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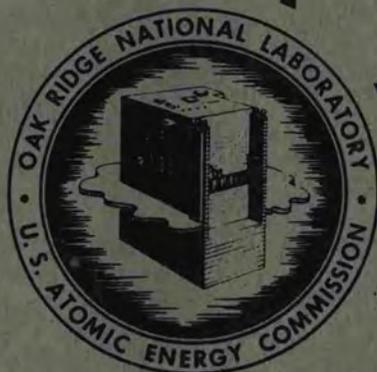
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ORNL-2215
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PROGRESS REPORT OF PROCESS TEST SECTION

FOR SEPTEMBER, 1956

A. D. Ryon
K. O. Johnsson



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CHEMICAL TECHNOLOGY DIVISION

PROGRESS REPORT OF
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A. D. Ryon and K. O. Johnsson

Date Issued

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DYNAMIC KINETIC STUDIES

R. R. Wiethaup

Abstract

The study of the rates of extraction and stripping with a Dapex-type organic and a high-uranium high-vanadium liquor has been continued. In the work reported so far¹ a conventional sampling technique was employed in which the mixed phases leaving the mixer were caught in a beaker and allowed to settle. After settling, the phases were separated by draining off the aqueous phase through a drain in the bottom of the beaker. In general, it took about one minute for the phases to separate, and during this time, further extraction probably took place. Therefore, the extraction results reported last month included the extraction occurring in the mixer plus any extraction occurring during coalescence of the mixture. Such results are adequate for use in designing mixers because they simulate the performance of a mixer plus a settler. However, for more fundamental studies of extraction in baffled tank mixers, it is desirable to reduce the extraction occurring during sampling so as to obtain a better indication of the actual concentrations inside the mixer.

It has been proposed that a sample of one phase could be obtained directly from a mixture of two phases by means of a porous barrier wetted by the desired phase. In order to test this proposal, runs were made in which samples were taken simultaneously by the proposed samplers and by the conventional beaker collector. A comparison of the results obtained by the two methods is presented in this report.

Equipment

The aqueous phase sampler consisted of a Dow Corning fritted glass disc, coarse grade, 1-1/8 inches in diameter, sealed into the end of a glass tube. When immersed in the mixer to a depth of 2 to 3 inches, a 15-ml sample of aqueous phase could be obtained in about two minutes.

The organic phase sampler consisted of a fritted Teflon disc, 7/8 inches in diameter, set in the end of a Plexiglas tube. The opposite end of the tube was fitted to a rubber

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1. Progress Report of Process Test Section, Chemical Technology Division, August 1956, ORNL-2214.

stopper so that vacuum could be applied. At a total head of 4 to 6 inches of water, a 15-ml sample could be obtained in 2 to 3 minutes.

The description of the mixer, procedures, operating conditions, and methods of calculation have been reported previously¹ and will not be repeated here.

Results

The performance of the mixer is shown in Fig. 1. The results are presented as the Murphree efficiency, E_M , based upon the aqueous phase compositions obtained by means of the fritted glass sampler. A comparison with the previous results based upon the regular beaker sampling shows that E_M increased with speed, as before, but did not level off at a minimum value except in one case. A lower value was obtained for E_M with the organic phase continuous than with the aqueous phase continuous. In the previous findings, they were the same.

The detailed results are given in Table 2, page 12.

The effect of the type of sampler upon the calculated efficiency, E_M , is shown in Fig. 2. When the mixer was operated with the aqueous phase continuous, the E_M based upon a beaker sampler was 10 to 17 percentage points greater than E_M based upon a fritted glass sampler. When the organic phase was continuous, the difference was larger, 20 to 30 percentage points. From this, it is concluded that appreciable extraction occurs while the mixed phases are being collected in the beaker and while the phases are separating. The fritted glass sampler gives a better measure of the concentrate in the mixer than does the beaker; but it cannot be concluded at this point that the fritted glass sampler introduces no error at all.

A correlation has been found between the concentrations indicated by the two sampling methods. It can be shown that:

$$C_B = a C_F + b$$

where: C_B, C_F = concentration of uranium in a phase obtained by sampling with the beaker and fritted sampler, respectively.

a, b = constants.

The restrictions are that the choice of the continuous phase, phase ratio, and coalescing time in the beaker must be held constant. Under these restrictions, a plot of C_B vs C_F

1. Ibid.

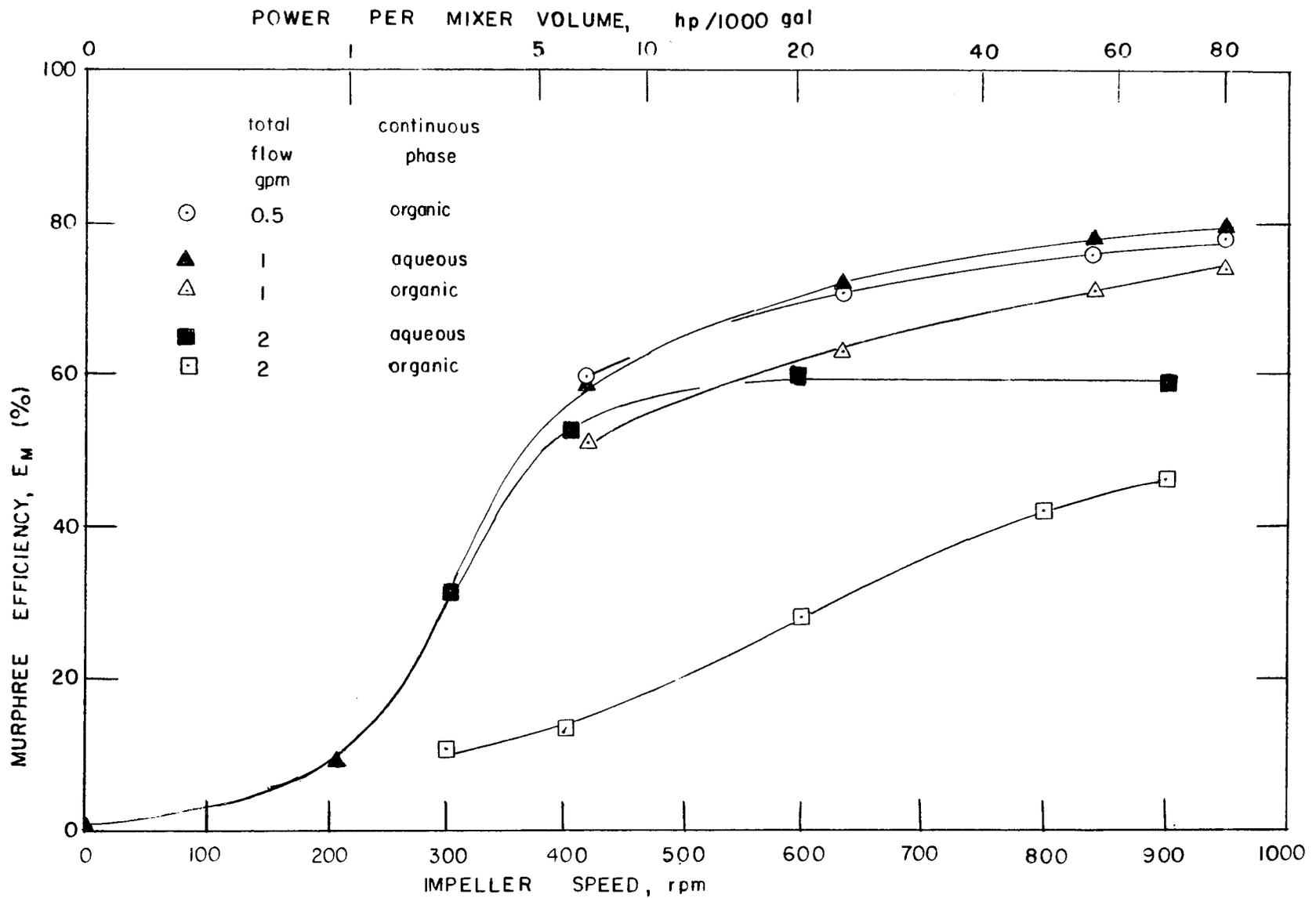


FIGURE 1 — PERFORMANCE OF A BAFFLED MIXER

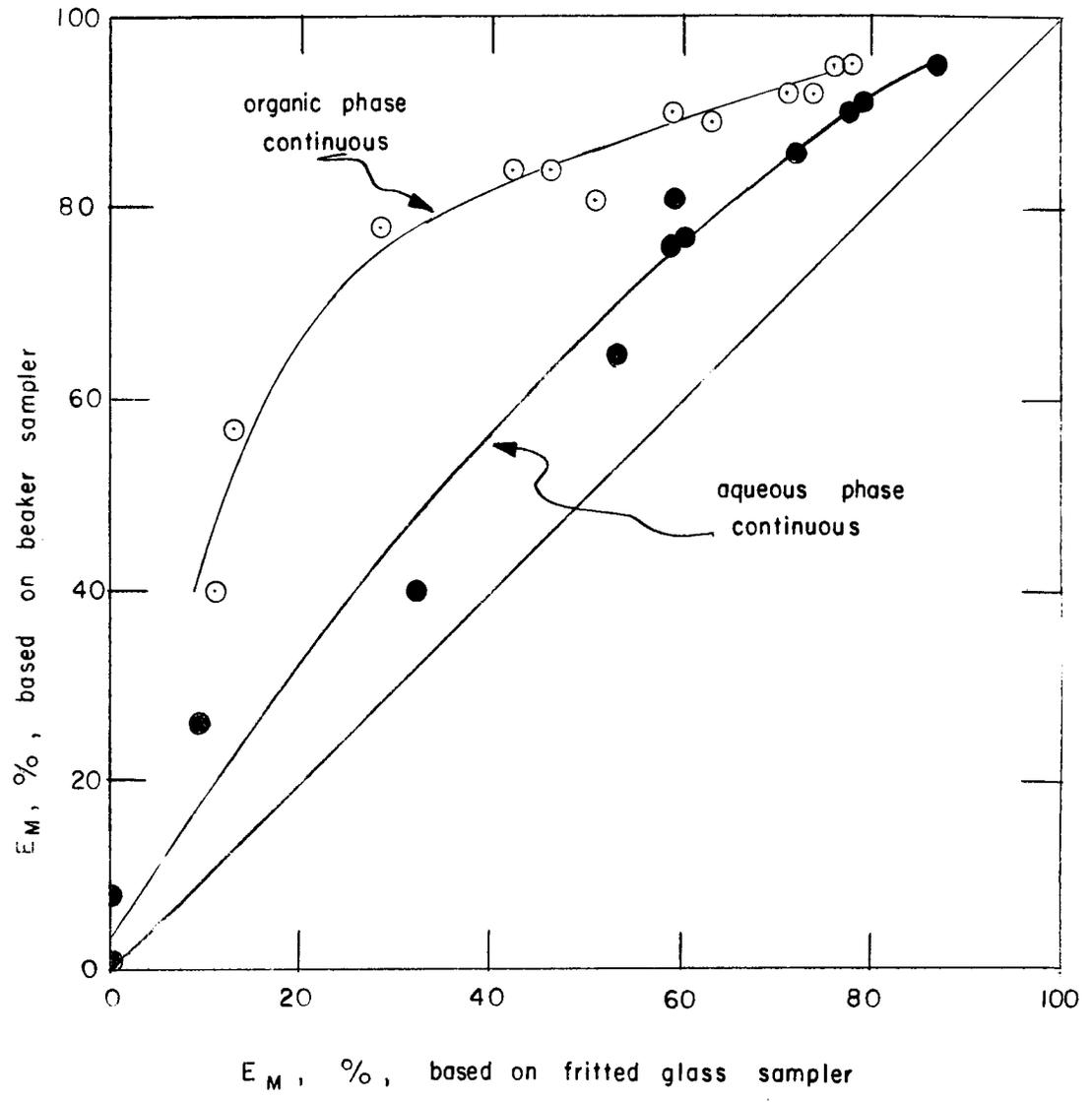


FIGURE 2— COMPARISON OF SAMPLING METHODS

should be a straight line. Such plots are shown in Fig. 3 for the fritted glass sampler and in Fig. 4 for the fritted Teflon sampler. It is seen that most of the experimental points do lie on fairly straight lines. Deviations occur at high concentrations in the aqueous phase and low concentrations in the organic phase. These deviations can be explained as follows: Such concentration conditions occurred only at a low mixer impeller speed, which also caused a shorter coalescing time in the beaker. This resulted in less extraction occurring in the beaker. C_B would then approach C_F , which is the direction of the deviations that occurred.

Although the fritted glass and Teflon samplers each provide a better measure of the actual concentrations in the mixer than does the beaker sampler, the two fritted samplers fail to give mutually consistent results. That is, the amounts of uranium transferred between the phases can be computed either from the change in concentration of the aqueous or organic phases. When these computations are made using the effluent concentration based upon the two fritted samplers, the amount of uranium lost by the aqueous phase does not equal the amount gained by the organic phase. Obviously, one or the other sampler is not correct.

Table 1 shows this inconsistency. Here, the concentration of uranium in the organic effluent sampled by the fritted

TABLE 1. COMPARISON OF FRITTED GLASS
AND FRITTED TEFLON SAMPLERS

Run No.	Uranium Concentration in the Organic Phase in the Mixer (g/l)		Difference
	Calculated from fritted glass	Measured by fritted Teflon	
	Aqueous Phase Continuous		
573	1.84	0.84	-1.0
574	3.0	1.57	-1.4
575	3.4	2.4	-1.0
579	3.8	3.5	-0.3
	Organic Phase Continuous		
576	0.63	1.70	+1.1
580	0.69	2.2	+1.5
581	1.46	3.0	+1.5
582	2.1	3.4	+1.3
583	2.3	3.4	+1.1

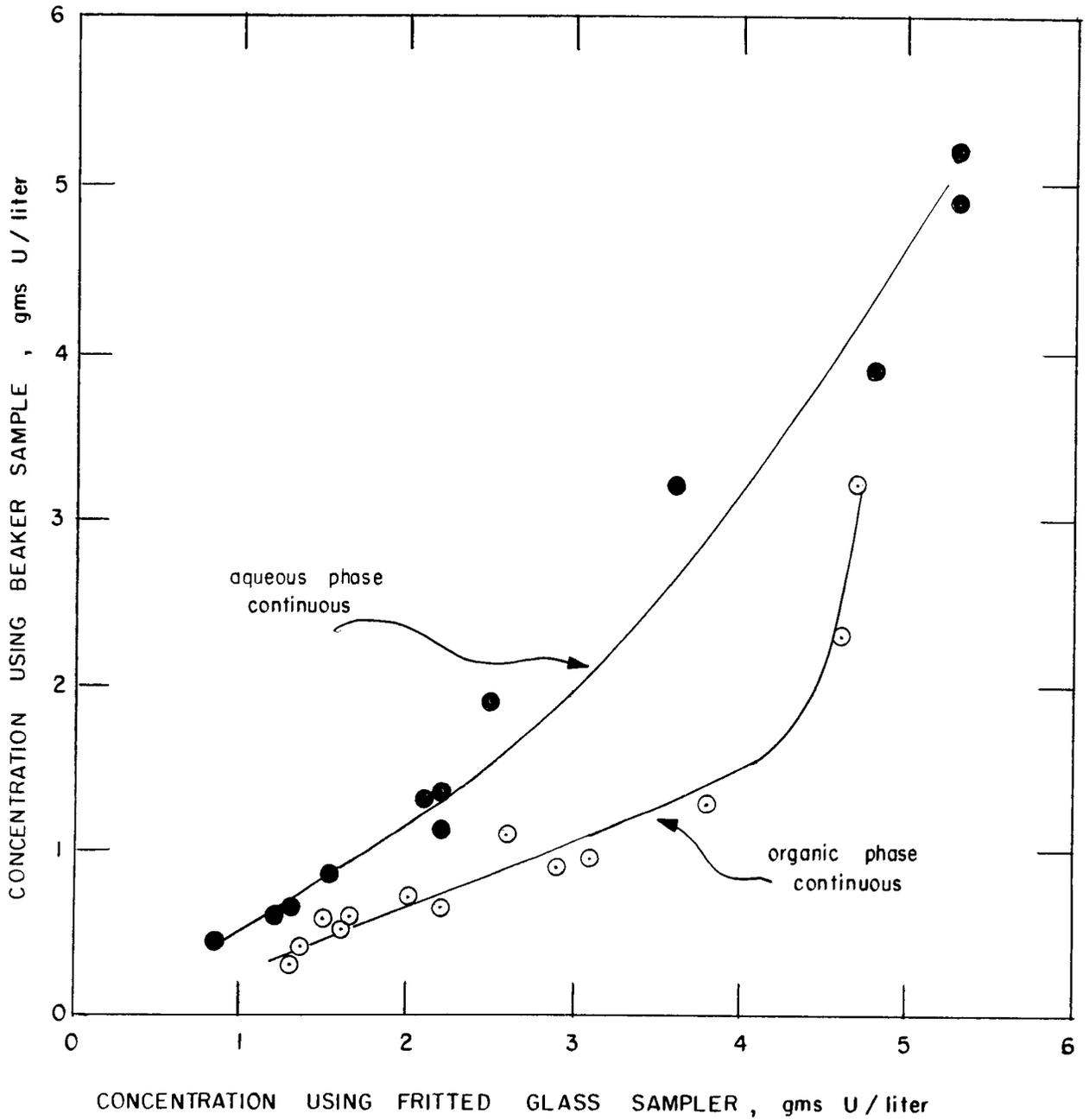


FIGURE 3 — CORRELATION OF AQUEOUS SAMPLES

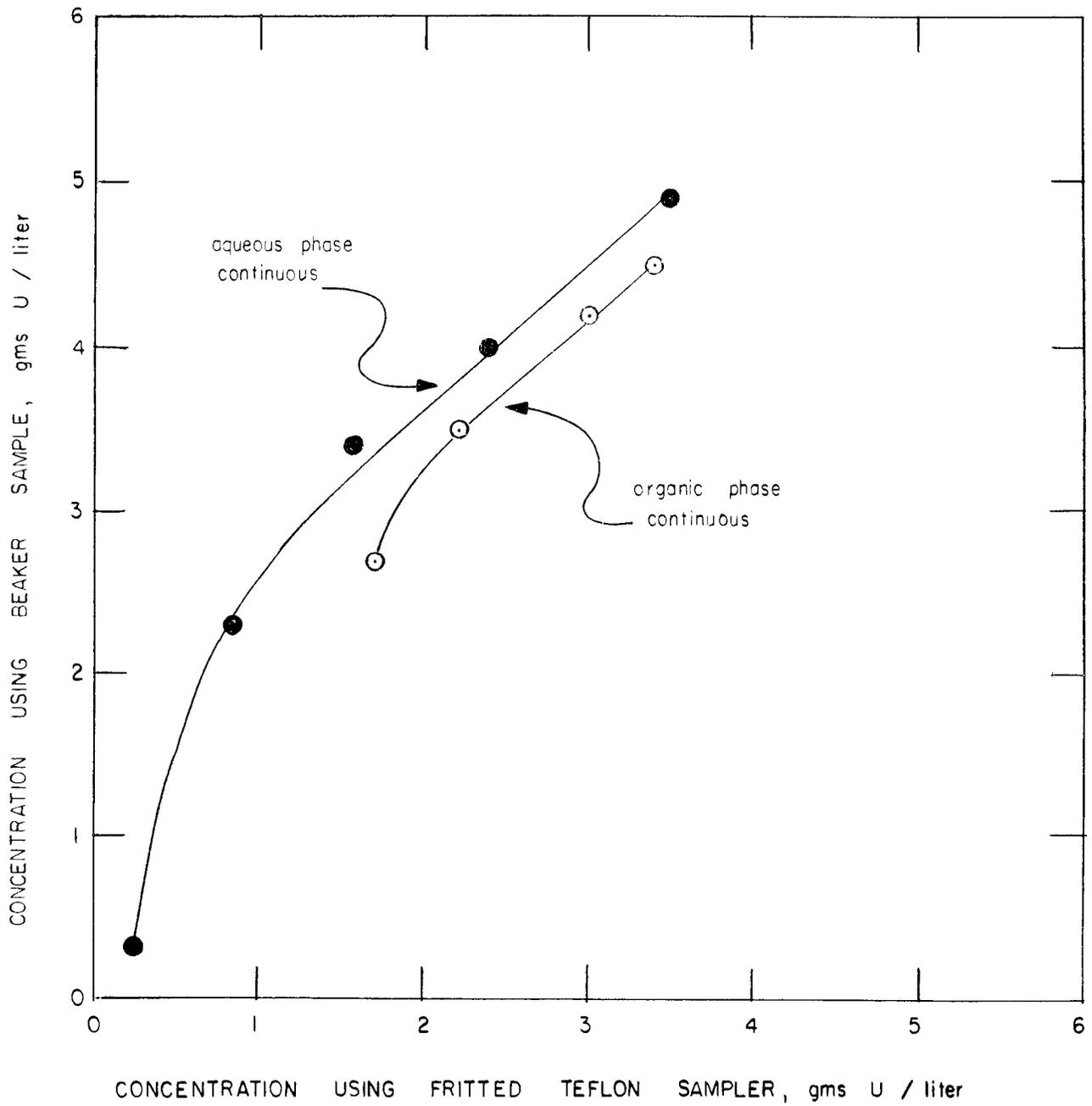


FIGURE 4 — CORRELATION OF ORGANIC SAMPLES

Teflon sampler is compared with the same concentration calculated from the concentration in the aqueous effluent obtained simultaneously by the fritted glass sampler. This table shows that when the aqueous phase is the continuous phase in the mixer, the calculated organic concentration is greater than the measured concentration. Now, it is not possible for the organic being pulled into the fritted Teflon sampler to lose uranium. Therefore, the measured organic concentration cannot be too low. The only other possibility is that the calculated value is too high. This would occur if further extraction of uranium had occurred in the process of obtaining a sample of the aqueous phase with the fritted glass sampler.

A similar discussion can be made in the case of the organic phase continuous, where the calculated value is less than the measured value.

The conclusions derived from the results in Table 1 are that when the aqueous phase is continuous, the fritted Teflon sampler for the organic phase yields a better measure of the actual concentration in the mixer. Conversely, when the organic phase is continuous, the fritted glass sampler for the aqueous phase is better.

In Table 2, two values of E_M are shown, one based upon the aqueous concentrations obtained with the fritted glass sampler, the other upon aqueous concentrations calculated from the organic concentrations obtained with the fritted Teflon sampler.

Future Work

The rate of extraction from a similar liquor with a lower uranium concentration will be studied (to simulate the performance of the second mixer in a countercurrent extractor). Both types of fritted samplers and the beaker sampler will be used. The rate of stripping will be studied in a manner analogous to the extraction studies.

TABLE 2. SUMMARY OF RESULTS

Run	Total Flow in (gpm)	Continuous Phase	Concentrations (grams U/liter)			Impeller Speed (rpm)	Power per Mixer Volume (hp/1000 gal)	Extraction Efficiency (%)	
			Aq in	Aq out	Org out			EM ^{3/}	EM ^{4/}
544	0.49	aqueous	5.3	0.84		630	23	87	
551	0.50	organic	5.3	2.2		420	6.9	59	
552	"	"	"	1.58		630	23	71	
553	"	"	"	1.34		840	55	76	
554	"	"	"	1.26		950	80	78	
555	0.99	aqueous	5.3	5.3		0	0	0	
556	"	"	"	4.8		210	0.86	9.4	
557	"	"	"	2.2		420	6.9	59	
558	"	"	"	1.53		630	23	72	
559	"	"	"	1.28		840	55	78	
560	"	"	"	1.21		950	80	79	
564	0.89	organic	5.3	2.6		420	6.9	51	
565	"	"	"	2.0		630	23	63	
566	"	"	"	1.63		840	55	71	
567	"	"	"	1.47		950	80	74	
577	1.93	aqueous	5.3	5.4	0.24	0	0	0	3
573	1.96	"	"	3.6	0.84	300	2.5	32	14
574	"	"	"	2.5	1.57	400	6.0	53	27
575	"	"	"	2.1	2.4	600	20	60	42
579	1.93	"	"	2.2	3.5	900	68	59	54
576	1.93	organic	5.3	4.7	1.70	300	2.5	11	26
580	1.99	"	"	4.6	2.2	400	6.0	13	43
581	"	"	"	3.8	3.0	600	20	28	59
582	"	"	"	3.1	3.4	800	48	42	68
583	"	"	"	2.9	3.4	900	68	46	68

1/ Obtained with fritted glass sampler.
2/ Obtained with fritted Teflon sampler

3/ Based on aqueous concentration via fritted glass sampler.

4/ Based on aqueous concentration calculated from organic concentration via fritted Teflon sampler.