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# FOAM SEPARATION
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## Abstract

Appreciable cesium enrichment in the foam has been obtained using the system sodium tetraphenyl boron-Geigy reagent. Enrichment ratios varied from 1.5 to 3.5 depending upon operating conditions. The enrichment appears to depend on the ratio of the sodium tetraphenyl boron to Geigy reagent rather than on the absolute values of the individual concentrations. Further experiments are being conducted to verify and extend the range of results.

Continuous countercurrent column operation has been continued. Decontamination factors have been correlated with the measured volumetric foam rate rather than the flow rate measured on a flowmeter. Decontamination in both the 2-foot and 5-foot columns is the same under the same operating conditions. This is attributed to operation in a "pinched" region.

## Cesium Enrichment

Appreciable enrichment of cesium in the foam has been obtained using the system sodium tetraphenyl boron-Geigy reagent. Experiments were run to determine the effect on enrichment ratio of variations in the reagent concentrations. The solution used in all experiments had the following concentration:

$[NaNO_3] = 1M$

$[Cs^+] = 10^{-6}M$

pH = 11.0

Table 1 shows the change in $\Gamma/C_B$ for cesium as the concentration of the Geigy reagent changes. The concentration of the sodium tetraphenyl boron is maintained constant at a value of 1 gram per liter.

Table 1

| Geigy reagent, mg/l | $\Gamma/C_B \times 10^5$, cm |
|---|---|
| 20 | 28.8 |
| 30 | 25.0 |
| 45 | 20.2 |
| 90 | 14.2 |
| 110 | 10.2 |
| 170 | 5.8 |

The data in Table 2 show the variation in $\Gamma/C_B$ with sodium tetraphenyl boron concentration at a constant Geigy reagent concentration of 0.114 grams per liter.

Table 2

| Sodium tetraphenyl boron, gm/l | $\Gamma/C_B \times 10^5$, cm |
|---|---|
| 0.1 | 1.0 |
| 0.2 | 1.8 |
| 0.5 | 3.8 |
| 0.95 | 10.5 |
| 1.0 | 10.2 |

The data in Table 3 show the variation in $\Gamma/C_B$ as the ratio of sodium tetraphenyl boron to Geigy reagent changes.

Table 3

| M sodium tetraphenyl boron / M Geigy reagent | $\Gamma/C_B \times 10^5$, cm |
|---|---|
| 1 | 1 |
| 2 | 2 |

Table 3 Continued

| | |
|---|---|
| 4.4 | 3.8 |
| 5.8 | 5.8 |
| 9.0 | 9.8 |
| 9.2 | 10.2 |
| 14.6 | 14.2 |
| 25.0 | 20.0 |
| 33 | 25.0 |

Three facts are apparent from these data. At a constant concentration of sodium tetraphenyl boron the cesium enrichment increases as the Geigy reagent concentration decreases. At a constant Geigy reagent concentration, the cesium enrichment increases as the sodium tetraphenyl boron concentration increases.

Using the data from Tables 1 and 2 the figures in Table 3 can be calculated. It becomes apparent that, at least up to a molar ratio of sodium tetraphenyl boron to Geigy reagent of 10, the cesium enrichment is dependent only on the ratio and not on the individual values of the concentrations.

On the basis of the above evidence the following tentative explanation is offered. The $Cs^+$ forms a compound with the $[T\phi B]^-$ which is surface active but not sufficiently surface active to give a good foam. The Geigy reagent provides the foam. If the ratio of sodium tetraphenyl boron to Geigy reagent is not large enough, the Geigy reagent will occupy most of the surface sites, thereby reducing the enrichment of the cesium in the surface layer. If, on the other hand, the ratio of sodium tetraphenyl boron to Geigy reagent is too large, insufficient foam will be generated and the efficiency of cesium removal will be reduced. In connection with this latter phenomenon, it has been noted that mixtures of sodium tetraphenyl boron and Geigy reagent foam better than the individual components.

The analytical grade of sodium tetraphenyl boron used in these experiments would be expensive for process use; inquiries are being made of manufacturers as to the possible price of technical grade material if produced on a large scale.

Continuous Countercurrent Column Operation

It had previously been found that fluctuations in the gas rate were occurring. Because of the extreme sensitivity of the decontamination factor to variations in the gas-to-liquid ratio it was necessary to modify the equipment to maintain a more constant gas flow rate.

Using the modified equipment and a freshly prepared solution, runs were made on both 2-foot and 5-foot, 48-mm. diameter columns using the technique described in the February Progress Report. Data from these runs appear in Table 4.

If one attempts to correlate the decontamination factor at a constant liquid feed rate with the gas flow rate as measured on the flowmeter, one observes the anomalous effect of greater decontamination in the 2-foot column than in the 5-foot column. If, however, the data are correlated on the basis of the measured volumetric foam rate, the data for the 2-foot and 5-foot column can be represented, within the limits of experimental error, by a single line on a log-log plot of decontamination factor versus volumetric foam rate. It would appear that the pressure drops in the two columns are sufficiently different to give different flow rates although the flowmeter readings are the same in both columns. For this reason we believe a more reliable correlation may be obtained using the volumetric foam rate rather than the flowmeter reading.

It will be noted that the decontamination is no greater in the 5-foot column than it is in the 2-foot column. This is an unexpected result and can only be accounted for at the present time by assuming that operations are being conducted in a "pinched" region of the equilibrium line-operating line graph.

Further experiments are being run to verify these results and to attempt to surmount these difficulties.

Table 4

| Column Height, ft | Liquid Feed Rate, L cc/min. | Gas Feed Rate, G cc/min. (Flowmeter) | Volumetric Foam Rate, F cc/min. | $\frac{F}{L}$ | $D_F$ |
|---|---|---|---|---|---|
| 2 | 15.5 | 106 | 128 | 8.2 | 1.5 |
| 2 | 15.5 | 155 | 190 | 12.3 | 12.9 |
| 2 | 15.5 | 155 | 194 | 12.5 | 11.6 |
| 2 | 15.5 | 180 | 222 | 14.3 | 21.1 |
| 5 | 15.5 | 104 | 119 | 7.7 | 1.2 |
| 5 | 15.5 | 106 | 120 | 7.8 | 1.4 |
| 5 | 15.5 | 130 | 169 | 10.9 | 1.5 |
| 5 | 15.5 | 155 | 178 | 11.5 | 8.7 |
| 5 | 15.5 | 155 | 190 | 12.3 | 7.1 |
| 5 | 15.5 | 180 | 214 | 13.8 | 12.2 |
| 5 | 15.5 | 206 | 223 | 14.4 | 25.5 |