ORNL/TM-6631

The Distribution of Iron During Full Loading of Amberlite IRC-72 Resin with Uranium from Nitrate Solutions at 30°C

J. H. Shaffer
C. W. Greene

OAK RIDGE NATIONAL LABORATORY
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National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy $4.50; Microfiche $3.00

ORNL/TM-6631
Dist. Category UC-77

Contract No. W-7405-eng-26

CHEMICAL TECHNOLOGY DIVISION

HTGR Fuel Recycle Development Program (189 #OH0145)
Fuel Reprocessing (Task 300)

THE DISTRIBUTION OF IRON DURING FULL LOADING OF AMBERLITE IRC-72 RESIN WITH URANIUM FROM NITRATE SOLUTIONS AT 30°C

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JANUARY 1979

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THE DISTRIBUTION OF IRON DURING FULL LOADING OF AMBERLITE IRC-72 RESIN WITH URANIUM FROM NITRATE SOLUTIONS AT 30°C

J. H. Shaffer
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ABSTRACT

The integrity of resin-based fuel kernels used in the fabrication of fuel elements for a high-temperature gas-cooled reactor will depend, in part, on the concentration of iron incorporated in the resin particles during their loading with uranium. Consequently, assessment of chemical specifications for iron as an impurity in uranyl nitrate solution should be based on its distribution during the resin loading operation. For this purpose, the behavior of iron, as an impurity in uranyl nitrate solutions, was investigated under equilibrium conditions at 30°C during full loading of Amberlite IRC-72 cation exchange resin with uranium. Equilibrium quotients for the exchange reaction were derived from calculations based on complex coordination of ferric ion with the resin over the nitrate ion concentration range of ∿0.5 to 2 N.

1. INTRODUCTION

As developed by the Thorium Utilization Program, high-temperature gas-cooled reactor (HTGR) fuels can be fabricated using fuel kernels derived from spherical cation exchange resins which have been fully loaded with fissionable uranium. This fabrication method simplifies the recycle of ^{233}U in that the ion exchange resin can be loaded directly from the uranyl nitrate product stream of a fuel reprocessing facility. These uranium-bearing particles are dried, subjected to successive thermal processes for carbonization and partial conversion to uranium carbide, and coated with carbon and silicon carbide during fabrication of the microsphere fuel kernels.

Resin loading with uranyl ion consists of the direct contact of a weak-acid cation exchange resin, in hydrogen form, with uranyl nitrate solution under conditions of chemical equilibrium and may be accomplished by either a batch or a countercurrent contact processing method.[1]

Adjustment of the uranyl nitrate feed stream to provide for the partial removal of nitrate ion, with respect to uranyl ion, may be necessary to achieve full resin loading. This requirement has been defined by a systematic study of the exchange reaction under conditions of chemical equilibrium for both Amberlite IRC-72* and Duolite C-464** resins.[2] The study of iron distribution during resin loading with uranium, presented in this report, represents an extension of the investigation on chemical equilibria associated with the resin loading process.

The purpose of this study was to define the behavior of iron, as an impurity in the uranyl nitrate feed stream, during full resin loading with uranium. The experimental results would be applicable for establishing realistic iron impurity specifications for the uranyl nitrate feed solution in an HTGR fuel fabrication facility. The scope of the experimental program was limited to very dilute concentrations of ferric ion in uranyl nitrate solutions and to uranyl ion concentrations, relative to nitrate ion concentration, which would be in equilibrium with resin that is fully loaded with uranium. Ferric ion concentrations used in this study corresponded to iron impurities of 25 to 1000 ppm by weight with respect to uranium in the uranyl nitrate feed solution at nitrate ion concentrations which ranged from ~0.5 to 2 N.

2. LABORATORY METHOD

The experimental procedure developed for this study was very similar to that used to determine equilibrium quotients for the primary reaction of uranyl ion with the resin. A series of five tests were conducted in which the nitrate and uranium concentrations were held constant and the iron concentration was varied from 25 to 1000 ppm by weight with respect to uranium. Each test consisted of a small batch loading of 15 ml of Amberlite IRC-72 resin (sized 540 to 623-μ diam in hydrogen form) by adding 100 ml of a standardized nitric acid solution and sufficient UO_3 to yield >90% loading of the resin with uranyl ion under equilibrium conditions at 30°C. Iron(III) nitrate was prepared as standard solutions

*A trademark of the Rohm and Haas Corporation.
**A trademark of the Diamond-Shamrock Company.

in nitrate acid having the same normality as that of the test series. In this manner, the introduction of iron into each test mixture was regulated by volumetric addition as a component of the standard nitric acid solution. Each test was contained in a 250-ml Erlenmeyer flask fitted with a ground glass stopper. Flasks that comprised one test series were equilibrated simultaneously by immersion and agitation within a constant-temperature water bath of commercial design. The reaction period was terminated when the acidity of each test solution showed negligible change in pH with time. In order to preserve equilibrium conditions after conclusion of the reaction period, the flasks were removed from the bath one at a time, and the contents were quickly poured onto a fritted glass filter which was connected to a vacuum source. The volume of filtrate was measured and the solution retained for analysis. The resin was washed free of uranyl nitrate solution with distilled water and oven dried at 110°C on the filter. The dried resin from each test was weighed and retained for analysis.

Because of the very low iron concentrations planned for this program, values for iron were derived from radiochemical analyses of the ^{59}Fe which had been added to each test. Approximately 15 mg of $^{59}Fe_2O_3$ was irradiated in the Oak Ridge Research Reactor to yield ∿0.1 mCi of ^{59}Fe gamma activity. This material together with a tared quantity of iron metal wire was dissolved in a known volume of standard 2.0 N nitric acid to make up the primary $Fe(NO_3)_3$-HNO_3 standard solution. Standard solutions at lower nitric acid concentrations were prepared by a successive dilution technique. Although the irradiated iron oxide was sparingly soluble in nitric acid, sufficient gamma activity was dissolved in or exchanged with the solution to yield a specific activity of ∿2.8 x 10^6 disintegrations per minute per gram of iron. Samples were withdrawn from each standard solution for radiochemical calibration standards.

Materials requirements for all test series conducted during this program are outlined in Table 1. The iron requirement for each test was a relative value of the uranium content. Iron concentrations were expressed as parts per million by weight with respect to the weight of uranium in each test and were varied from 25 to 1000 ppm. The

Table 1. Materials outline for distribution of iron during loading of Amberlite IRC-72 resin with uranium from nitrate solutions at 30°C

(Resin vol, 15 ml; nitric acid vol, 100 ml; calculated resin loading, 90%)

Nitrate ion (N)	UO_3 (g/test)	Uranium content (g/test)	Iron requirements (g) for selected iron concentrations, ppm/U				
			1000	300	100	50	25
0.2	11.0	9.2	9.2×10^{-3}	2.76×10^{-3}	9.2×10^{-4}	4.6×10^{-4}	2.3×10^{-4}
0.6	17.5	14.6	1.46×10^{-2}	4.38×10^{-3}	1.46×10^{-3}	7.3×10^{-4}	3.7×10^{-4}
1.0	23.5	19.6	1.96×10^{-2}	5.88×10^{-3}	1.96×10^{-3}	9.8×10^{-4}	4.9×10^{-4}
1.6	35.0	29.1	2.91×10^{-2}	8.73×10^{-3}	2.91×10^{-3}	1.46×10^{-3}	7.3×10^{-4}
2.0	41.5	34.5	3.45×10^{-2}	1.04×10^{-2}	3.45×10^{-3}	1.73×10^{-3}	8.6×10^{-4}

quantity of UO_3 added to each test was determined by considering equilibrium measurements from the earlier program.[2]

3. EXPERIMENTAL RESULTS

The data obtained from this program were derived from the results of chemical analyses of filtrate and dried resin samples from each test for uranium. Corresponding values for iron in each sample were obtained by radiochemical analyses. The nitrate ion concentration of each test solution was also confirmed by chemical analyses. These data are summarized in the appendix of this report.

Using gamma energy intensity as a measure of iron required an additional test, without added iron, for each series in order to examine radiation background levels. Uranium daughter products that were present in the UO_3 were also exchanged onto the resin and had gamma activities which significantly enhanced the gamma intensity attributed to ^{59}Fe activity. Consequently, both liquid and resin samples from these blank runs were used to determine background corrections for the radiochemical method. The magnitude of these background corrections together with the very low iron concentrations in the test solutions made it necessary to reject data obtained at a nitrate ion concentration of 0.2 N.

4. DISCUSSION

The experimental program was designed to examine the distribution of iron, as an impurity in uranyl nitrate solution, under conditions of essentially full resin loading with uranium. This relation may be described as the simple metathesis

$$2Fe^{3+} + 3UO_2R_2 \rightleftarrows 2FeR_3 + 3UO_2^{2+}, \qquad (1)$$

where R denotes the anionic exchange group of the resin. The equilibrium quotient, K_Q, for this reaction may be expressed as

$$K_Q = \frac{[FeR_3]^2[UO_2^{2+}]^3}{[Fe^{3+}]^2[UO_2R_2]^3}, \qquad (2)$$

where concentrations are expressed as moles per unit volume for both the aqueous and resin phases. As defined for this study, the resin volume was its solid volume and was calculated to be six-tenths of its measured bulk volume in hydrogen form. For application to the engineering process, Eq. (2) was expressed as

$$[Fe/U]_R^2 = K_Q D_U [Fe/U]_{aq}^2, \qquad (3)$$

where [Fe/U] denotes the concentration of iron with respect to uranium in the designated phase. This relative concentration term may also have units of parts per million by weight of iron per unit weight of uranium without altering the value for K_Q. The uranium distribution coefficient, D_U, was defined as its concentration ratio (resin/aqueous). Since each test series was conducted at constant D_U values and constant nitrate ion concentrations, Eq. (3) expresses the concentration of iron in the resin phase as a function of its concentration in the aqueous phase. However, a typical illustration of the data plotted according to Eq. (3) in Fig. 1 shows a nonlinear relation between these system variables. This nonlinear relationship was also evident from calculated values of K_Q for all test series. In each case, the value for the iron separation factor, $[Fe/U]_R/[Fe/U]_{aq}$, was larger than unity and increased with increasing iron concentrations in the aqueous phase. Thus, within the validity of the experimental data, the behavior of iron in the exchange system is apparently more complex than that implied by Eq. (1).

Because of the limited scope of the experimental program, the true behavior of iron in the exchange system could not be adequately described. However, reasonable correlation of the data was obtained by considering the coordination of iron by the resin as

$$Fe^{3+} + \frac{3}{2}(UO_2)_R \rightleftarrows \frac{1}{M}(Fe_M)_R + \frac{3}{2}UO_2^{2+}, \qquad (4)$$

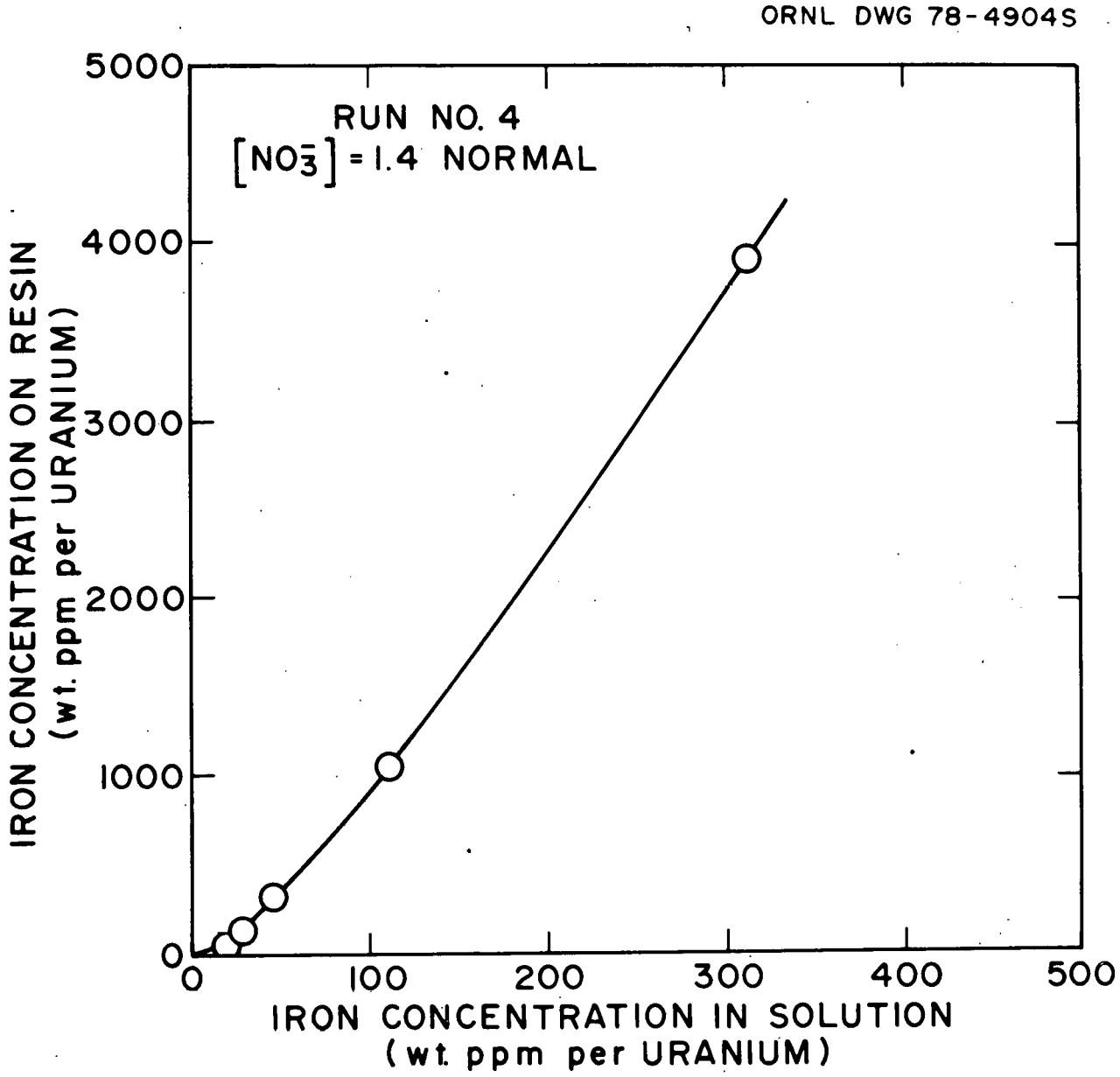

Fig. 1. Distribution of iron during full loading of Amberlite IRC-72 resin with uranium from nitrate solution at 30°C.

where M denotes the degree polymerization of Fe(III) in the resin phase. This complex behavior could also be assigned, mathematically, as a function of hydrolysis in the aqueous phase. Under the experimental conditions of the various test series, this argument would contradict that of current hydrolysis theory.[3] In addition, infrared spectral analyses of loaded cation exchange resins have indicated complex bonding between uranyl ion and other cations and the carboxyl exchange groups of the resin.[4] Comparable results obtained from a similar study of the thorium distribution during resin loading with uranium from nitrate solution relied on an empirical expression of the activity coefficient ratio of thorium for correlation of the experimental data.[5] However, this correlation was not satisfactory for explaining Fe(III) behavior in this study.

The equilibrium constant for the reaction noted as Eq. (4) may be expressed as

$$K = \frac{[(Fe)_M]_R^{1/M} \; [UO_2^{2+}]^{3/2}}{[Fe^{3+}][UO_2]_R^{3/2}} , \qquad (5)$$

where the subscript, R, denotes the resin phase. Concentration terms were calculated as molar quantities. Since the uranium distribution coefficient, D_U, was maintained at a constant value for each test series, Eq. (5) could be evaluated as a linear expression from its logarithmic form,

$$\ln [(Fe)_M]_R = M \ln [Fe^{3+}] + M \ln (KD_U^{3/2}). \qquad (6)$$

Values for M were determined by successive linear regression analysis until the best fit of the data was obtained. Corresponding values for K were calculated from the intercept value, I, by the expression

$$I = M \ln K + 3/2M \ln D_U. \qquad (7)$$

The results of these analyses are summarized in Table 2 and are included in the appendix.

The apparent dependence of the coordination factor, M, on the nitrate ion concentration is graphically illustrated in Fig. 2. Within the range and accuracy of the experimental data, these values increased as a continuous function from unity to an apparent constant value of ∿1.5 as the nitrate ion concentration was increased. The effect of nitrate ion on the calculated values for K is shown in Fig. 3. Experimental values for D_U, which approximated those for full resin loading with uranium, are plotted versus nitrate ion concentration in Fig. 4.

Table 2. Summary of constants from linear regression analysis of experimental data according to:

$$\ln [(Fe)_M]_R = I + M \ln[Fe^{3+}]$$
$$I = M \ln (K) + 3/2\ M \ln (D_U)$$

Run No.	$[NO_3^-]$	D_U[a]	I	M	K[b]
1[c]	0.18	21.6	-	(1.06)	(3.5)
2	0.56	7.7	6.62	1.18	9.0
3	0.89	4.7	5.44	1.30	11.6
4	1.39	2.9	6.70	1.49	13.0
5	1.75	2.4	6.02	1.52	15.9
			Av 6.20 ± .59		

[a]Equilibrium distribution coefficient for uranium at full resin loading ($[UO_2R_2]/[UO_2^{2+}]$).

[b]Calculated using average value for I.

[c]Analytical values for iron in solution were too low for it to be significant. Values for M and K were calculated by extrapolation.

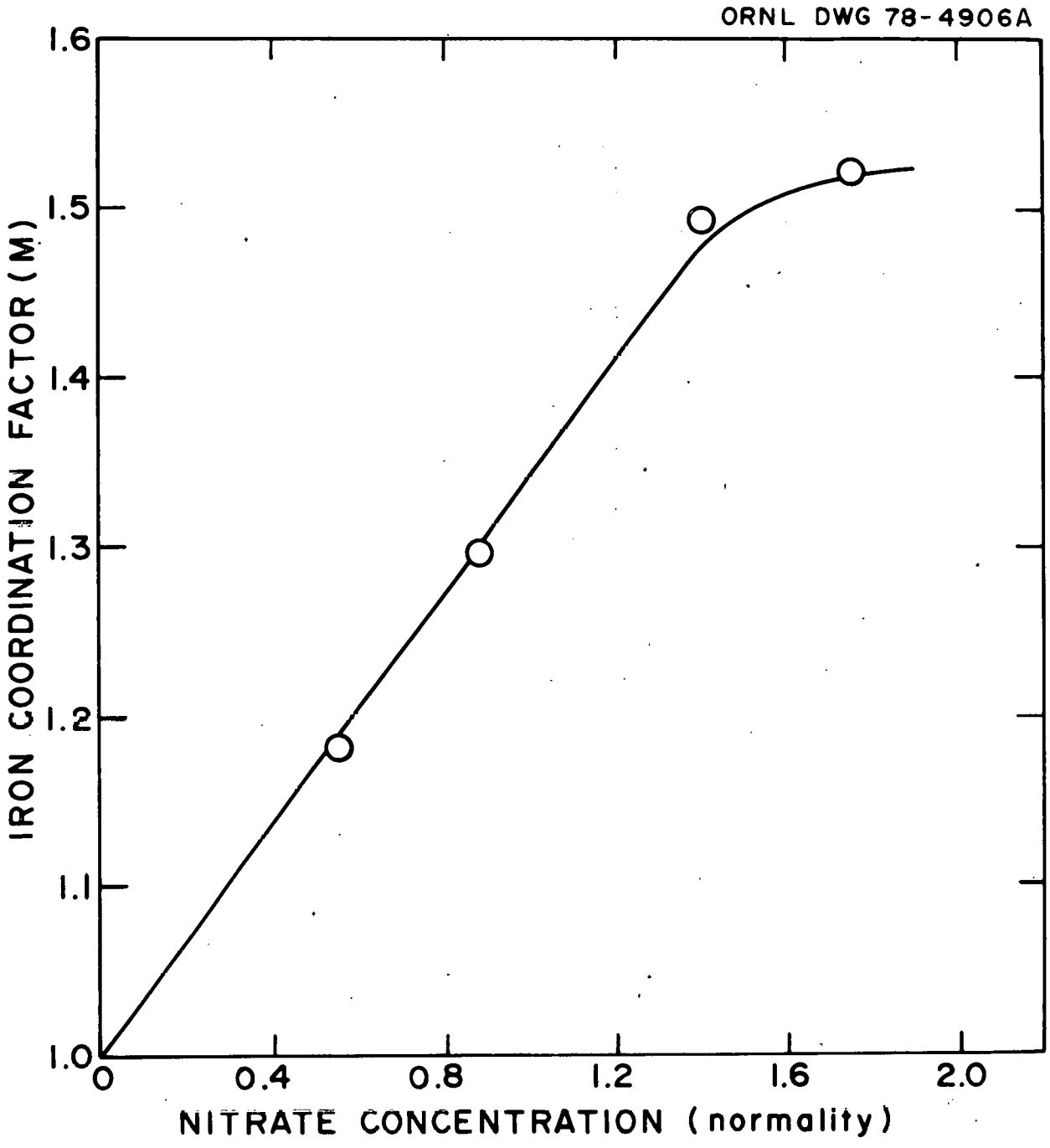

Fig. 2. Effect of nitrate concentration on the coordination of iron with Amberlite IRC-72 resin during full resin loading with uranium from nitrate solution at 30°C.

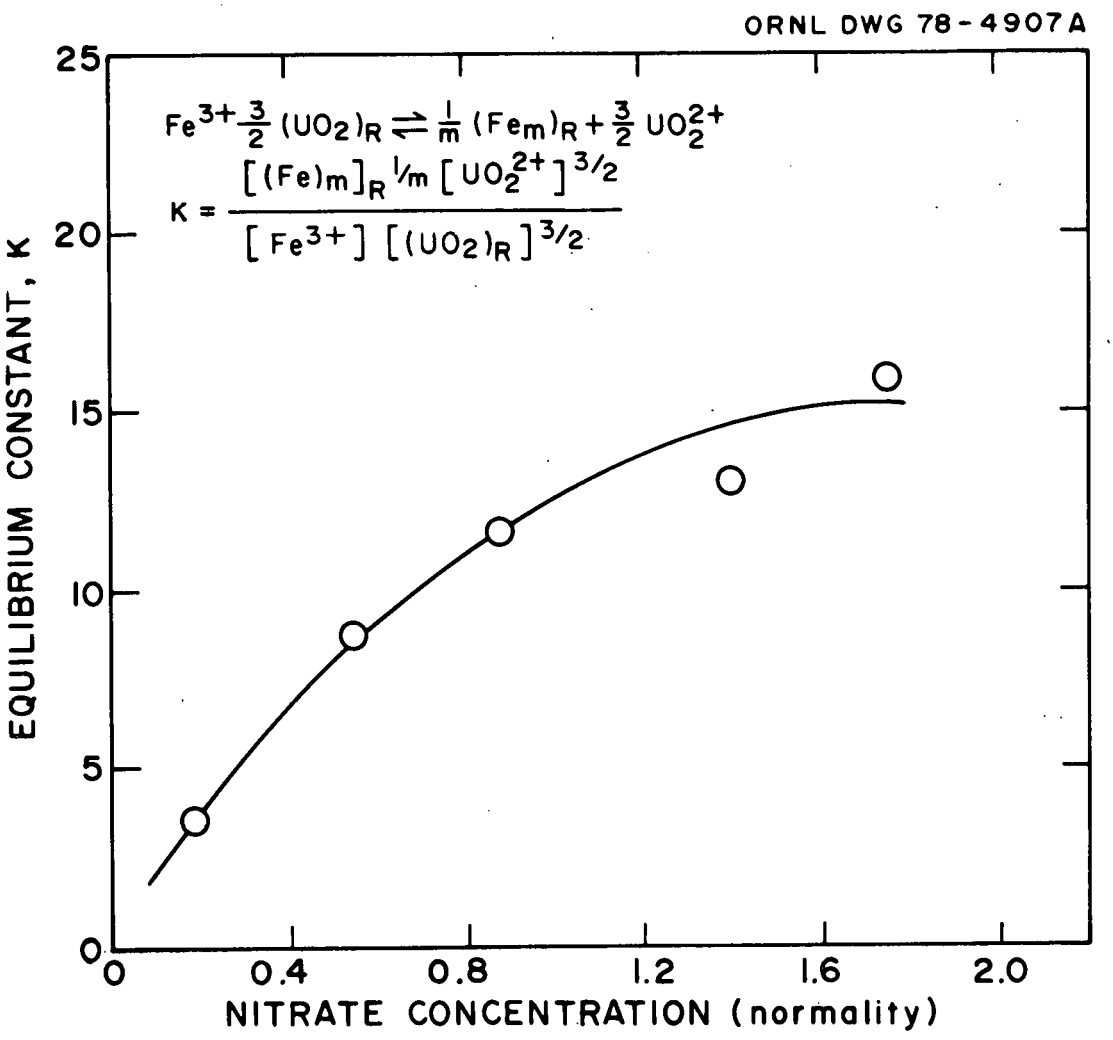

Fig. 3. Effect of nitrate concentration on the equilibrium distribution of ferric and uranyl ions between Amberlite IRC-72 resin and nitrate solution at full resin loading with uranium at 30°C.

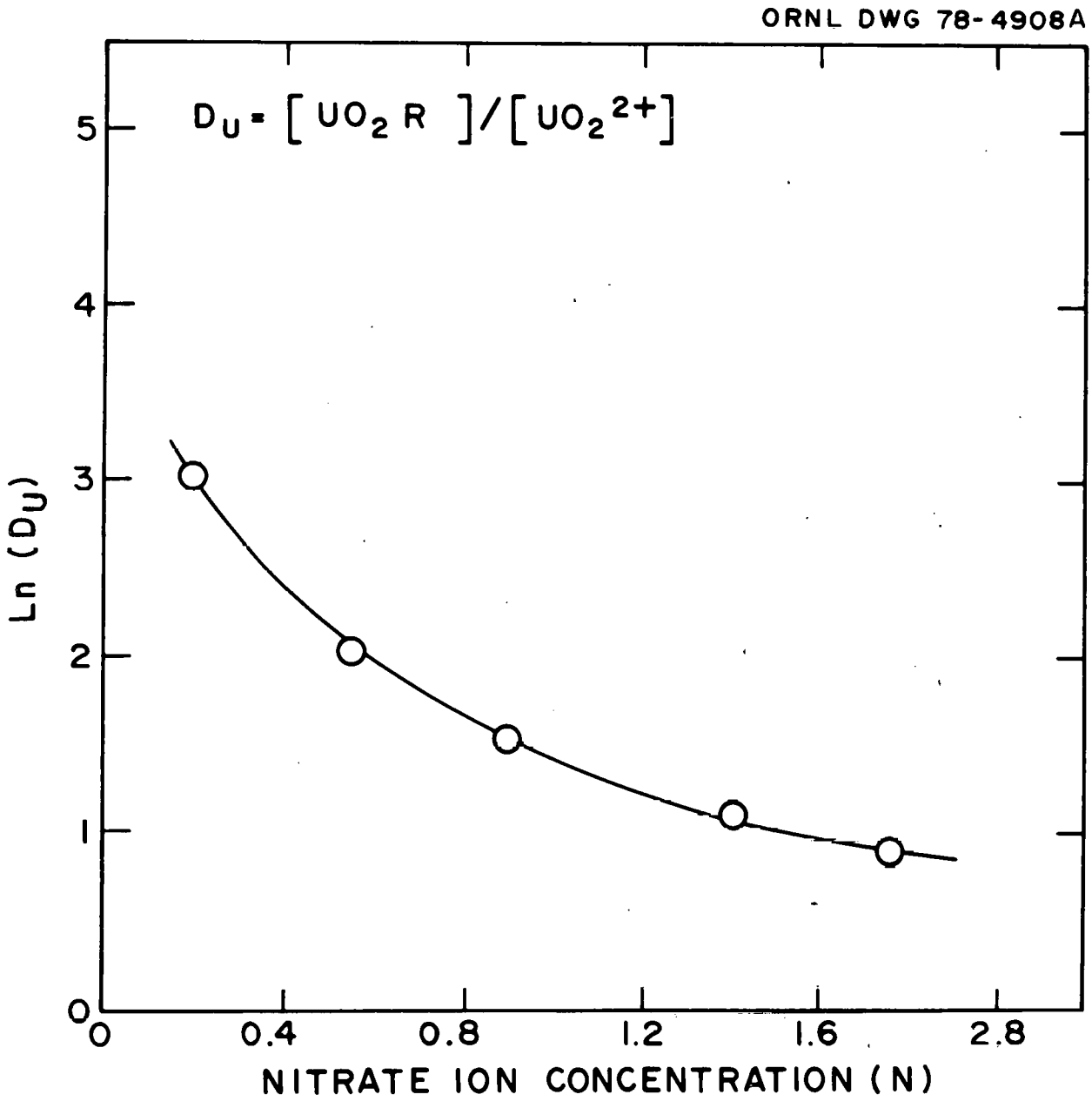

Fig. 4. The dependence of uranium distribution coefficient on nitrate ion concentration for full resin loading at 30°C.

The metathetical reaction of Fe(III) with resin loaded with uranyl ion may be related to the individual cation exchange reaction with the hydrogen form of the resin by

$$Fe^{3+} + 3(H)_R \rightleftarrows \frac{1}{M}(Fe)_M + 3H^+ \qquad (8)$$

and

$$UO_2^{2+} + 2(H)_R \rightleftarrows (UO_2)_R + 2H^+, \qquad (9)$$

through their respective equilibrium quotients. Thus, the equilibrium quotient, K_{Fe}, for Eq. (8) may be calculated from values for the equilibrium quotient, K_U, for Eq. (9) and values for K from Eq. (5) generated from this investigation by the relation

$$K_{Fe} = (K_{Fe-U})(K_U)^{3/2}. \qquad (10)$$

Values for K_{Fe} obtained from Eq. (10) together with those obtained for K_U in a related investigation (ref. 2) are shown graphically in Fig. 5.

5. CONCLUSIONS AND RECOMMENDATIONS

The apparent complexity of the exchange of ferric ion with Amberlite IRC-72 cation exchange resin from nitrate solution has required interpretation of the data beyond the scope of the experimental program. However, these interpretations have provided consistent correlations over nitrate ion concentrations of ~0.5 to 2 N and may provide the basis for a more fundamental investigative program. Increased iron concentrations would permit the use of alternate or comparative analytical methods and should improve both the accuracy and precision of the data. Direct examination of the resin particles may also elucidate complex bonding properties of the exchange resins.

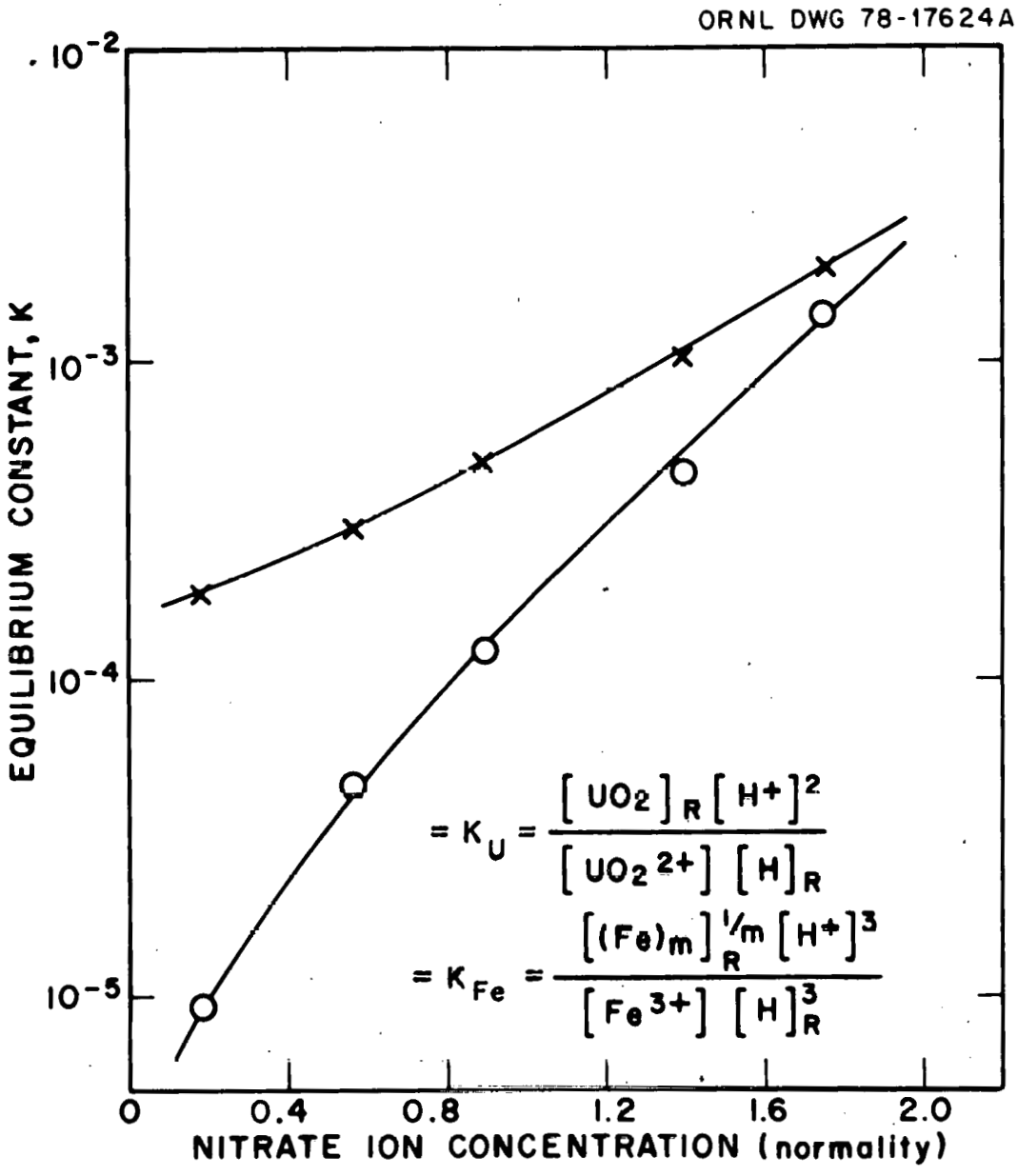

Fig. 5. Effect of nitrate concentration on the equilibrium distribution of ferric and uranyl ions between Amberlite IRC-72 resin and nitrate soluton at 30°C.

Reasonable estimation of iron behavior during resin loading operations associated with an HTGR fuel fabrication facility may be obtained from the results presented in Table 2. However, the assessment of chemical specifications for iron in the uranyl nitrate feed solution to this plant may also be influenced by the operating conditions of the resin loading process employed. The preferential concentration of iron, relative to uranium, in the resin phase indicates that under certain process conditions (i.e., countercurrent flow) the distribution of iron throughout the resin batch may not be uniform. In all cases the separation factors for iron, $[Fe/U]_R/[Fe/U]_{aq}$, had values greater than unity. Consequently, a study of the redistribution of iron on resin contained in a countercurrent flow system may be necessary to establish minimum aqueous feed recycle rates which would yield a resin product having iron concentrations within specified limits. This study may also show that a small scavenger bed of resin, fully loaded with uranium, may suffice for reducing iron impurity from the uranyl nitrate feed stream prior to its introduction into the production unit.

6. ACKNOWLEDGMENTS

The analytical support of W. R. Laing, J. F. Emery, and K. J. Northcutt, Analytical Chemistry Division, is gratefully acknowledged. Technical review comments and recommendations were provided by C. F. Baes, Jr., Chemistry Division, and by P. A. Haas and K. H. Lin, Chemical Technology Division. Thelma Patton organized and prepared the manuscript for publication. Administrative support of this program was provided by K. J. Notz and A. P. Malinauskas.

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APPENDIX:

SUMMARY OF EXPERIMENTAL DATA

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EXPERIMENT NO. 157
RUN NO. 2
IRON DISTRIBUTION ON AMBERLITE IRC-72 RESIN
AT 30 DEG C

U-RES WT %	FE-RES WT %	R WT GRAMS	U-LIQ MG/ML	FE-LIQ MG/ML
47.68	3.51E-03	11.60	80.00	0.382
47.50	6.29E-03	11.56	78.40	0.764
47.52	1.19E-02	11.60	79.50	1.530
47.49	3.63E-02	11.61	80.40	2.670
47.07	1.19E-01	11.67	78.20	8.404

IONIC STRENGTH	[NO3-] MOLAR	[UO2++] MOLAR	[FE3+] MOLAR	FE/U PPM/U
0.956	0.568	0.336	6.84E-06	4.78
0.937	0.556	0.329	1.37E-05	9.74
0.953	0.569	0.334	2.74E-05	19.25
0.961	0.571	0.338	4.78E-05	33.21
0.924	0.532	0.329	1.50E-04	107.47

BULK RESIN CAPACITY(EQ/LITER) 3.2
BULK RESIN VOLUME(LITERS)= 0.015

[UO2R2] MOLES/L	[FER3] MOLES/L	[FE/U]R PPM/U	D(U) RES/LIQ	D(FE) R/L/U
2.582	8.10E-04	73.62	7.682	15.417
2.563	1.45E-03	132.42	7.782	13.589
2.573	2.75E-03	250.42	7.704	13.012
2.574	8.38E-03	764.37	7.620	23.017
2.564	2.76E-02	2528.15	7.805	23.525

[(FE)MR3]^(1/M)=K*[FE3+]*[D(U)]^(3/2)
M= 1.1817
AVG D(U)= 7.7185

EQUATION: Y = A + B*X

Y=LOG([(FE)MR3])
X=M*LOG([FE3+])
A=M*LOG(K)+(3*M/2)*LOG(D(U))

INDEX (R^2)	EXPL VAR	UNEXPL VAR	STD ERROR
0.970945	1.55128	0.046422	0.215458

PARAMETER	VALUE	95 PCT CONFIDENCE LIMITS	
A	6.62862	6.33336	6.92389
B	1.0007	0.76488	1.23653

EXPERIMENT NO. 157
RUN NO. 3
IRON DISTRIBUTION ON AMBERLITE IRC-72 RESIN
AT 30 DEG C

U-RES WT %	FE-RES WT %	R WT GRAMS	U-LIQ MG/ML	FE-LIQ MG/ML
46.14	2.50E-03	11.43	124.00	1.785
45.86	8.28E-03	11.39	127.00	7.497
46.05	3.45E-02	11.42	122.00	17.136
45.98	1.42E-01	11.43	125.00	40.341

IONIC STRENGTH	[NO3-] MOLAR	[UO2++] MOLAR	[FE3+] MOLAR	FE/U PPM/U
1.482	0.879	0.521	3.20E-05	14.40
1.511	0.885	0.534	1.34E-04	59.03
1.466	0.879	0.513	3.07E-04	140.46
1.502	0.897	0.525	7.22E-04	322.73

BULK RESIN CAPACITY(EQ/LITER) 3.2
BULK RESIN VOLUME(LITERS)= 0.015

[UO2R2] MOLES/L	[FER3] MOLES/L	[FE/U]R PPM/U	D(U) RES/LIQ	D(FE) R/L/U
2.462	5.68E-04	54.18	4.726	3.764
2.439	1.88E-03	180.55	4.570	3.059
2.455	7.84E-03	749.19	4.790	5.334
2.454	3.23E-02	3088.30	4.672	9.569

[(FE)MR3]^(1/M)=K*[FE3+]*[D(U)]^(3/2)
M= 1.2961
AVG D(U)= 4.68917

EQUATION: Y = A + B*X

Y=LOG([(FE)MR3])
X=M*LOG([FE3+])
A=M*LOG(K)+(3*M/2)*LOG(D(U))

INDEX (R^2)	EXPL VAR	UNEXPL VAR	STD ERROR
0.934652	2.14813	0.150192	0.387546

PARAMETER	VALUE	95 PCT CONFIDENCE LIMITS	
A	5.44819	4.70183	6.19455
B	1.00071	0.499796	1.50163

EXPERIMENT NO. 157
RUN NO. 4
IRON DISTRIBUTION ON AMBERLITE IRC-72 RESIN
AT 30 DEG C

U-RES WT %	FE-RES WT %	R WT GRAMS	U-LIQ MG/ML	FE-LIQ MG/ML
46.97	2.80E-03	11.58	217.00	4.228
47.41	6.29E-03	11.70	215.00	5.738
47.41	1.48E-02	11.79	205.00	9.362
48.04	5.14E-02	11.84	207.00	22.952
47.74	1.87E-01	11.72	210.00	65.232

IONIC STRENGTH	[NO3-] MOLAR	[UO2++] MOLAR	[FE3+] MOLAR	FE/U PPM/U
2.541	1.434	0.912	7.57E-05	19.48
2.536	1.458	0.903	1.03E-04	26.69
2.405	1.363	0.861	1.68E-04	45.67
2.420	1.356	0.870	4.11E-04	110.88
2.443	1.347	0.882	1.17E-03	310.63

BULK RESIN CAPACITY(EQ/LITER) 3.2
BULK RESIN VOLUME(LITERS)= 0.015

[UO2R2] MOLES/L	[FER3] MOLES/L	[FE/U]R PPM/U	D(U) RES/LIQ	D(FE) R/L/U
2.539	6.45E-04	59.61	2.785	3.060
2.590	1.46E-03	132.67	2.867	4.971
2.610	3.47E-03	312.17	3.030	6.836
2.655	1.21E-02	1069.94	3.053	9.650
2.612	4.36E-02	3917.05	2.960	12.610

[(FE)MR3]^(1/M)=K*[FE3+]*[D(U)]^(3/2)
M= 1.4943
AVG D(U)= 2.93895

EQUATION: Y = A + B*X

Y=LOG([(FE)MR3])
X=M*LOG([FE3+])
A=M*LOG(K)+(3*M/2)*LOG(D(U))

INDEX (R^2)	EXPL VAR	UNEXPL VAR	STD ERROR
0.974622	2.19049	5.70381E-2	0.238827

PARAMETER	VALUE	95 PCT CONFIDENCE LIMITS	
A	6.70163	6.37434	7.02892
B	0.99944	0.779569	1.21931

EXPERIMENT NO. 157
RUN NO. 5
IRON DISTRIBUTION ON AMBERLITE IRC-72 RESIN
AT 30 DEG C

U-RES WT %	FE-RES WT %	R WT GRAMS	U-LIQ MG/ML	FE-LIQ MG/ML
47.47	2.32E-03	11.79	258.00	5.160
47.42	7.05E-03	11.62	258.00	12.900
47.43	1.41E-02	11.74	258.00	22.400
47.91	5.57E-02	12.05	258.00	43.900
46.98	2.11E-01	11.86	258.00	108.000

IONIC STRENGTH	[NO3-] MOLAR	[UO2++] MOLAR	[FE3+] MOLAR	FE/U PPM/U
3.039	1.742	1.084	9.24E-05	20.00
3.048	1.758	1.084	2.31E-04	50.00
3.065	1.790	1.084	4.01E-04	86.82
3.043	1.742	1.084	7.86E-04	170.16
3.024	1.694	1.084	1.93E-03	418.60

BULK RESIN CAPACITY(EQ/LITER) 3.2
BULK RESIN VOLUME(LITERS)= 0.015

[UO2R2] MOLES/L	[FER3] MOLES/L	[FE/U]R PPM/U	D(U) RES/LIQ	D(FE) R/L/U
2.613	5.44E-04	48.87	2.410	2.444
2.572	1.63E-03	148.67	2.373	2.973
2.600	3.29E-03	297.28	2.398	3.424
2.695	1.34E-02	1162.60	2.486	6.833
2.601	4.98E-02	4491.27	2.400	10.729

[(FE)MR3]^(1/M)=K*[FE3+]*[D(U)]^(3/2)
M= 1.5213
AVG D(U)= 2.41345

EQUATION: Y = A + B*X

Y=LOG([(FE)MR3])
X=M*LOG([FE3+])
A=M*LOG(K)+(3*M/2)*LOG(D(U))

INDEX (R^2)	EXPL VAR	UNEXPL VAR	STD ERROR
0.982716	2.46699	4.33888E-2	0.2083

PARAMETER	VALUE	95 PCT CONFIDENCE LIMITS	
A	6.00613	5.72068	6.29159
B	0.999096	0.818154	1.18004

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