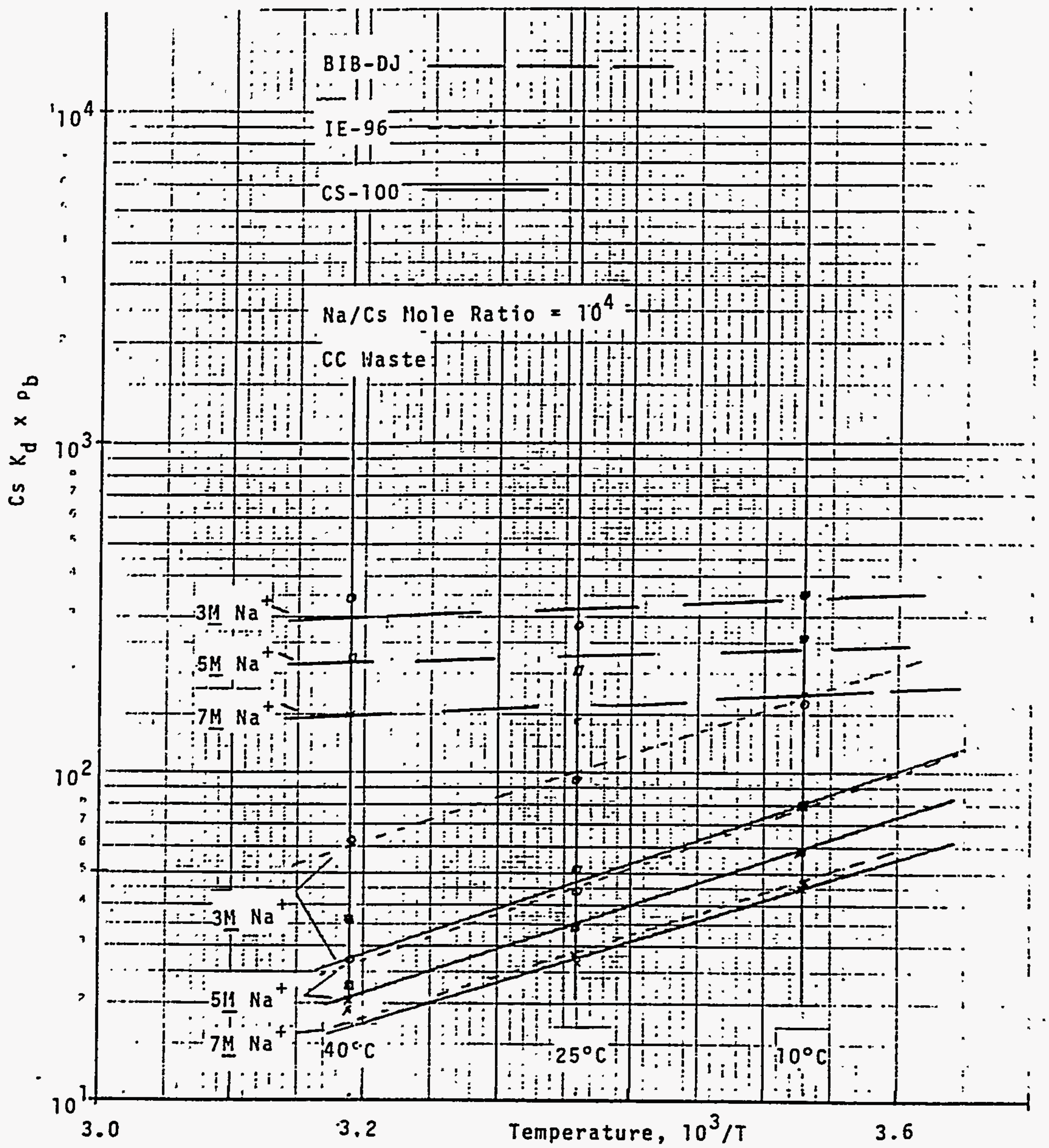

FIGURE 3. Performance of Ion Exchangers Using CC Waste as a Function of Temperature

The cesium exchange capacity for IE-96 and CS-100, as indicated by the batch distribution coefficient times the bed density (Cs $K_d \times \rho_b = \lambda$), increases with decreasing temperature. The λ values doubled with other conditions held constant, by decreasing the temperature from 40°C to 10°C. The temperature effect was not as pronounced for the BIB-DJ resin.

When the Cs $K_d \times \rho_b = \lambda$ values (25°C) were plotted as a function of the sodium concentration in the initial feed and at a Na/Cs mole ratio = 10^4, the three exchangers can be compared on an equal basis, Figure 4. The initial volume of feed that can be processed using IE-96 increases ≈ 50% with a 3X feed dilution (6<u>M</u> Na^+ diluted to 2<u>M</u> Na^+). The initial feed volume with the BIB-DJ resin decreases by ≈10% with a 3X feed dilution, and >30% with CS-100.

The batch Cs $K_d \times \rho_b = \lambda$ values at 5<u>M</u> Na^+ for NCAW and CC waste (Figure 4) were similar; 45-57, 65-80 and 240 for CS-100, IE-96, and BIB-DJ, respectively, at an equilibrium Na/Cs mole ratio of 10^4, at 10°C. From these results, it is postulated that basic ion exchange data can be applied to a broad range of tank waste types.

4.1 EFFECT OF POTASSIUM AND RUBIDIUM ON CESIUM DISTRIBUTION VALUES

To evaluate the effect of potassium (K^+) and rubidium (Rb^+) on the Cs distribution coefficient, feed samples of CC and NCAW waste were adjusted to contain varying amounts of these ions. The Cs K_d values were then determined at 25°C for the three ion exchangers (CS-100, IE-96 and BIB-DJ). The test conditions and results are shown in the APPENDIX, pages B-2B and B-3B. The Na^+/Rb^+ mole ratio was varied from 1.15E4 to 4.6E4 (Cs/Rb mole ratio from 0.2 to 92) without noting a change in the Cs λ values for either CC or NCA waste. When the Na/K mole ratio was varied from 11 to 200, the Cs λ values for both CC and NCA wastes were affected. The results using the BIB-DJ resin (Tables 1 and 2) are graphically displayed in Figure 5. The results show that for a constant equilibrium Na/Cs value that increasing the amount of K^+ present decreased the Cs λ as the K^+ competes with the cesium for ion exchange sites. Future studies should include the development of an equilibrium model for Cs λ that includes the effects of competing ions (Na, K, Rb). Similar trends for potassium interference were noted for IE-96 and CS-100.

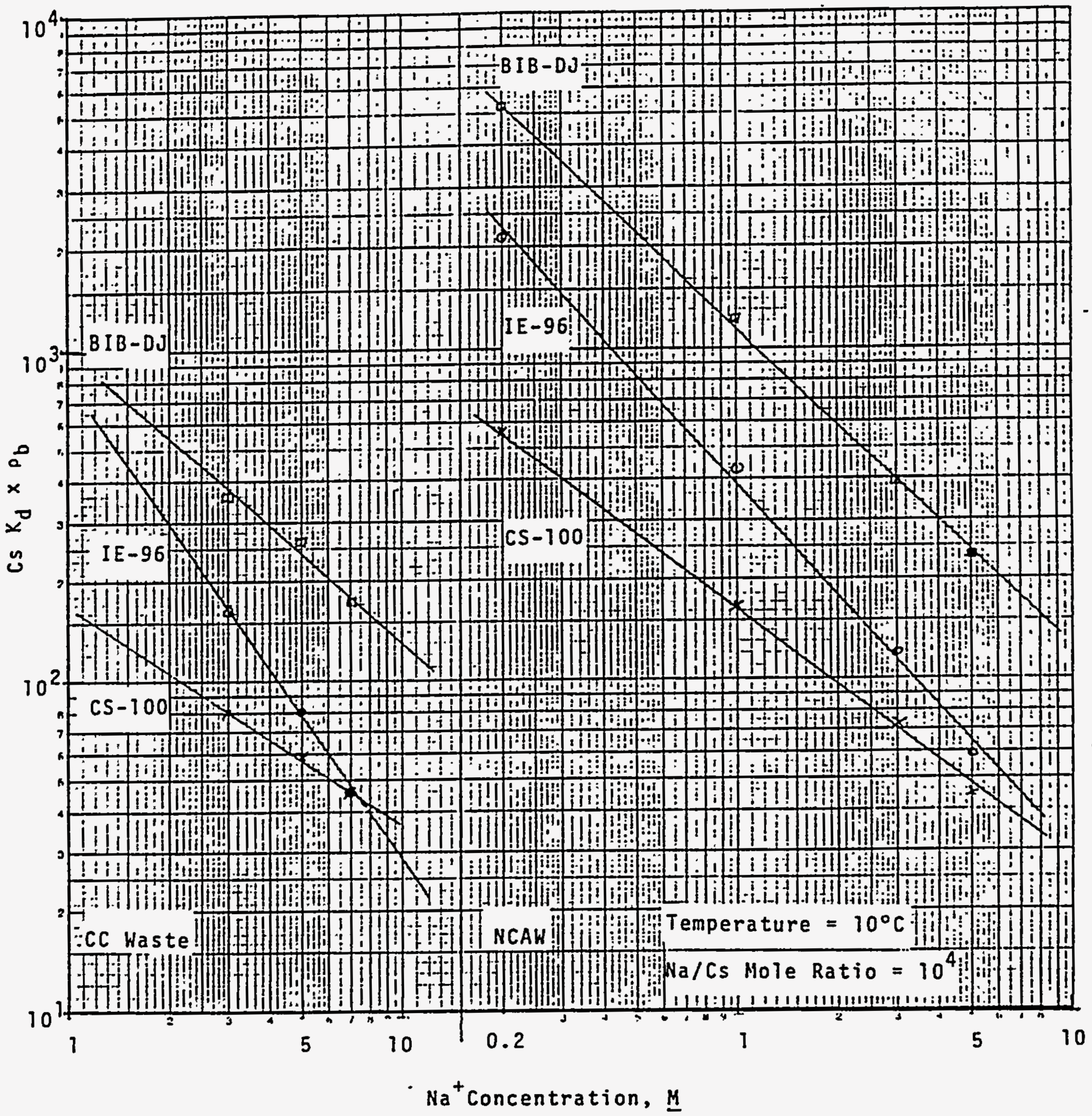

FIGURE 4. Effect of [Na^+] in CC and NCAW on performance of Ion Exchangers at 10°C

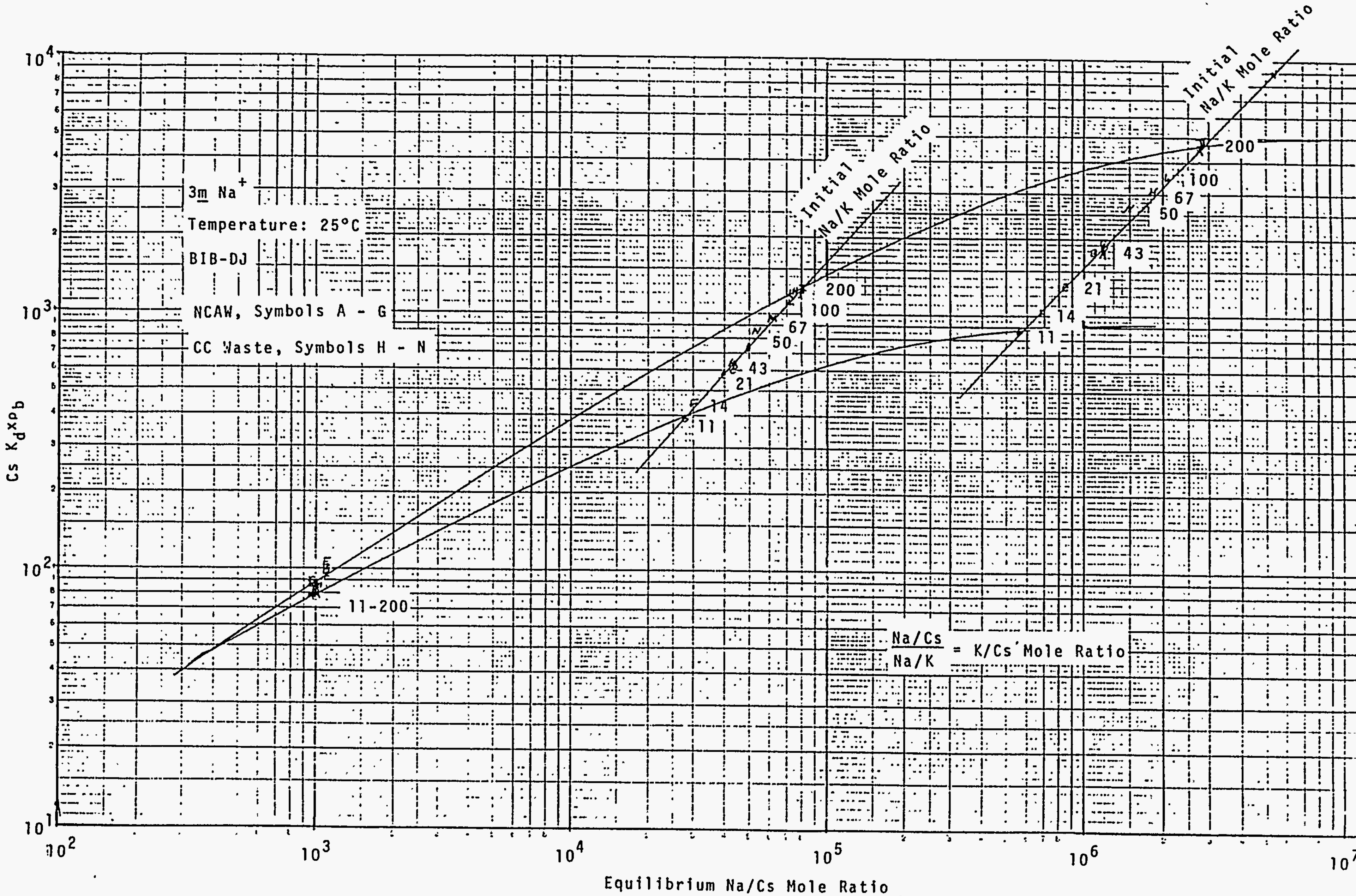

FIGURE 5. Cesium Distribution as a Function of the Initial Na/K Mole Ratio

TABLE 1. Cesium Distribution Values - CC Waste, 25°C, BIB-DJ

ID	Initial, Mole Ratio Na/Cs	Na/Rb	Na/K	Initial, M Na+	K+	Rb+	Final Na/Cs	λ	Symbol
ASW	5E2	--	200	3	0.015	0	1.0E3	84	H
ATW	5E3	--	200	3	0.015	0	7.7E4	1229	
AUW	5E4	--	200	3	0.015	0	5.4E6	8996	
BSW	5E2	4.6E4	200	3	0.015	6.5E-5	1.0E3	86	I
BTW	5E3	4.6E4	200	3	0.015	6.5E-5	8.1E4	1246	
BUW	5E4	4.6E4	200	3	0.015	6.5E-5	2.9E6	4777	
CSW	5E2	2.3E4	200	3	0.015	1.3E-4	1.0E3	83	J
CTW	5E3	2.3E4	200	3	0.015	1.3E-4	7.8E4	1229	
CUW	5E4	2.3E4	200	3	0.015	1.3E-4	2.8E6	4821	
DSW	5E2	1.5E4	200	3	0.015	1.95E-4	1.0E3	85	K
DTW	5E3	1.5E4	200	3	0.015	1.95E-4	7.1E4	1196	
DUW	5E4	1.5E4	200	3	0.015	1.95E-4	2.8E6	4559	
ESW	5E2	--	100	3	0.030	0	1.0E3	83	L
ETW	5E3	--	100	3	0.030	0	7.2E4	1109	
EUW	5E4	--	100	3	0.030	0	2.1E6	3478	
FSW	5E2	--	67	3	0.045	0	9.5E2	79	M
FTW	5E3	--	67	3	0.045	0	6.1E4	950	
FUW	5E4	--	67	3	0.045	0	1.8E6	3032	
GSW	5E2	--	50	3	0.060	0	9.7E2	79	N
GTW	5E3	--	50	3	0.060	0	5.3E4	856	
GUW	5E4	--	50	3	0.060	0	1.5E6	2699	

TABLE 2. Cesium Distribution Values - NCAW Waste, 25°C, BIB-DJ

ID	Initial, Mole Ratio Na/Cs	Initial, Mole Ratio Na/Rb	Initial, Mole Ratio Na/K	Initial, M Na+	Initial, M K+	Initial, M Rb+	Final Na/Cs	λ	Symbol
ASZ	5E2	4.6E4	43	3	0.07	6.5E-5	1.1E3	86	A
ATZ	5E3	4.6E4	43	3	0.07	6.5E-5	4.3E4	640	
AUZ	5E4	4.6E4	43	3	0.07	6.5E-5	1.2E6	1758	
BSZ	5E2	2.3E4	43	3	0.07	1.3E-4	1.0E3	83	B
BTZ	5E3	2.3E4	43	3	0.07	1.3E-4	4.2E4	624	
BUZ	5E4	2.3E4	43	3	0.07	1.3E-4	1.1E6	1767	
CSZ	5E2	1.5E4	43	3	0.07	1.95E-4	1.0E3	86	C
CTZ	5E3	1.5E4	43	3	0.07	1.95E-4	4.3E4	601	
CUZ	5E4	1.5E4	43	3	0.07	1.95E-4	1.2E6	1962	
DSZ	5E2	1.15E4	43	3	0.07	2.6E-4	1.1E3	99	D
DTZ	5E3	1.15E4	43	3	0.07	2.6E-4	5.0E4	731	
DUZ	5E4	1.15E4	43	3	0.07	2.6E-4	1.2E6	1885	
ESZ	5E2	4.6E4	21	3	0.14	6.5E-5	1.1E3	104	E
ETZ	5E3	4.6E4	21	3	0.14	6.5E-5	4.0E4	584	
EUZ	5E4	4.6E4	21	3	0.14	6.5E-5	8.3E5	1291	
FSZ	5E2	4.6E4	14	3	0.21	6.5E-5	1.1E3	93	F
FTZ	5E3	4.6E4	14	3	0.21	6.5E-5	3.0E4	420	
FUZ	5E4	4.6E4	14	3	0.21	6.5E-5	6.8E5	1026	
GSZ	5E2	4.6E4	11	3	0.28	6.5E-5	1.1E3	100	G
GTZ	5E3	4.6E4	11	3	0.28	6.5E-5	2.8E4	392	
GUZ	5E4	4.6E4	11	3	0.28	6.5E-5	5.6E5	854	

5.0 FUTURE STUDIES

The following items should be completed to provide a comprehensive study of the equilibrium behavior of the ion exchange materials under consideration;

-determine lambda (λ) as a function of pH for materials already tested,

-develop an equilibrium model for λ that includes the effects of competing ions (Na, K, Rb), pH, total salt concentration and temperature,

-check the stability of materials (time, temperature, chemical [OH^-], radiation, cycling),

-measure total material capacity with Cs-137 and Na-22, K-42, Rb-86 tracers,

-complete ion exchange column studies, and

-confirm equilibrium data with actual waste.

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APPENDIX A

Preparation of CC and NCAW Tank Waste

APPENDIX A

1. Test Solution Make-Up, CC Stock Solution

Component	FW,g	M	g/L	4 liters,g	Weighed,g	Date
$NaNO_3$	85	2.74	232.9	932		
Na_2SO_4	142.05	0.1	14.2	57		
KNO_3	101.11	0.05	5.0	20		
$Na_2CO_3 \cdot H_2O$	124.0	0.64	79.4	318		
$NaNO_2$	69.0	1.5	103.5	414		
$Na_2HPO_4 \cdot 7H_2O$	268.07	0.03	8.0	32		
$Al(NO_3)_3 \cdot 9H_2O$	375.15	0.5	188.0	750		
$Ca(NO_3)_2 \cdot 4H_2O$	236.16	0.02	4.7	19		
NaF	42.0	0.15	6.3	25		
NaCl	58.45	0.1	5.85	23		
NaOH(0.5M Free)	40.0	3.46	138.5	554		
$Fe(NO_3)_3 \cdot 9H_2O$	404.02	0.06	24.2	97		
$La(NO_3)_3 \cdot 6H_2O$	371.0	0.001	0.37	1.5		
$Mg(NO_3)_2 \cdot 6H_2O$	256.4	0.01	2.6	10.3		
$Mn(NO_3)_2$, 50%	8.64M	0.02	2.3mL	9.3mL		
MoO_3	169.43	0.005	0.85	3.4		
$Ni(NO_3)_2 \cdot 6H_2O$	290.8	0.01	2.9	11.6		
SiO_2	60.08	0.005	0.3	1.2		
$Sr(NO_3)_2$	211.63	0.0007	0.15	0.6		
$Zn(NO_3)_2 \cdot XH_2O$	297.5	0.002	0.59	2.4		
$ZrO(NO_3)_2 \cdot 2H_2O$	267	0.002	0.53	2.1		
Na_4EDTA	292.24	0.03	8.8	35.1		
Citric Acid	210.14	0.064	13.5	54		
$Na_3HEDTA \cdot 2H_2O$	344	0.038	13.1	52.3		
Na_3NTA	191.1	0.0074	1.41	5.7		
Na Gluconate	218	0.30	65.4	262		
Iminodiacetic	133.1	0.23	30.6	122.5		

Target Composition	
Species	CC,M
Al	0.5
Ca	0.02
Cs	0
Fe	0.06
K	0.05
La	0.001
Mg	0.01
Mn	0.02
Mo	0.005
Na	10.00
Ni	0.01
Si	0.005
Sr	0.0007
Zn	0.002
Zr	0.002
CO_3	0.64
F	0.15
Cl	0.10
NO_2	1.50
NO_3	4.62
PO_4	0.03
OH (free)	0.5
TOC	46g/L

APPENDIX A

1. Test Solution Make-Up, NCAW Stock Solution

Component	FW,g	M	g/L	4 liters,g	Weighed,g	Date
$NaNO_3$	85	0.310	26.3	105	______	____
Na_2SO_4	142.05	0.18	25.7	103	______	____
KNO_3	101.11	0.14	14.3	58	______	____
$RbNO_3$	147.47	1.3E-4	0.02	0.08	______	____
$Na_2CO_3 \cdot H_2O$	124.0	0.24	29.7	119	______	____
$NaNO_2$	69.0	0.52	35.8	143	______	____
$Na_2HPO_4 \cdot 7H_2O$	268.07	0.03	8	32	______	____
$Al(NO_3)_3 \cdot 9H_2O$	375.15	0.52	196.3	785	______	____
NaF	42.0	0.107	4.48	17.9	______	____
NaOH	40.0	4.08	163	653	______	____

Target Composition

Species	NCAW,M
Na	5.92
K	0.14
Rb	1.3E-4
Cs	0
Al	0.52
SO_4	0.18
OH(free)	2.0
CO_3	0.24
F	0.107
NO_2	0.52
NO_3	1.87

APPENDIX B

Batch Distribution Data Package

TABLE OF CONTENTS (Appendix B)

TABLE OF CONTENTS (Appendix B)

Solution		°C	Na^+	Initial Mole Ratio			Exchanger		
CC	NCAW	25	3M	Na/Cs	Na/Rb	Na/K	CS-100	BIB	IE-96
X		X	X	5E2	--	200	X	X	X
X		X	X	5E3	--	200	X	X	X
X		X	X	5E4	--	200	X	X	X
X		X	X	5E2	4.6E4	200	X	X	X
X		X	X	5E3	4.6E4	200	X	X	X
X		X	X	5E4	4.E49	200	X	X	X
X		X	X	5E2	2.3E4	200	X	X	X
X		X	X	5E3	2.3E4	200	X	X	X
X		X	X	5E4	2.3E4	200	X	X	X
X		X	X	5E2	1.5E4	200	X	X	X
X		X	X	5E3	1.5E4	200	X	X	X
X		X	X	5E4	1.5E4	200	X	X	X
X		X	X	5E2	--	100	X	X	X
X		X	X	5E3	--	100	X	X	X
X		X	X	5E4	--	100	X	X	X
X		X	X	5E2	--	67	X	X	X
X		X	X	5E3	--	67	X	X	X
X		X	X	5E4	--	67	X	X	X
X		X	X	5E2	--	50	X	X	X
X		X	X	5E3	--	50	X	X	X
X		X	X	5E4	--	50	X	X	X

TABLE OF CONTENTS (Appendix B)

TABLE OF CONTENTS (Appendix B)

Solution		°C	Na^+	Initial Mole Ratio			Exchanger		
CC	NCAW	25	3M	Na/Cs	Na/Rb	Na/K	CS-100	BIB	IE-96
	X	X	X	5E2	4.6E4	43	X	X	X
	X	X	X	5E3	4.6E4	43	X	X	X
	X	X	X	5E4	4.6E4	43	X	X	X
	X	X	X	5E2	2.3E4	43	X	X	X
	X	X	X	5E3	2.3E4	43	X	X	X
	X	X	X	5E4	2.3E4	43	X	X	X
	X	X	X	5E2	1.5E4	43	X	X	X
	X	X	X	5E3	1.5E4	43	X	X	X
	X	X	X	5E4	1.5E4	43	X	X	X
	X	X	X	5E2	1.15E4	43	X	X	X
	X	X	X	5E3	1.15E4	43	X	X	X
	X	X	X	5E4	1.15E4	43	X	X	X
	X	X	X	5E2	4.6E4	21	X	X	X
	X	X	X	5E3	4.6E4	21	X	X	X
	X	X	X	5E4	4.6E4	21	X	X	X
	X	X	X	5E2	4.6E4	14	X	X	X
	X	X	X	5E3	4.6E4	14	X	X	X
	X	X	X	5E4	4.6E4	14	X	X	X
	X	X	X	5E2	4.6E4	11	X	X	X
	X	X	X	5E3	4.6E4	11	X	X	X
	X	X	X	5E4	4.6E4	11	X	X	X

CC WASTE 10 DEGREES C				
sample number	AHW1-2	AIW1-2	AJW1-2	
Material	BIB B	BIB B	BIB B	
Na conc.	3	3	3	
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	
Na/Cs final	1.06E+03	4.68E+04	3.35E+06	
lambda	100	742	5456	
ref. lambda	60	445	3273	
sample number	AGX1	AGW1	AGZ1	AGY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	1.65E+07	2.95E+08	1.46E+07	2.58E+07
lambda	214	4372	212	299
ref. lambda	128	2623	127	179
sample number	BHW1-2	BIW1-2	BJW1-2	
Material	BIB B	BIB B	BIB B	
Na conc.	5	5	5	
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	
Na/Cs final	7.92E+02	3.69E+04	1.24E+06	
lambda	50	590	2181	
ref. lambda	50	590	2181	
sample number	BGX1	BGW1	BGZ1	BGY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	1.24E+07	1.70E+08	9.56E+06	2.12E+07
lambda	139	2685	106	206
ref. lambda	139	2685	106	206
sample number	CHW1-2	CIW1-2	CJW1-2	
Material	BIB B	BIB B	BIB B	
Na conc.	7	7	7	
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	
Na/Cs final	6.92E+02	2.19E+04	6.71E+05	
lambda	34	282	1070	
ref. lambda	47	395	1498	
sample number	CGX1	CGW1	CGZ1	CGY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	1.04E+07	1.07E+08	7.48E+06	1.75E+07
lambda	106	1638	60	155
ref. lambda	149	2293	84	217

sample number	AEX1	AEW1	AEZ1	AEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	9.72E+04	2.40E+06	1.32E+05	1.23E+05
lambda	97	3573	180	88
ref. lambda	58	2144	108	53

sample number	BEX1	BEW1	BEZ1	BEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	9.57E+04	1.90E+06	1.30E+05	9.25E+04
lambda	80	2566	167	61
ref. lambda	80	2566	167	61

sample number	CEX1	CEW1	CEZ1	CEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	7.11E+04	5.90E+05	7.19E+04	8.15E+04
lambda	40	837	50	43
ref. lambda	56	1172	70	61

sample number	AFX1	AFW1	AFZ1	AFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.10E+06	1.93E+07	8.94E+05	1.77E+06
lambda	113	2851	94	161
ref. lambda	68	1711	56	97

sample number	BFX1	BFW1	BFZ1	BFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.07E+06	1.73E+07	8.99E+05	1.64E+06
lambda	108	2528	96	148
ref. lambda	108	2528	96	148

sample number	CFX1	CFW1	CFZ1	CFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	9.29E+05	6.10E+06	7.34E+05	1.28E+06
lambda	84	892	55	110
ref. lambda	117	1249	77	153

CC WASTE 25 DEGREES C														
sample number	AHW2-2	AIW2-2	AJW2-2		sample number	AEX2	AEW2	AEZ2	AEY2	sample number	AFX2	AFW2	AFZ2	AFY2
Material	BIB-B	BIB	BIB		Material	Cs-100	BIB	IE-96	SRL-DJ	Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3		Na conc.	3	3	3	3	Na conc.	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04		Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04	Na/Cs start	5.00E+05	2.75E+05	5.00E+05	5.00E+05
Na/Cs final	9.89E+02	3.74E+04	1.99E+06		Na/Cs final	7.98E+04	2.10E+06	1.02E+05	9.12E+04	Na/Cs final	8.75E+05	1.90E+07	7.94E+05	1.21E+06
lambda	85	515	3356		lambda	60	3255	123	55	lambda	70	2781	67	102
ref. lambda	51	309	2014		ref. lambda	36	1953	74	33	ref. lambda	42	1668	40	61
sample number	AGX2	AGW2	AGZ2	AGY2										
Material	Cs-100	BIB	IE-96	SRL-DJ										
Na conc.	3	3	3	3										
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06										
Na/Cs final	1.15E+07	2.60E+08	1.12E+07	1.82E+07										
lambda	116	4027	138	193										
ref. lambda	69	2416	83	116										
sample number	BHW2-2	BIW2-2	BJW2-2		sample number	BEX2	BEW2	BEZ2	BEY2	sample number	BFX2	BFW2	BFZ2	BFY2
Material	BIB	BIB	BIB		Material	Cs-100	BIB	IE-96	SRL-DJ	Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5		Na conc.	5	5	5	5	Na conc.	5	5	5	5
Na/Cs start	5.00E+02	5.00E+03	5.00E+04		Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04	Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	8.14E+02	2.97E+04	1.25E+06		Na/Cs final	7.78E+04	1.55E+06	9.87E+04	8.62E+04	Na/Cs final	8.17E+05	1.78E+07	7.66E+05	1.15E+06
lambda	52	400	1793		lambda	52	2337	110	46	lambda	63	2564	62	91
ref. lambda	52	400	1793		ref. lambda	52	2337	110	46	ref. lambda	63	2564	62	91
sample number	BGX2	BGW2	BGZ2	BGY2										
Material	Cs-100	BIB	IE-96	SRL-DJ										
Na conc.	5	5	5	5										
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06										
Na/Cs final	9.56E+06	1.90E+08	7.88E+06	1.36E+07										
lambda	86	2698	71	118										
ref. lambda	86	2698	71	118										
sample number	CHW2-2	CIW2-2	CJW2-2		sample number	CEX2	CEW2	CEZ2	CEY2	sample number	CFX2	CFW2	CFZ2	CFY2
Material	BIB	BIB	BIB		Material	Cs-100	BIB	IE-96	SRL-DJ	Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7		Na conc.	7	7	7	7	Na conc.	7	7	7	7
Na/Cs start	5.00E+02	5.00E+03	5.00E+04		Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04	Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	6.14E+02	1.72E+04	6.75E+05		Na/Cs final	6.81E+04	7.80E+05	6.34E+04	7.24E+04	Na/Cs final	7.98E+05	1.05E+07	6.55E+05	5.47E+05
lambda	19	204	992		lambda	35	1040	32	30	lambda	56	1585	37	75
ref. lambda	27	285	1388		ref. lambda	48	1456	45	42	ref. lambda	78	2219	52	105
sample number	CGX2	CGW2	CGZ2	CGY2										
Material	Cs-100	BIB	IE-96	SRL-DJ										
Na conc.	7	7	7	7										
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06										
Na/Cs final	8.73E+06	1.08E+08	6.98E+06	1.25E+07										
lambda	72	1789	43	111										
ref. lambda	101	2504	60	156										

CC Waste 40 degrees C

sample number	AHW3-2	AIW3-2	AJW3-2
Material	BIB B	BIB B	BIB B
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.19E+02	3.01E+04	1.75E+06
lambda	72	426	2998
ref. lambda	43	255	1799

sample number	AEX3	AEW3	AEZ3	AEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	6.80E+04	1.55E+06	8.11E+04	8.13E+04
lambda	39	2346	76	44
ref. lambda	23	1407	46	26

sample number	AFX3	AFW3	AFZ3	AFY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	6.95E+05	1.30E+07	7.20E+05	9.74E+05
lambda	36	2099	52	66
ref. lambda	22	1260	31	39

sample number	AGX3	AGW3	AGZ3	AGY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	8.28E+06	1.98E+08	8.31E+06	1.27E+07
lambda	67	3000	72	110
ref. lambda	40	1800	43	66

sample number	BHW3-2	BIW3-2	BJW3-2
Material	BIB B	BIB B	BIB B
Na conc.	5	5	5
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	7.14E+02	2.29E+04	9.73E+05
lambda	39	329	1579
ref. lambda	39	329	1579

sample number	BEX3	BEW3	BEZ3	BEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	6.55E+04	1.07E+06	8.63E+04	7.40E+04
lambda	30	1602	82	32
ref. lambda	30	1602	82	32

sample number	BFX3	BFW3	BFZ3	BFY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	6.96E+05	1.25E+07	6.81E+05	8.96E+05
lambda	41	1903	40	57
ref. lambda	41	1903	40	57

sample number	BGX3	BGW3	BGZ3	BGY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	7.42E+06	1.45E+08	6.98E+06	1.11E+07
lambda	51	2009	48	80
ref. lambda	51	2009	48	80

sample number	CHW3-2	CIW3-2	CJW3-2
Material	BIB B	BIB B	BIB B
Na conc.	7	7	7
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	6.48E+02	1.56E+04	5.94E+05
lambda	27	189	997
ref. lambda	38	265	1396

sample number	CEX3	CEW3	CEZ3	CEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	6.17E+04	5.55E+05	6.16E+04	6.83E+04
lambda	24	817	27	26
ref. lambda	34	1144	38	37

sample number	CFX3	CFW3	CFZ3	CFY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	6.50E+05	8.45E+06	6.03E+05	8.78E+05
lambda	28	1283	24	55
ref. lambda	39	1797	34	77

sample number	CGX3	CGW3	CGZ3	CGY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	7	7	7	7
Na/Cs start	5.00E+06	5.00E+06	5.00E+06	5.00E+06
Na/Cs final	7.31E+06	9.90E+07	6.30E+06	1.02E+07
lambda	46	1568	30	71
ref. lambda	64	2195	42	99

CC WASTE - EFFECT OF K AND Rb									
A series K = 0.015 M Rb = 0 M									
sample number	ASW2-2	ATW2-2	AUW2-2	ASX2-2	ATX2-2	AUX2-2	ASZ2-2	ATZ2-2	AUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.99E+02	7.64E+04	5.32E+06	5.84E+02	6.79E+03	1.27E+05	8.00E+02	9.66E+03	1.18E+05
lambda	84	1229	8996	17	37	163	76	116	168
ref. lambda	50	737	5398	10	22	98	45	69	101
B series K = 0.015 M Rb = 6.5E-5 M									
sample number	BSW2-2	BTW2-2	BUW2-2	BSX2-2	BTX2-2	BUX2-2	BSZ2-2	BTZ2-2	BUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.01E+03	8.13E+04	2.91E+06	5.83E+02	6.82E+03	8.13E+04	8.01E+02	9.33E+03	1.01E+05
lambda	85	1246	4777	16	38	67	72	108	123
ref. lambda	51	748	2866	10	23	40	43	65	74
C series K = 0.015 M Rb = 1.3E-4 M									
sample number	CSW2-2	CTW2-2	CUW2-2	CSX2-2	CTX2-2	CUX2-2	CSZ2-2	CTZ2-2	CUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.02E+03	7.81E+04	2.89E+06	5.78E+02	7.01E+03	8.77E+04	8.35E+02	9.06E+03	9.91E+04
lambda	83	1229	4821	17	40	73	81	99	123
ref. lambda	50	738	2893	10	24	44	48	60	74
D series K = 0.015 M Rb = 1.95E-4									
sample number	DSW2-2	DTW2-2	DUW2-2	DSX2-2	DTX2-2	DUX2-2	DSZ2-2	DTZ2-2	DUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.99E+02	7.13E+04	2.74E+06	5.84E+02	6.86E+03	8.31E+04	7.70E+02	9.55E+03	9.97E+04
lambda	85	1196	4558	17	39	70	70	111	122
ref. lambda	51	718	2735	10	23	42	42	66	73

CC WASTE - EFFECT OF K AND Rb									
E series K = 0.03 M Rb = 0 M							ESZ2-2	ETZ2-2	EUZ2-2
sample number	ESW2-2	ETW2-2	EUW2-2	ESX2-2	ETX2-2	EUX2-2	IE-96	IE-96	IE-96
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	25°	25°	25°
Temp, °C	25°	25°	25°	25°	25°	25°	3	3	3
Na conc.	3	3	3	3	3	3	5.00E+02	5.00E+03	5.00E+04
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	7.95E+02	8.98E+03	9.86E+04
Na/Cs final	9.86E+02	7.23E+04	2.14E+06	5.82E+02	6.95E+03	8.25E+04	77	93	124
lambda	83	1109	3478	17	39	64	46	56	75
ref. lambda	50	666	2087	10	23	38			
F series K = 0.045 M Rb = 0 M							FSZ2-2	FTZ2-2	FUZ2-2
sample number	FSW2-2	FTW2-2	FUW2-2	FSX2-2	FTX2-2	FUX2-2	IE-96	IE-96	IE-96
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	25°	25°	25°
Temp, °C	25°	25°	25°	25°	25°	25°	3	3	3
Na conc.	3	3	3	3	3	3	5.00E+02	5.00E+03	5.00E+04
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	7.64E+02	9.28E+03	9.00E+04
Na/Cs final	9.49E+02	6.13E+04	1.79E+06	5.88E+02	6.81E+03	8.15E+04	69	100	103
lambda	79	949	3031	17	37	65	41	60	62
ref. lambda	47	569	1819	10	22	39			
G series K = 0.06 M Rb = 0 M							GSZ2-2	GTZ2-2	GUZ2-2
sample number	GSW2-2	GTW2-2	GUW2-2	GSX2-2	GTX2-2	GUX2-2	IE-96	IE-96	IE-96
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	25°	25°	25°
Temp, °C	25°	25°	25°	25°	25°	25°	3	3	3
Na conc.	3	3	3	3	3	3	5.00E+02	5.00E+03	5.00E+04
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	7.91E+02	8.78E+03	9.32E+04
Na/Cs final	9.71E+02	5.30E+04	1.55E+06	5.88E+02	6.85E+03	8.00E+04	68	94	101
lambda	79	856	2699	17	37	63	41	56	61
ref. lambda	48	513	1619	10	22	38			

NCAW 10 DEGREES C				
sample number	KDX1	KDW1	KDZ1	KDY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	4.12E+04	1.43E+06	1.23E+05	3.42E+04
lambda	731	22154	2436	432
ref. lambda	29	886	97	17
sample number	LDX1	LDW1	LDZ1	LDY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	1.48E+04	2.70E+05	2.56E+04	1.07E+04
lambda	172	4277	449	79
ref. lambda	34	855	90	16
sample number	MDX1	MDW1	MDZ1	MDY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	7.84E+03	6.80E+04	9.84E+03	7.18E+03
lambda	60	914	121	29
ref. lambda	36	549	72	17
sample number	NDX1	NDW1	NDZ1	NDY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	7.23E+03	2.70E+04	7.35E+03	6.51E+03
lambda	41	363	59	19
ref. lambda	41	363	59	19

sample number	KEX1	KEW1	KEZ1	KEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	7.71E+05	1.65E+07	1.32E+06	7.34E+05
lambda	1287	26742	2828	870
ref. lambda	51	1070	113	35
sample number	LEX1	LEW1	LEZ1	LEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	2.20E+05	4.00E+06	2.55E+05	2.31E+05
lambda	298	6579	461	241
ref. lambda	60	1316	92	48
sample number	MEX1	MEW1	MEZ1	MEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	1.17E+05	1.40E+06	1.02E+05	1.19E+05
lambda	113	2138	130	90
ref. lambda	68	1283	78	54
sample number	NEX1	NEW1	NEZ1	NEY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	9.07E+04	5.70E+05	8.10E+04	8.86E+04
lambda	76	853	69	55
ref. lambda	76	853	69	55

sample number	KFX1	KFW1	KFZ1	KFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	8.76E+06	1.69E+08	1.42E+07	8.50E+06
lambda	1522	26039	3123	1135
ref. lambda	61	1042	125	45
sample number	LFX1	LFW1	LFZ1	LFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	2.82E+06	5.20E+07	2.80E+06	3.90E+06
lambda	411	7804	524	430
ref. lambda	82	1561	105	86
sample number	MFX1	MFW1	MFZ1	MFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.38E+06	1.83E+07	1.09E+06	1.78E+06
lambda	163	2756	145	180
ref. lambda	98	1654	87	108
sample number	NFX1-1	NFW1-1	NFZ1	NFY1
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.03E+06	1.31E+07	7.84E+05	1.41E+06
lambda	109	1913	71	121
ref. lambda	109	1913	71	121

NCAW 10 DEGREES C						
sample number	KPW1-2	KQW1-2	KRW1-2	LPW1-2	LQW1-2	LRW1-2
Material	BIB B	BIB B	BIB B	BIB B	BIB B	BIB B
Temp, °C	10°	10°	10°	10°	10°	10°
Na conc.	0.2	0.2	0.2	1	1	1
Na/Cs start	50	500	5000	50	500	5000
Na/Cs final	355	3536746	#DIV/0!	74	5051	353678
lambda	572	643708	#DIV/0!	44	786	6349
ref. lambda	23	25748	#DIV/0!	9	157	1270
sample number	MPW1-2	MQW1-2	MRW1-2	NPW1-2	NQW1-2	NRW1-2
Material	BIB B	BIB B	BIB B	BIB B	BIB B	BIB B
Temp, °C	10°	10°	10°	10°	10°	10°
Na conc.	3	3	3	5	5	5
Na/Cs start	50	500	5000	50	500	5000
Na/Cs final	59	1069	66683	56	791	32965
lambda	15	102	1121	11	51	476
ref. lambda	9	61	673	11	51	476

NCAW 25 degrees C				
sample number	KDX2	KDW2	KDZ2	KDY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.2	0.2	0.2	0.2
Na/Cs start	5000	5000	5000	5000
Na/Cs final	26700	1035000	95650	21150
lambda	415	15111	1954	231
ref. lambda	17	604	78	9
sample number	LDX2	LDW2	LDZ2	LDY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	1.04E+04	2.10E+05	1.87E+04	9.26E+03
lambda	104	3195	310	55
ref. lambda	21	639	62	11
sample number	MDX2	MDW2	MDZ2	MDY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	7.13E+03	4.80E+04	8.38E+03	6.37E+03
lambda	41	659	79	19
ref. lambda	25	396	48	11
sample number	NDX2	NDW2	NDZ2	NDY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	6.73E+03	2.25E+04	6.57E+03	6.16E+03
lambda	31	289	41	16
ref. lambda	31	289	41	16

sample number	KEX2	KEW2	KEZ2	KEY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.2	0.20	0.20	0.20
Na/Cs start	50000	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	359000	1.23E+07	1.02E+06	3.70E+05
lambda	630	17824	2146	454
ref. lambda	25	713	86	18
sample number	LEX2	LEW2	LEZ2	LEY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	1.43E+05	3.25E+06	1.81E+05	1.61E+05
lambda	177	5175	325	153
ref. lambda	35	1035	65	31
sample number	MEX2	MEW2	MEZ2	MEY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	8.70E+04	1.13E+06	8.55E+04	9.25E+04
lambda	70	1632	85	58
ref. lambda	42	979	51	35
sample number	NEX2	NEW2	NEZ2	NEY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	7.65E+04	6.21E+05	6.71E+04	7.81E+04
lambda	50	903	44	39
ref. lambda	50	903	44	39

sample number	KFX2	KFW2	KFZ2	KFY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	4.53E+06	1.10E+08	1.10E+07	5.11E+06
lambda	753	16555	2239	552
ref. lambda	30	662	90	22
sample number	LFX2	LFW2	LFZ2	LFY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.78E+06	3.90E+07	1.95E+06	2.27E+06
lambda	224	6155	341	230
ref. lambda	45	1231	68	46
sample number	MFX2	MFW2	MFZ2	MFY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	9.74E+05	1.40E+07	8.71E+05	1.14E+06
lambda	94	2131	89	98
ref. lambda	56	1279	54	59
sample number	NFX2	NFW2	NFZ2	NFY2
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	8.77E+05	8.48E+06	6.90E+05	9.61E+05
lambda	70	1317	45	69
ref. lambda	70	1317	45	69

NCAW 25 DEGREES C						
sample number	KPW2-2	KQW2-2	KRW2-2	LPW2-2	LQW2-2	LRW2-2
Material	BIB	BIB	BIB	BIB	BIB	BIB
Temp, ° C	25°	25°	25°	25°	25°	25°
Na conc.	0.2	0.2	0.2	1	1	1
Na/Cs start	5.00E+01	5.00E+02	5.00E+03	5.00E+01	5.00E+02	5.00E+03
Na/Cs final	2.70E+02	4.61E+04	1.10E+06	6.85E+01	3.05E+03	1.95E+05
lambda	347	7608	18260	31	407	2962
ref. lambda	14	304	730	6	81	592
sample number	MPW2-2	MQW2-2	MRW2-2	NPW2-2	NQW2-2	NRW2-2
Material	BIB	BIB	BIB	BIB	BIB	BIB
Temp, ° C	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	5	5	5
Na/Cs start	5.00E+01	5.00E+02	5.00E+03	5.00E+01	5.00E+02	5.00E+03
Na/Cs final	5.71E+01	9.72E+02	4.57E+04	5.54E+01	7.42E+02	2.28E+04
lambda	12	75	658	9	40	296
ref. lambda	7	45	395	9	40	296

NCAW - EFFECT OF K AND Rb

A series K = 0.015 M Rb = 0 M			
sample number	ASW2-2	ATW2-2	AUW2-2
Material	BIB	BIB	BIB
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.04E+03	4.27E+04	1.17E+06
lambda	86	639	1778
ref. lambda	52	383	1067
B series K = 0.07 M Rb = 1.3E-4 M			
sample number	BSW2-2	BTW2-2	BUW2-2
Material	BIB	BIB	BIB
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.90E+02	4.19E+04	1.13E+06
lambda	82	623	1767
ref. lambda	49	374	1060
C series K=0.07 M Rb = 1.95E-4 M			
sample number	CSW2-2	CTW2-2	CUW2-2
Material	BIB	BIB	BIB #2
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.03E+03	4.37E+04	1.23E+06
lambda	85	603	1962
ref. lambda	51	362	1177
D series K=0.07 M Rb = 2.6E-4 M			
sample number	DSW2-2	DTW2-2	DUW2-2
Material	BIB B	BIB B	BIB B
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.08E+03	4.97E+04	1.21E+06
lambda	98	731	1885
ref. lambda	59	439	1131

sample number	ASX2-2	ATX2-2	AUX2-2
Material	CS-100	CS-100	CS-100
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	6.26E+02	7.45E+03	8.29E+04
lambda	25	48	63
ref. lambda	15	29	38
sample number	BSX2-2	BTX2-2	BUX2-2
Material	CS-100	CS-100	CS-100
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	6.14E+02	7.22E+03	8.54E+04
lambda	25	43	70
ref. lambda	15	26	42
sample number	CSX2-2	CTX2-2	CUX2-2
Material	CS-100	CS-100	CS-100
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	6.15E+02	7.19E+03	8.48E+04
lambda	23	42	71
ref. lambda	14	25	43
sample number	DSX2-2	DTX2-2	DUX2-2
Material	CS-100	CS-100	CS-100
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	6.20E+02	7.04E+03	8.36E+04
lambda	25	42	71
ref. lambda	15	25	43

sample number	ASZ2-2	ATZ2-2	AUZ2-2
Material	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.29E+02	8.90E+03	9.45E+04
lambda	103	93	100
ref. lambda	62	56	60
sample number	BSZ2-2	BTZ2-2	BUZ2-2
Material	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.22E+02	8.83E+03	8.87E+04
lambda	105	97	99
ref. lambda	63	58	59
sample number	CSZ2-2	CTZ2-2	CUZ2-2
Material	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	9.19E+02	8.47E+03	8.90E+04
lambda	104	86	95
ref. lambda	62	52	57
sample number	DSZ2-2	DTZ2-2	DUZ2-2
Material	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°
Na conc.	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	8.59E+02	8.38E+03	8.43E+04
lambda	94	84	88
ref. lambda	56	50	53

NCAW - EFFECT OF K AND Rb									
E series K = 0.14 M Rb = 6.5E-5 M									
sample number	ESW2-2	ETW2-2	EUW2-2	ESX2-2	ETX2-2	EUX2-2	ESZ2-2	ETZ2-2	EUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.15E+03	4.17E+04	8.36E+05	6.23E+02	6.94E+03	7.85E+04	9.03E+02	7.85E+03	7.97E+04
lambda	104	584	1291	26	38	57	100	69	72
ref. lambda	62	350	774	16	23	34	60	41	43
F series K = 0.21 M Rb=6.5E-5 M									
sample number	FSW2-2	FTW2-2	FUW2-2	FSX2-2	FTX2-2	FUX2-2	FSZ2-2	FTZ2-2	FUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.05E+03	2.97E+04	6.83E+05	6.14E+02	6.76E+03	7.59E+04	8.83E+02	7.29E+03	7.41E+04
lambda	93	420	1026	24	36	48	95	59	62
ref. lambda	56	252	615	14	22	29	57	35	37
G series K = 0.28 M Rb = 6.5E-5 M									
sample number	GSW2-2	GTW2-2	GUW2-2	GSX2-2	GTX2-2	GUX2-2	GSZ2-2	GTZ2-2	GUZ2-2
Material	BIB B	BIB B	BIB B	CS-100	CS-100	CS-100	IE-96	IE-96	IE-96
Temp, °C	25°	25°	25°	25°	25°	25°	25°	25°	25°
Na conc.	3	3	3	3	3	3	3	3	3
Na/Cs start	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04	5.00E+02	5.00E+03	5.00E+04
Na/Cs final	1.10E+03	2.81E+04	5.64E+05	6.25E+02	6.78E+03	7.25E+04	8.44E+02	7.37E+03	7.01E+04
lambda	99	391	854	27	36	47	84	56	49
ref. lambda	60	235	513	16	22	28	50	34	29

NCAW 40 DEGREES C				
sample number	KDX3	KDW3	KDZ3	KDY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	1.74E+04	5.60E+05	5.75E+04	1.68E+04
lambda	256	9147	1337	171
ref. lambda	10	366	53	7
sample number	LDX3	LDW3	LDZ3	LDY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	9.01E+03	1.30E+05	1.09E+04	1.05E+04
lambda	71	1993	137	81
ref. lambda	14	399	27	16
sample number	MDX3	MDW3	MDZ3	MDY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	6.42E+03	2.70E+04	7.27E+03	6.35E+03
lambda	28	380	55	19
ref. lambda	17	228	33	11
sample number	NDX3	NDW3	NDZ3	NDY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+03	5.00E+03	5.00E+03	5.00E+03
Na/Cs final	6.10E+03	1.55E+04	6.09E+03	5.95E+03
lambda	22	189	26	13
ref. lambda	22	189	26	13

sample number	KEX3	KEW3	KEZ3	KEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	2.45E+05	7.10E+06	6.67E+05	2.70E+05
lambda	383	11531	1459	309
ref. lambda	15	461	58	12
sample number	LEX3	LEW3	LEZ3	LEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	1.05E+05	2.10E+06	1.44E+05	1.02E+05
lambda	102	3224	236	76
ref. lambda	20	645	47	15
sample number	MEX3	MEW3	MEZ3	MEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	7.12E+04	6.85E+05	6.61E+04	7.79E+04
lambda	43	1035	40	40
ref. lambda	26	621	24	24
sample number	NEX3	NEW3	NEZ3	NEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+04	5.00E+04	5.00E+04	5.00E+04
Na/Cs final	7.04E+04	4.30E+05	7.02E+04	6.94E+04
lambda	37	599	49	27
ref. lambda	37	599	49	27

sample number	KFX3	KFW3	KEZ3	KEY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	0.20	0.20	0.20	0.20
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	2.66E+06	7.75E+07	6.21E+06	2.88E+06
lambda	403	11518	1451	340
ref. lambda	16	461	58	14
sample number	LFX3	LFW3	LFZ3	LFY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	1	1	1	1
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	1.22E+06	2.55E+07	1.69E+06	1.57E+06
lambda	130	3870	241	151
ref. lambda	26	774	48	30
sample number	MFX3	MFW3	MFZ3	MFY3
Material	0	BIB	IE-96	SRL-DJ
Na conc.	3	3	3	3
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	6.82E+05	8.55E+06	7.50E+05	8.26E+05
lambda	34	1350	64	46
ref. lambda	20	810	38	28
sample number	NFX3	NFW3	NFZ3	NFY3
Material	Cs-100	BIB	IE-96	SRL-DJ
Na conc.	5	5	5	5
Na/Cs start	5.00E+05	5.00E+05	5.00E+05	5.00E+05
Na/Cs final	7.72E+05	6.30E+06	6.02E+05	8.85E+05
lambda	54	909	25	58
ref. lambda	54	909	25	58

SUMMARY OF BATCH DISTRIBUTION DATA

9/11/92

NCAW 40 DEGREES C								
sample number	KPW3-2	KQW3-2	KRW3-2			LPW3-2	LQW3-2	LRW3-2
Material	BIB B	BIB B	BIB B			BIB B	BIB B	BIB B
Temp, °C	40°	40°	40°			40°	40°	40°
Na conc.	0.2	0.2	0.2			1	1	1
Na/Cs start	5.00E+01	5.00E+02	5.00E+03			5.00E+01	5.00E+02	5.00E+03
Na/Cs final	2.04E+02	4.34E+04	1.74E+07			7.27E+01	2.51E+03	1.33E+05
lambda	2.91E+02	7.55E+03	3.18E+05			3.72E+01	3.62E+02	2.31E+03
ref. lambda	12	302	12726			7	72	462
sample number	MPW3-2	MQW3-2	MRW3-2			NPW3-2	NQW3-2	NRW3-2
Material	BIB B	BIB B	BIB B			BIB B	BIB B	BIB B
Temp, °C	40°	40°	40°			40°	40°	40°
Na conc.	3	3	3			5	5	5
Na/Cs start	5.00E+01	5.00E+02	5.00E+03			5.00E+01	5.00E+02	5.00E+03
Na/Cs final	5.60E+01	9.04E+02	3.33E+04			5.42E+01	7.12E+02	1.85E+04
lambda	10	72	519			8	39	247
ref. lambda	6	43	311			8	39	247

filename =BATCH1.XLS

APPENDIX C
Graphical Presentation of Distribution Data

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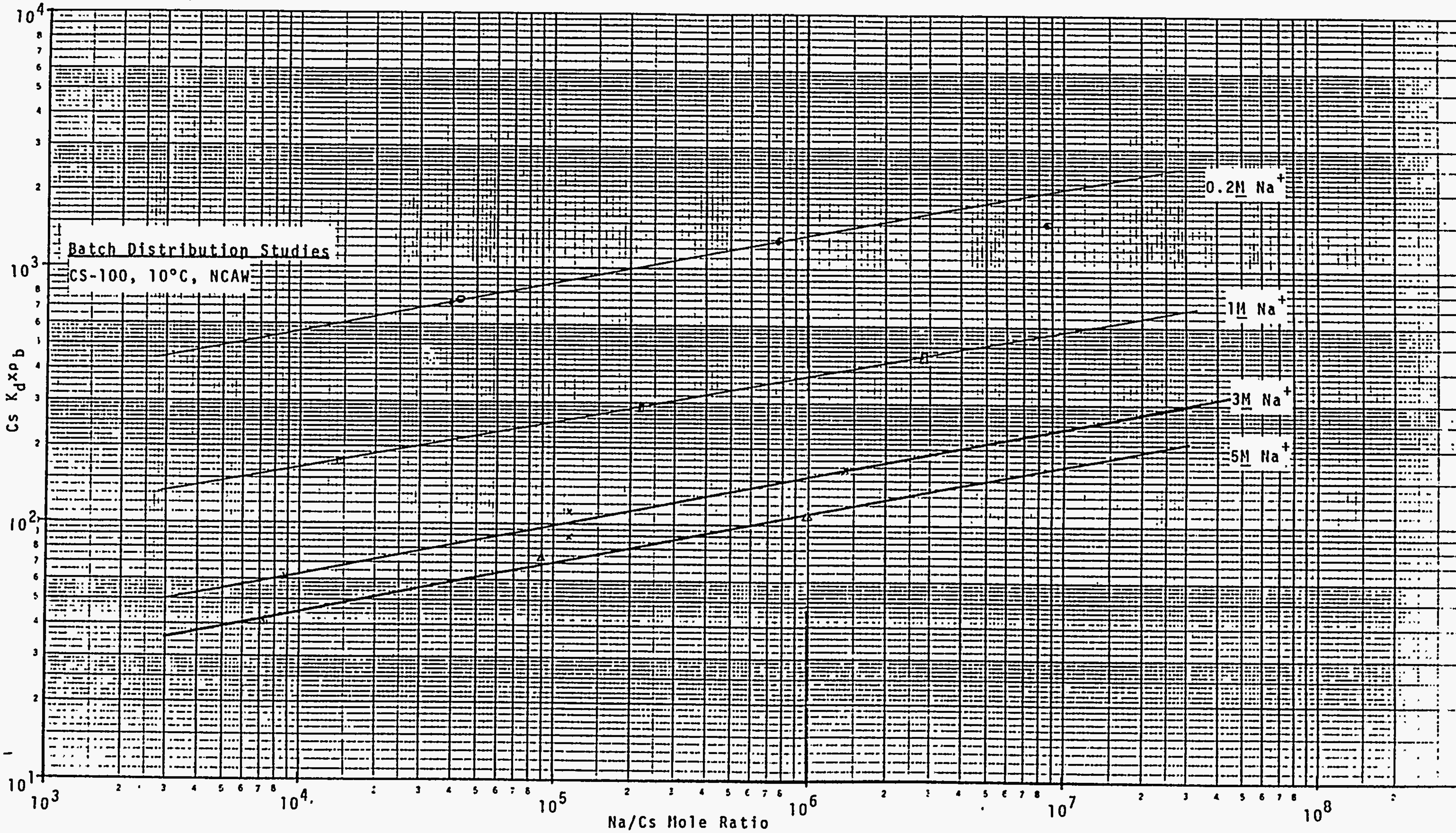
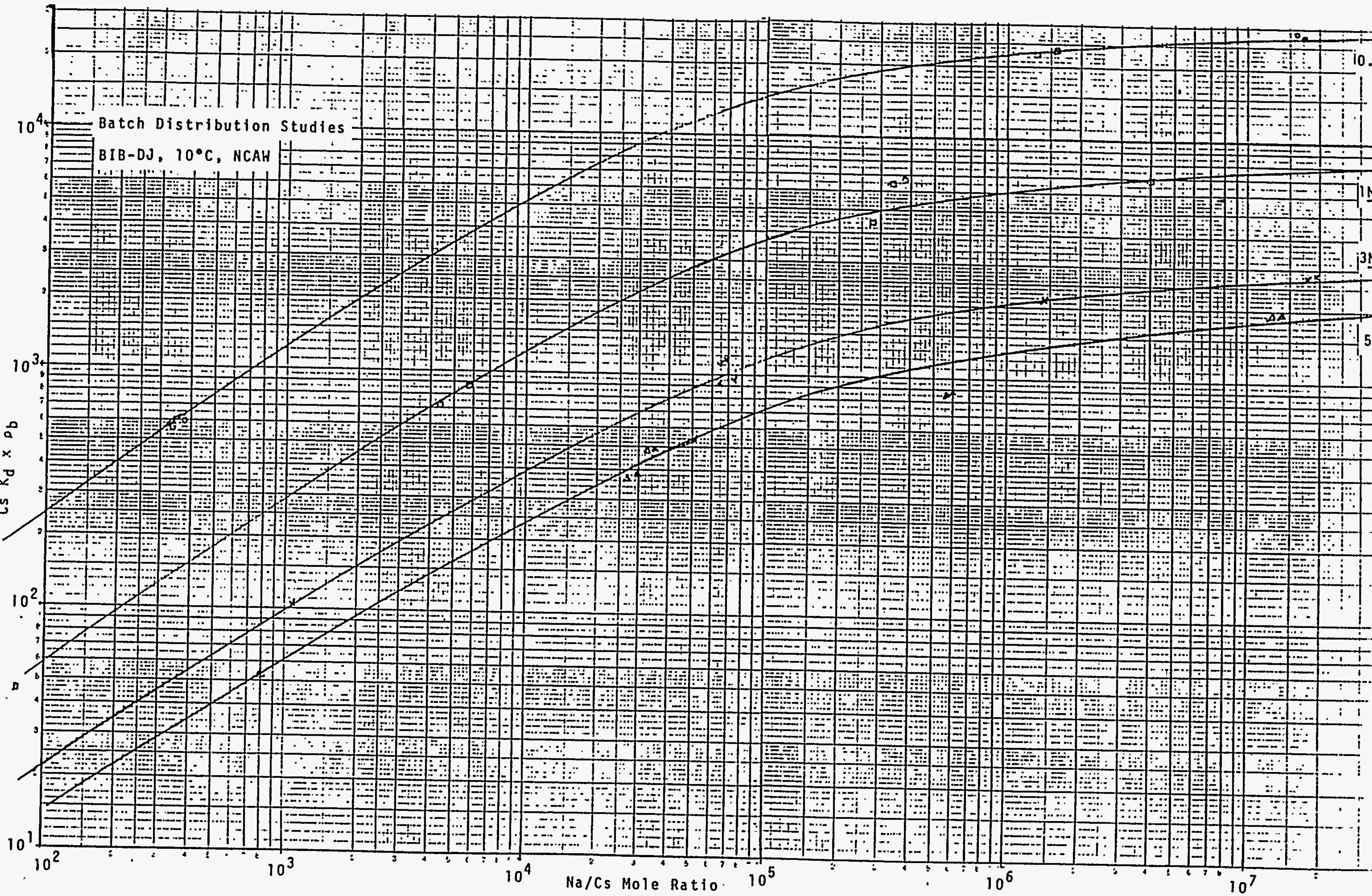
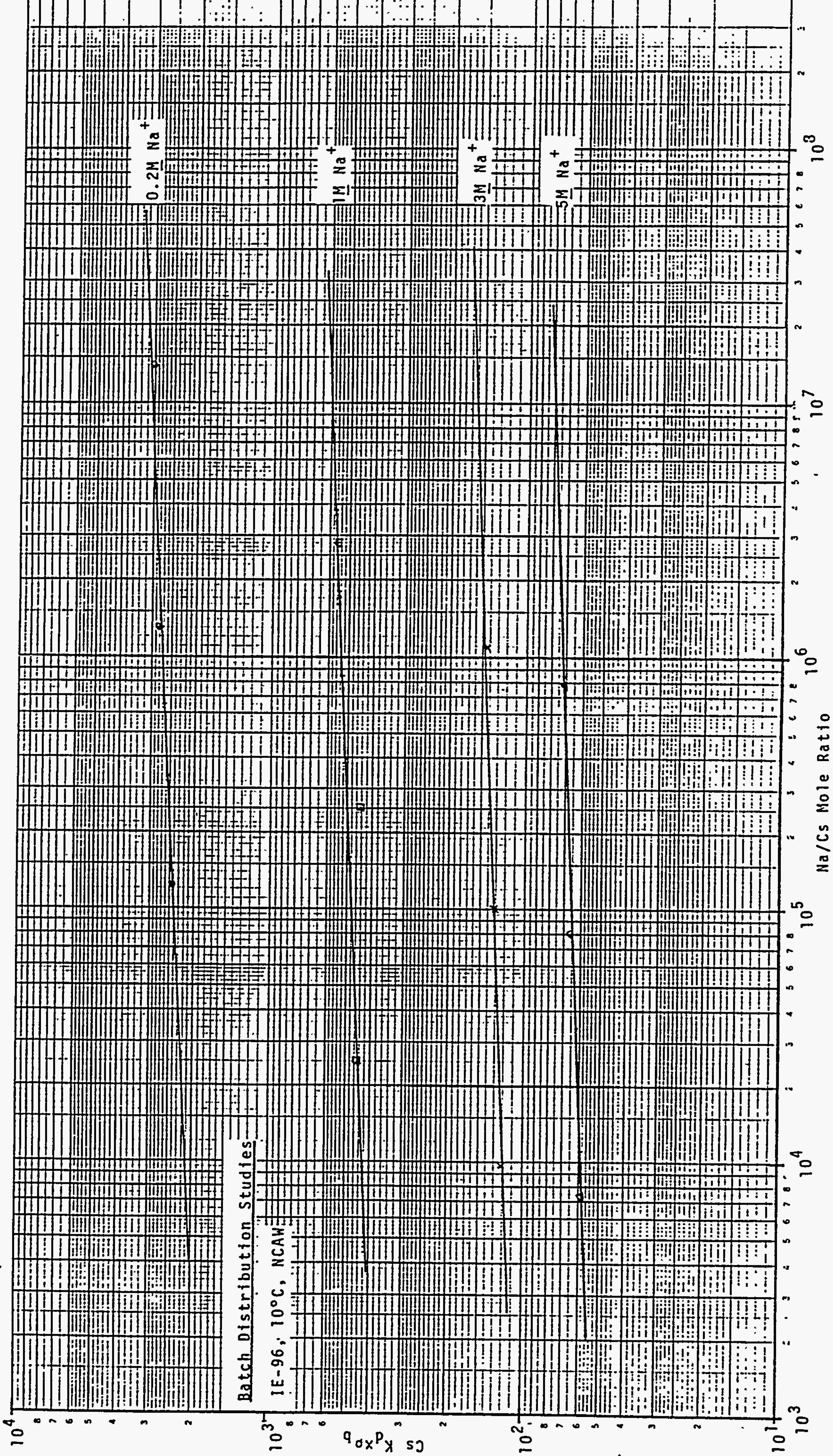
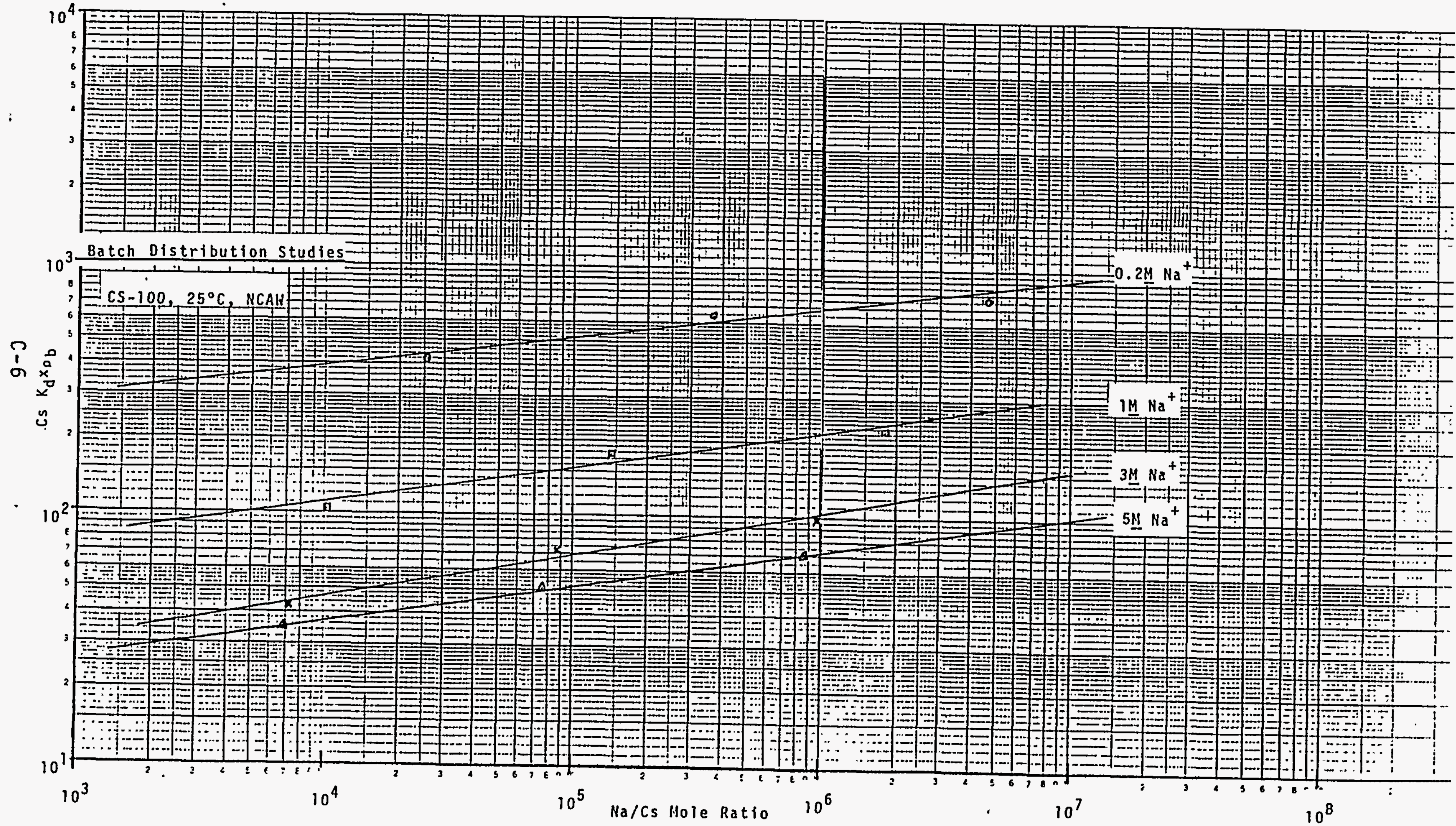


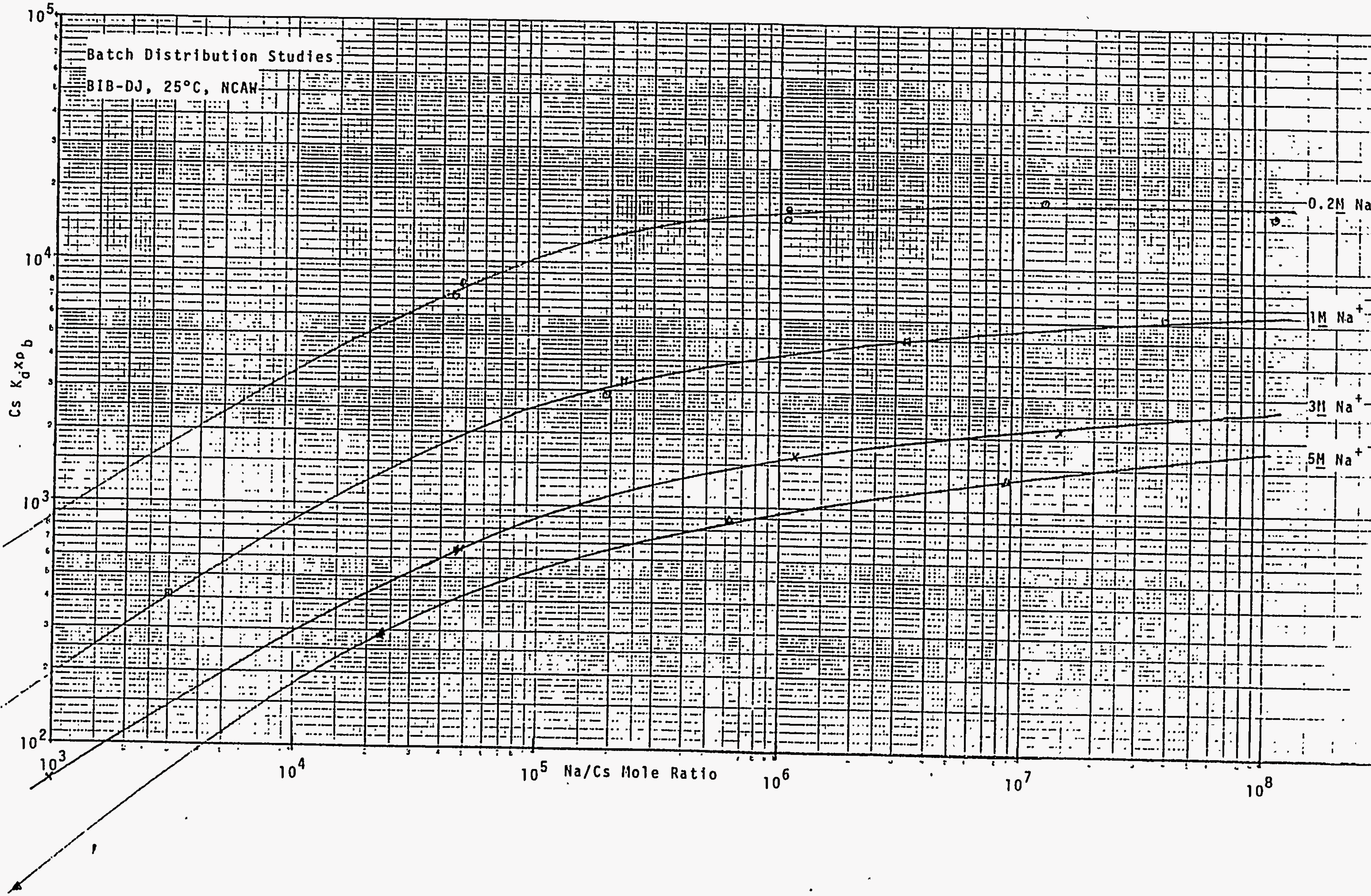
Batch Distribution Studies
CS-100, 10°C, NCAW
0.2M Na+
1M Na+
3M Na+
5M Na+
Cs Kd x ρb
Na/Cs Mole Ratio

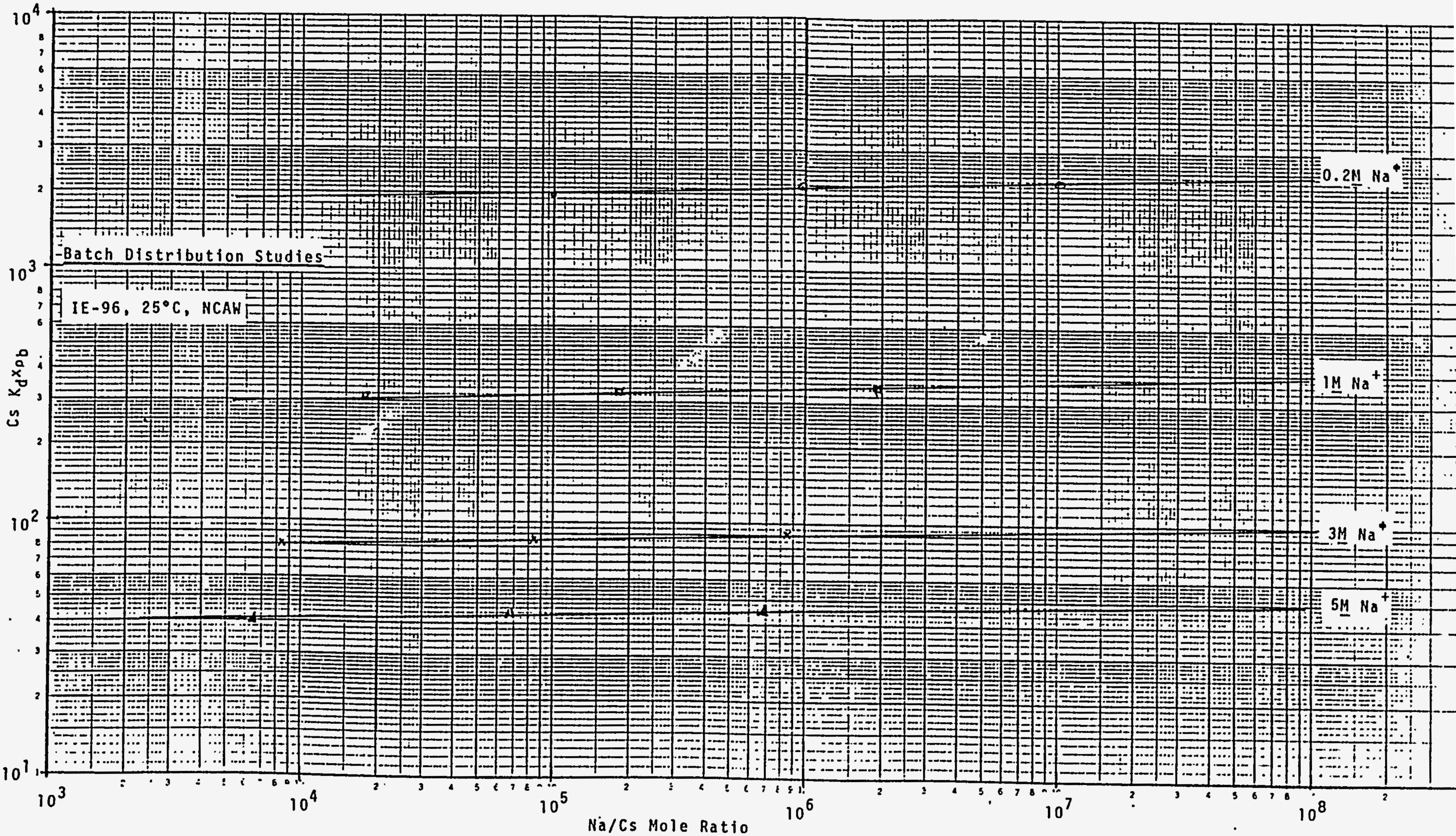
C-3

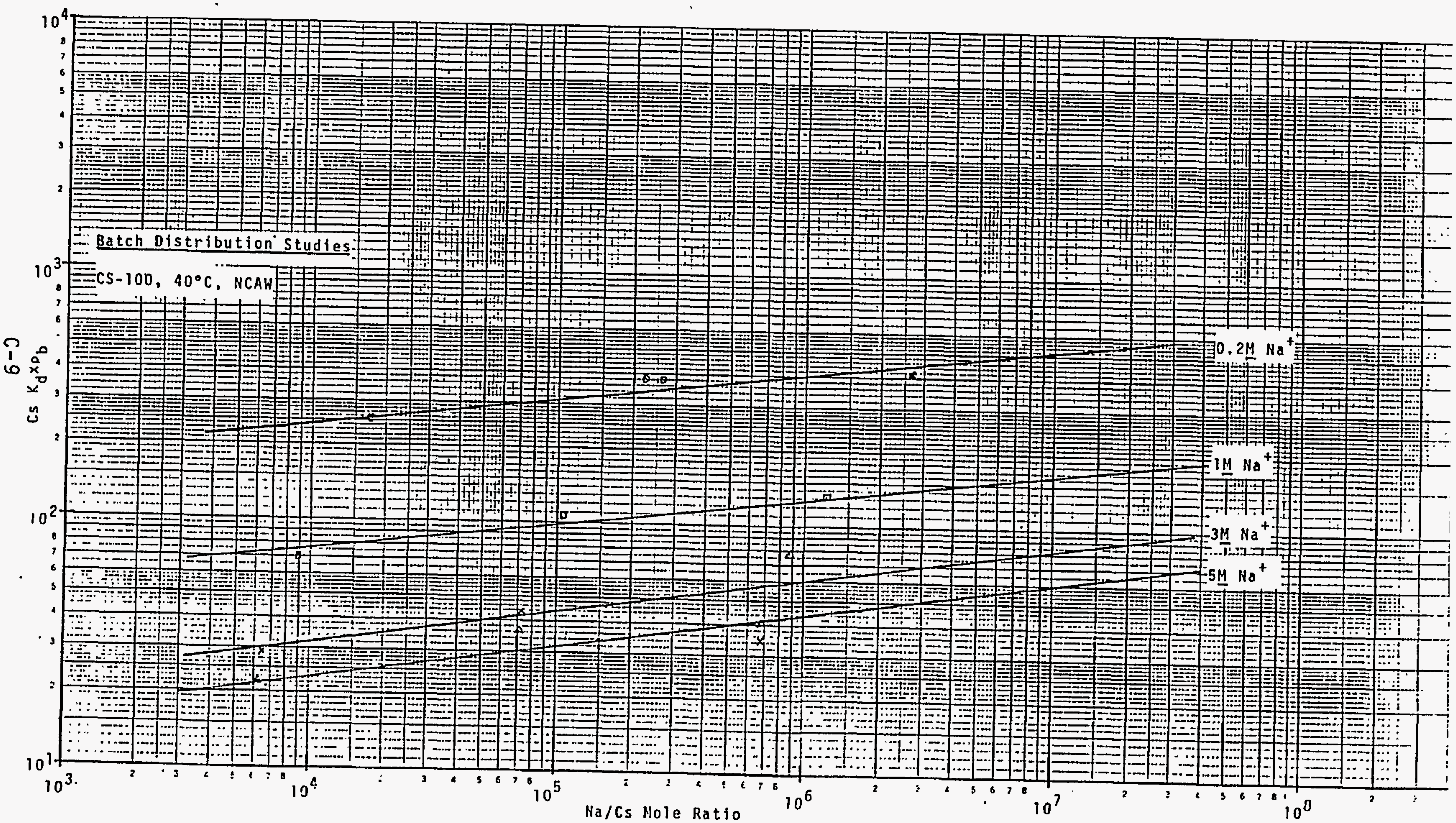

Batch Distribution Studies
BIB-DJ, 10°C, NCAW
Cs $K_d \times \rho_b$
Na/Cs Mole Ratio
10^1
10^2
10^3
10^4
10^5
10^6
10^7


Batch Distribution Studies
IE-96, 10°C, NCAW
0.2M Na+
1M Na+
3M Na+
5M Na+
Cs Kdxρb
Na/Cs Mole Ratio
10^4
10^3
10^2
10^1
10^3
10^4
10^5
10^6
10^7
10^8


Batch Distribution Studies
CS-100, 25°C, NCAW
0.2M Na+
1M Na+
3M Na+
5M Na+
Cs Kd x ρb
Na/Cs Mole Ratio
10^3
10^4
10^5
10^6
10^7
10^8
10^1
10^2


Batch Distribution Studies
BIB-DJ, 25°C, NCAW
0.2M Na
1M Na+
3M Na+
5M Na+
Cs Kd x ρb
Na/Cs Mole Ratio
10^5
10^4
10^3
10^2
10^3
10^4
10^5
10^6
10^7
10^8


Batch Distribution Studies
IE-96, 25°C, NCAW
0.2M Na+
1M Na+
3M Na+
5M Na+
Cs Kd x ρb
Na/Cs Mole Ratio
10^3
10^4
10^5
10^6
10^7
10^8
10^1
10^2


Batch Distribution Studies
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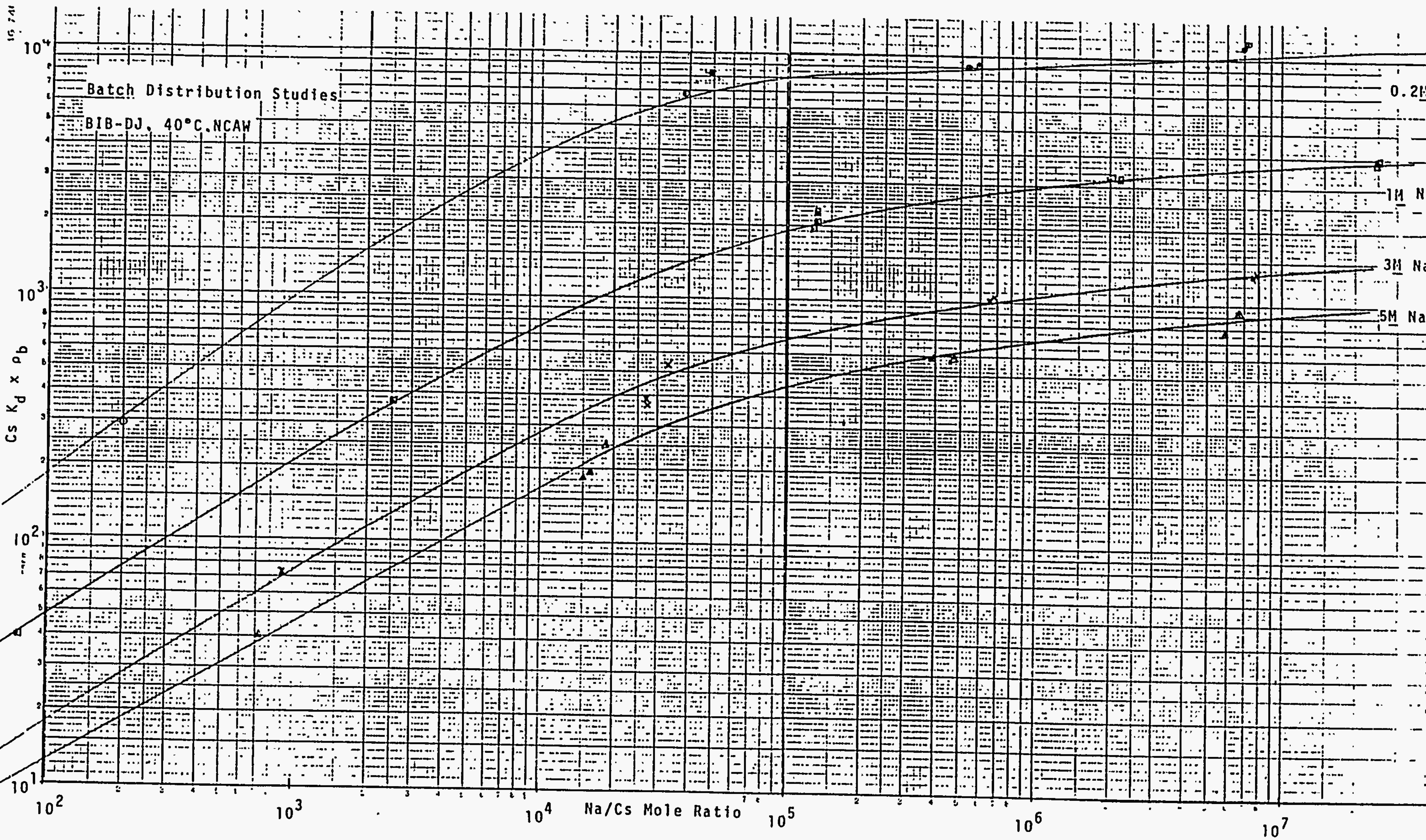
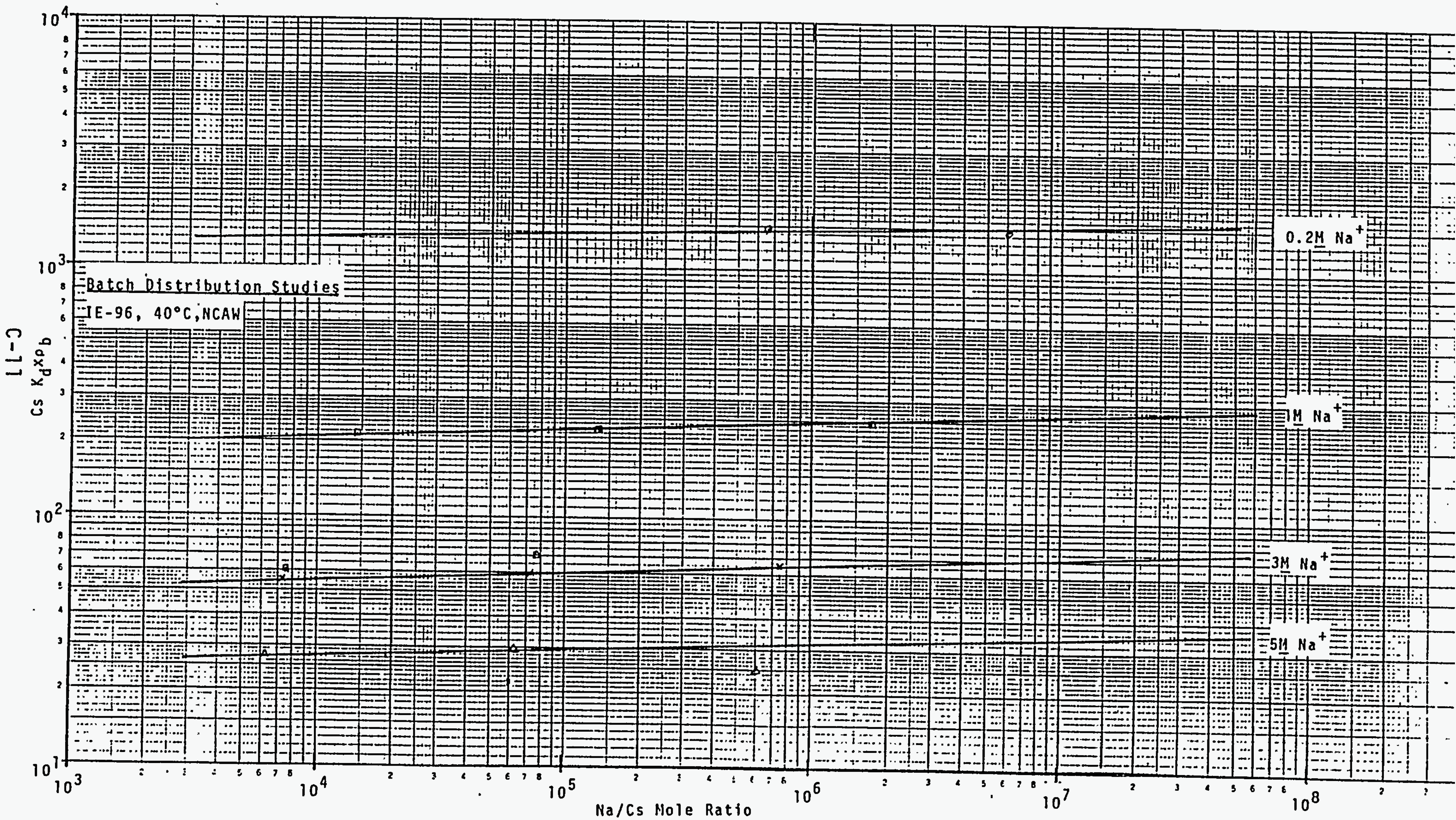
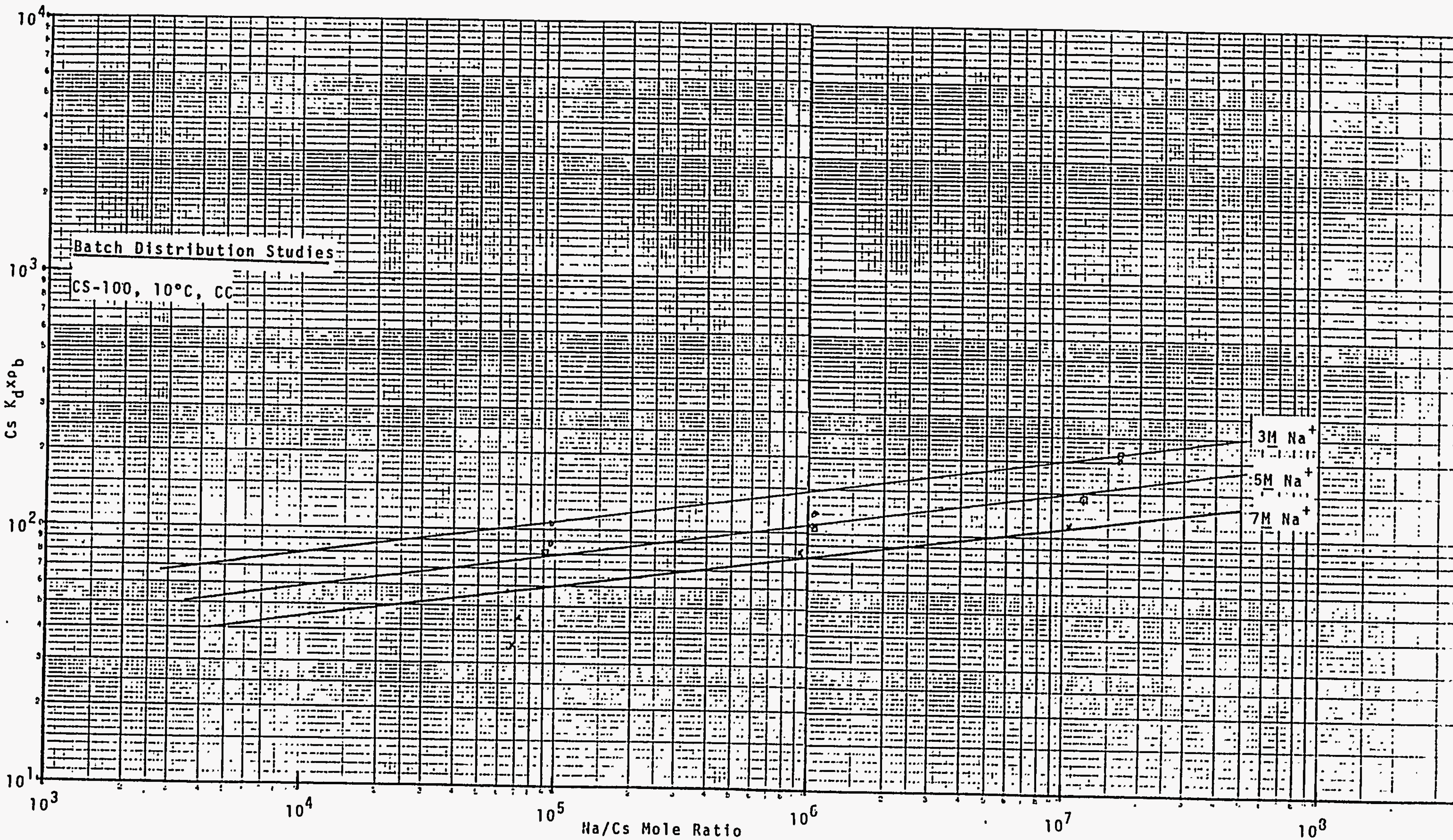
0.2M Na+
1M Na+
3M Na+
5M Na+
Cs Kd x ρb
C-9
Na/Cs Mole Ratio

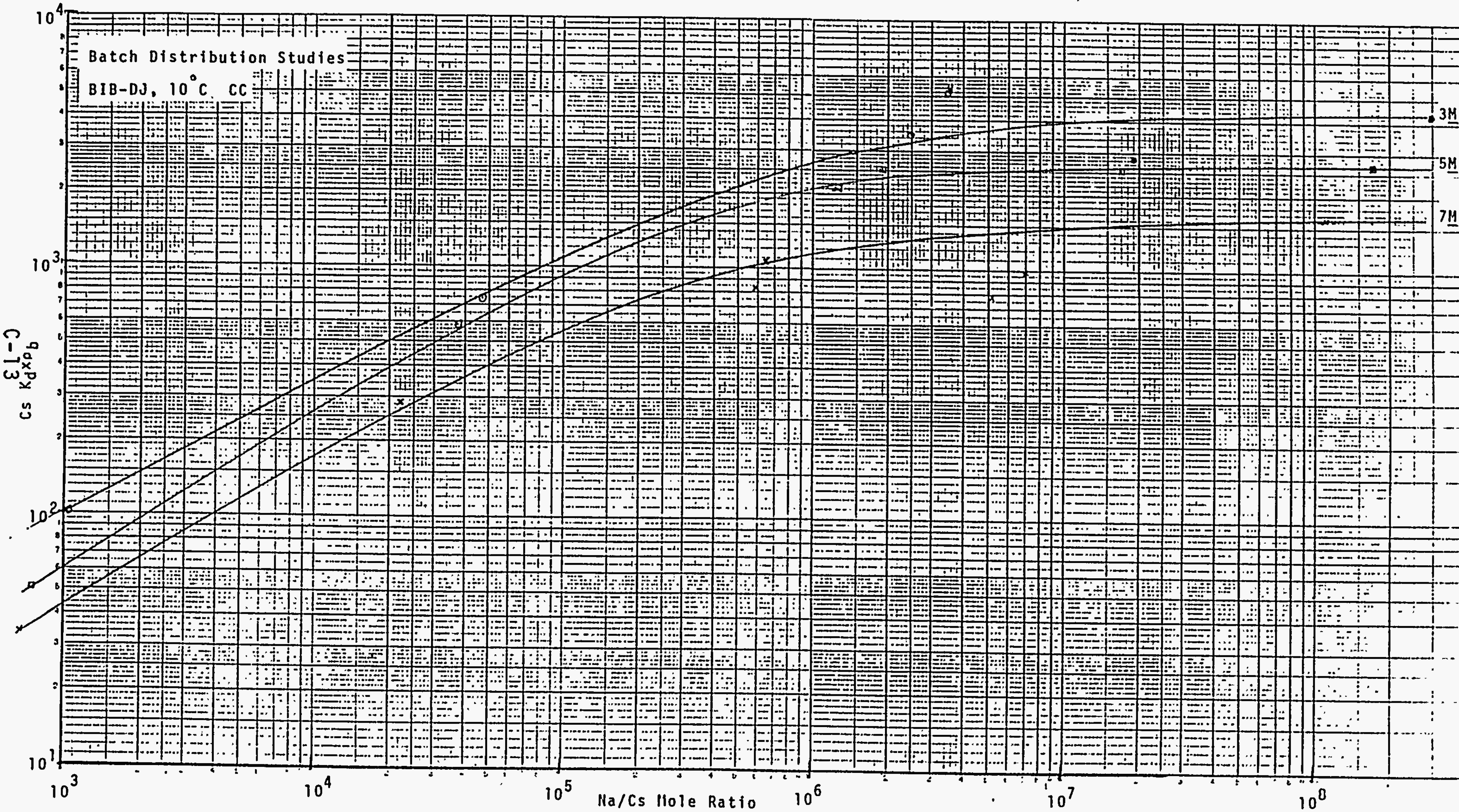


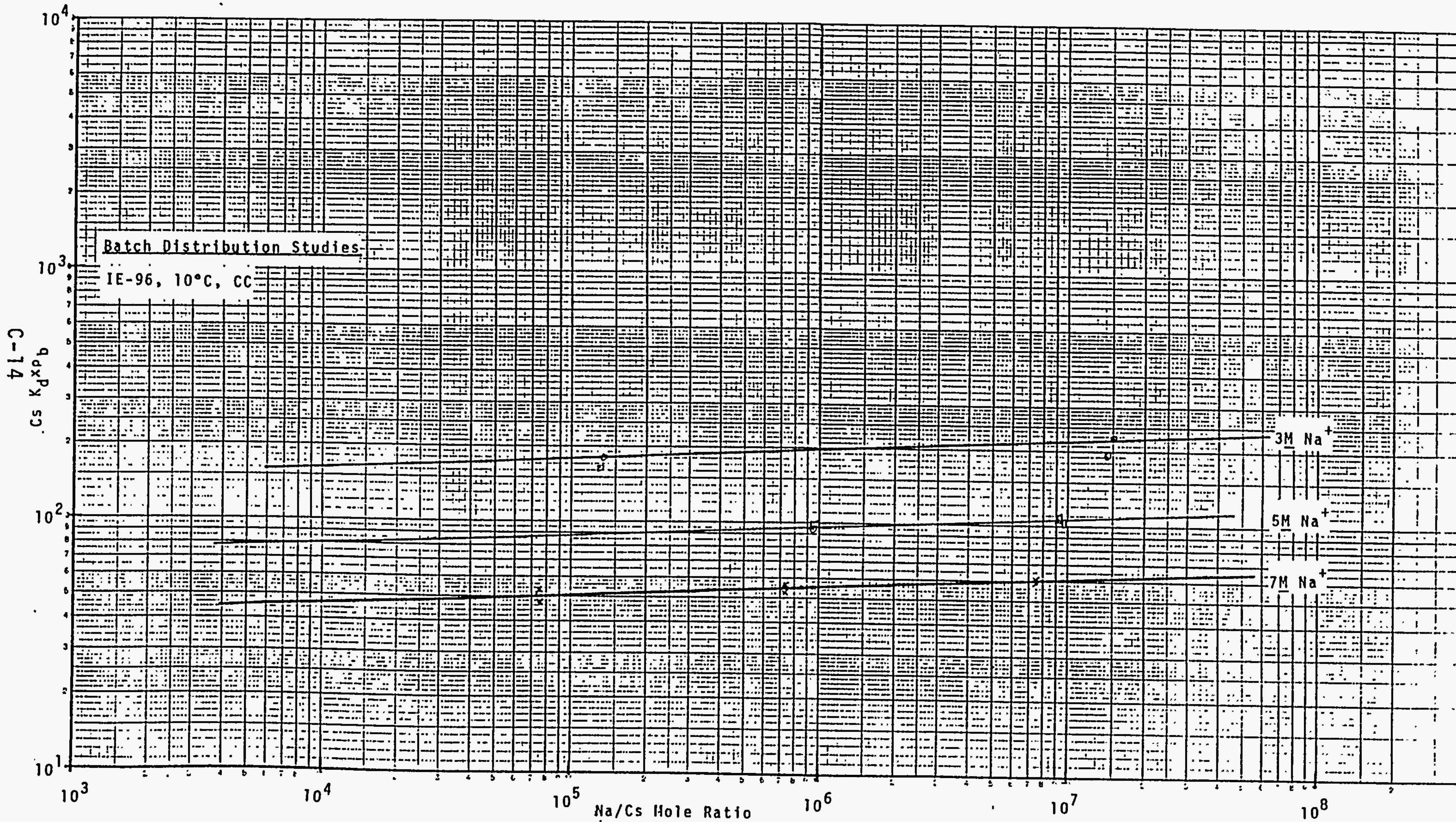
Batch Distribution Studies
BIB-DJ, 40°C,NCAW
0.2M
1M N
3M Na
5M Na
Cs $K_d \times \rho_b$
Na/Cs Mole Ratio



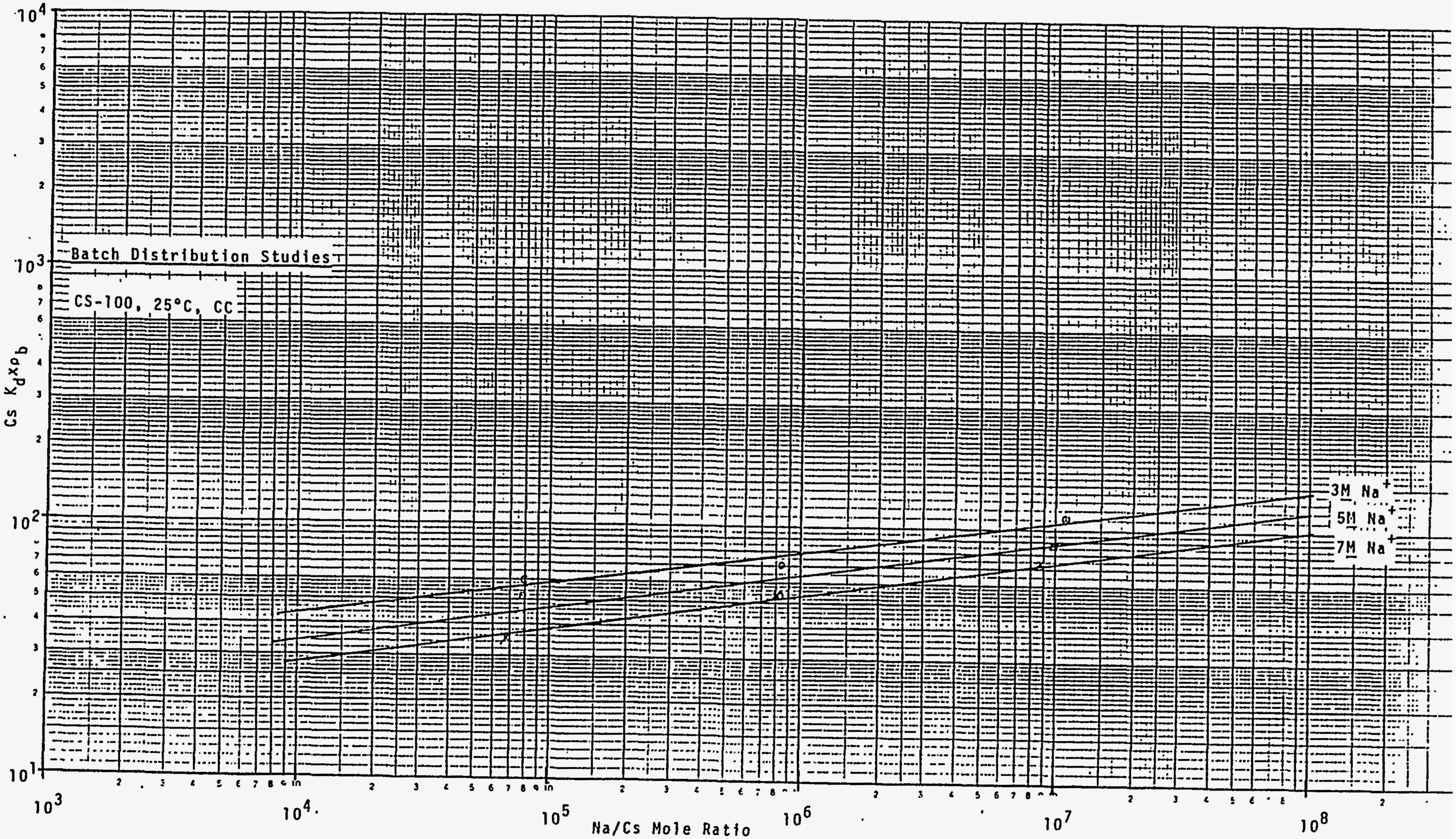
Batch Distribution Studies
IE-96, 40°C, NCAW
Cs $K_d x \rho_b$ [l-1]
Na/Cs Mole Ratio
0.2M Na+
1M Na+
3M Na+
5M Na+

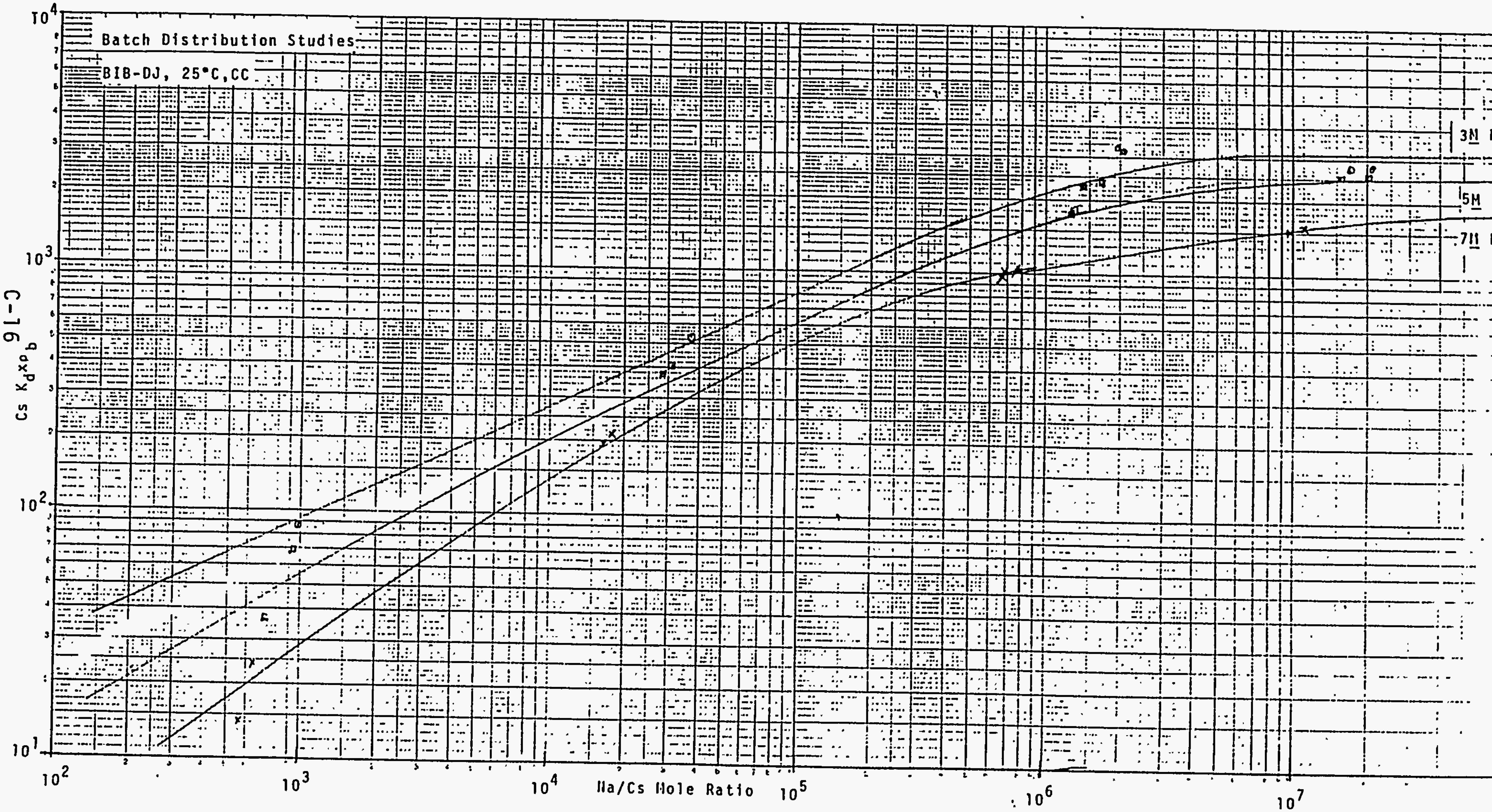

Batch Distribution Studies
CS-100, 10°C, CC
3M Na+
5M Na+
7M Na+
Cs Kd x ρb
Na/Cs Mole Ratio
10^1
10^2
10^3
10^4
10^3
10^4
10^5
10^6
10^7
10^8

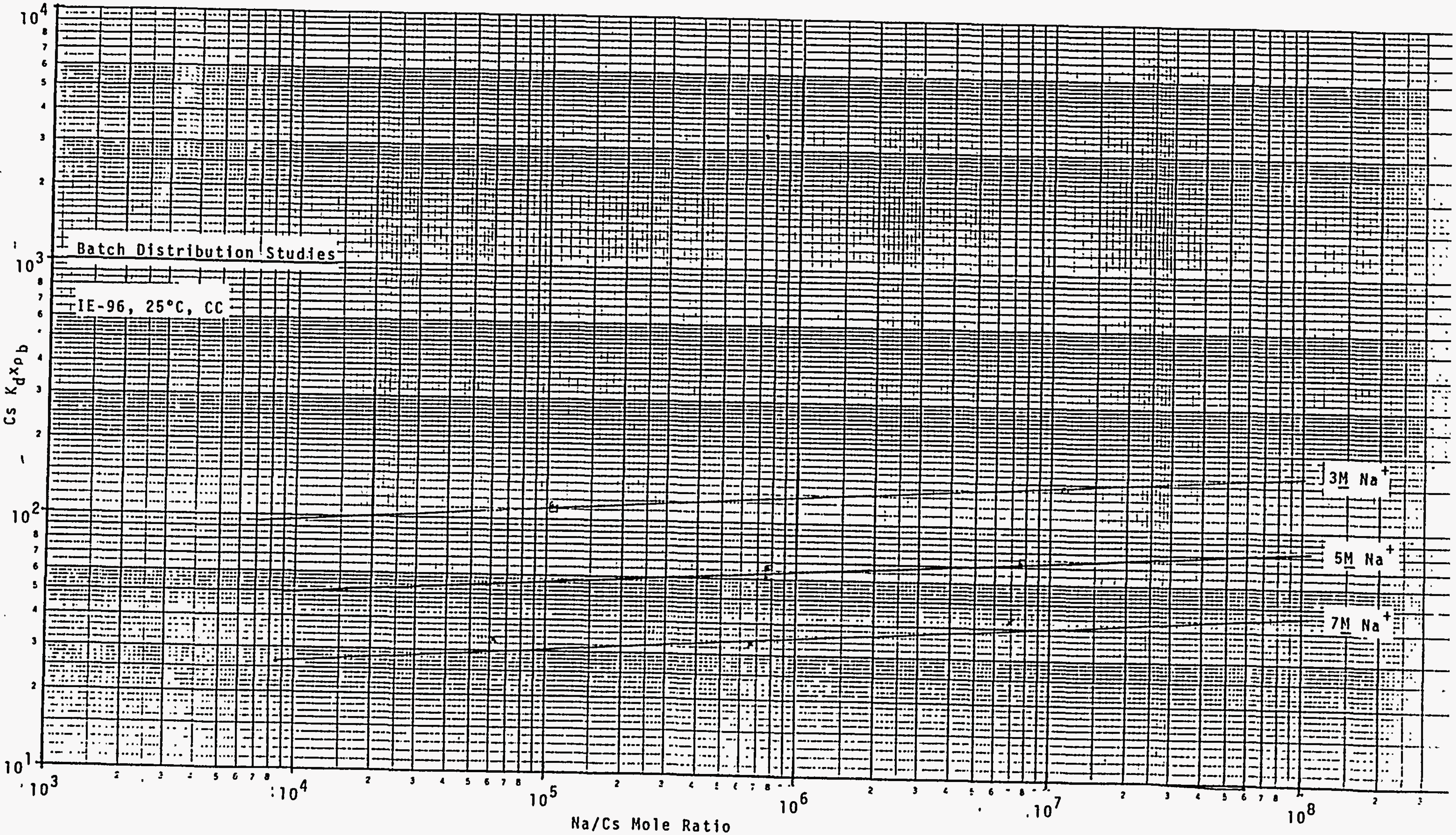

Batch Distribution Studies
BIB-DJ, 10°C CC
3M
5M
7M
Cs $K_d x \rho_b$
Na/Cs Mole Ratio
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8



Batch Distribution Studies
IE-96, 10°C, CC
3M Na+
5M Na+
7M Na+
Cs Kd x ρb
Na/Cs Mole Ratio


Batch Distribution Studies
CS-100, 25°C, CC
Cs Kd x ρb
Na/Cs Mole Ratio
3M Na+
5M Na+
7M Na+
10^4
10^3
10^2
10^1
10^3
10^4
10^5
10^6
10^7
10^8


Batch Distribution Studies
BIB-DJ, 25°C,CC
Cs Kdxρb
C-16
3N
5M
7M
Na/Cs Mole Ratio
10^1
10^2
10^3
10^4
10^5
10^6
10^7


Batch Distribution Studies
IE-96, 25°C, CC
3M Na+
5M Na+
7M Na+
Cs Kd x ρb
Na/Cs Mole Ratio
10^4
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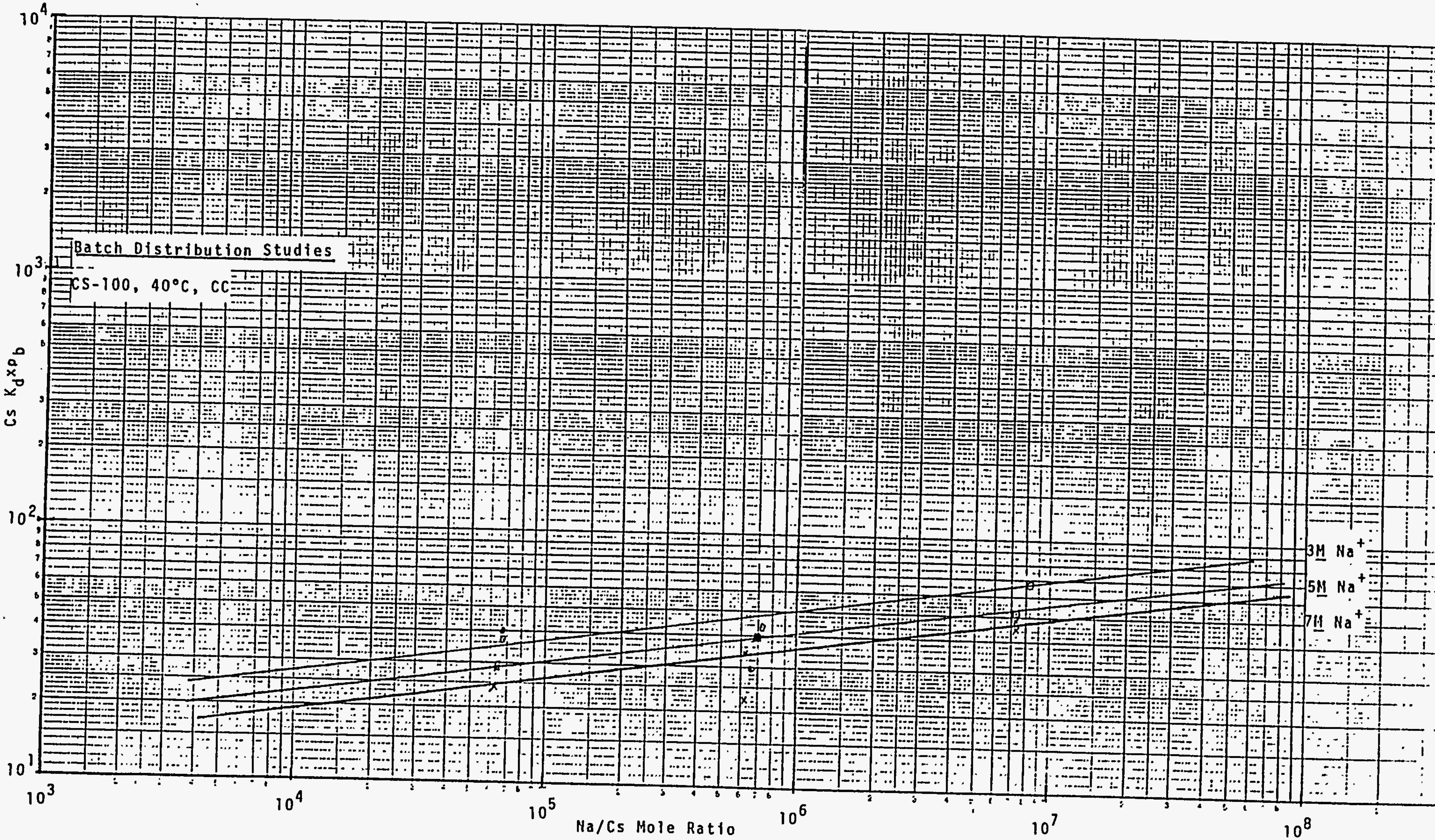
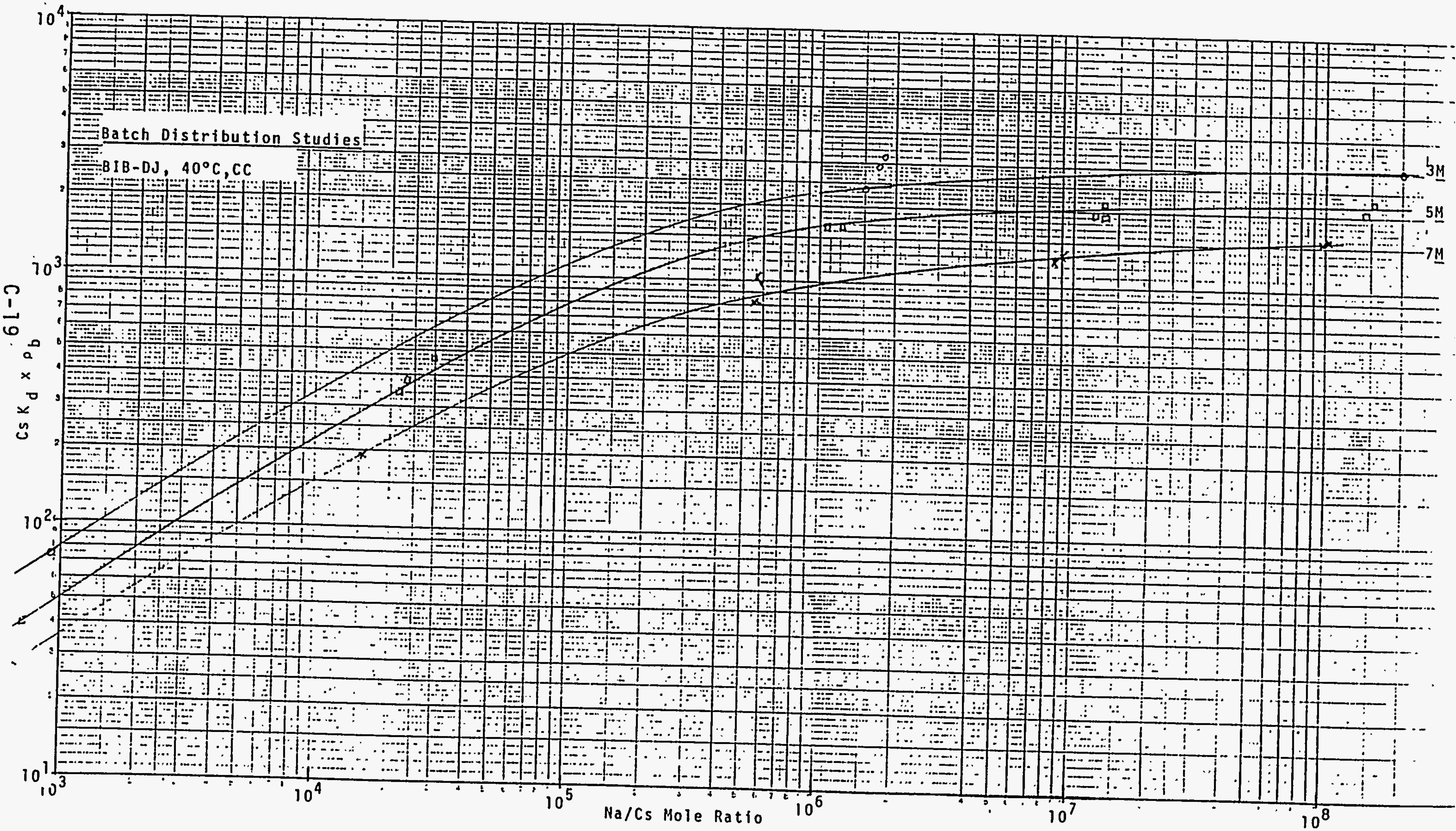
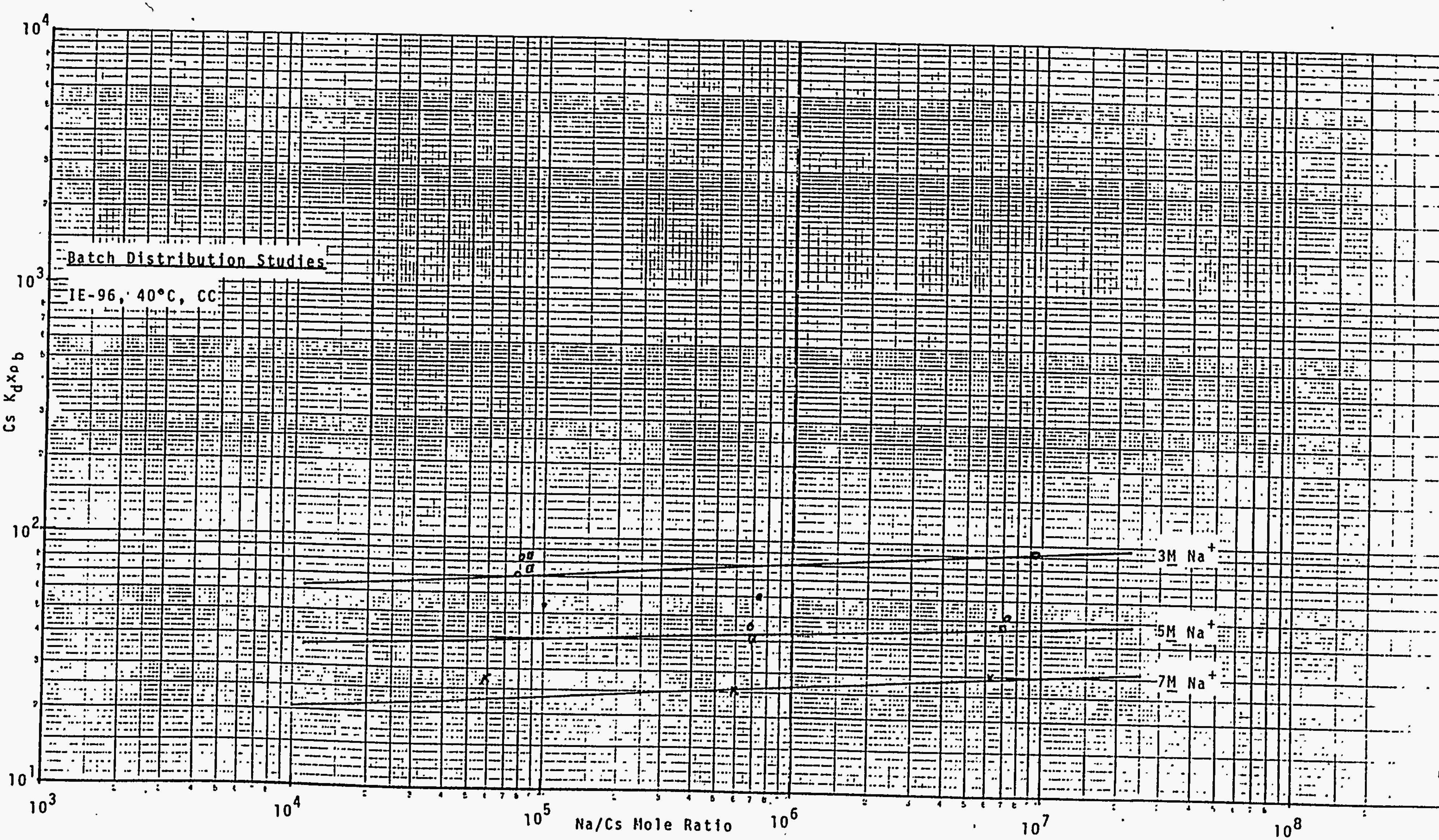
10^2
10^1
10^5
10^6
10^7
10^8


Batch Distribution Studies
CS-100, 40°C, CC
Cs K_d x p_b
Na/Cs Mole Ratio
3M Na+
5M Na+
7M Na+
10^4
10^3
10^2
10^1
10^5
10^6
10^7
10^8


Batch Distribution Studies
BIB-DJ, 40°C,CC
3M
5M
7M
Cs K_d x ρ_b
Na/Cs Mole Ratio
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8


Batch Distribution Studies
IE-96, 40°C, CC
Cs Kdxρb
Na/Cs Mole Ratio
3M Na+
5M Na+
7M Na+
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8