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(19)



(54) ION EXCHANGE PROCESS

(71) We, HIMSLEY ENGINEERING LIMITED, a company organized and existing under the laws of the Province of Ontario, Canada, of 250 Merton Street, Toronto, Ontario, M4S 1B1, Canada, do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a continuous ion exchange process for recovering a concentrated solution of an ion of interest from a feed solution containing the ion of interest and containing an unwanted impurity component.

In conventional recovery processes, the presence of unwanted impurity in the feed solutions often detracts from the efficiency of the process. Firstly, if the unwanted component is present in significant concentrations it often tends initially to saturate ion exchange resin in the step of exhaustion of the feed solution onto the resin, even though the resin has less affinity for the unwanted component than for the component of interest. As a result, longer periods are required for achieving a loading of the component of interest approaching the equilibrium loading. Alternatively, if a shorter period is allowed for the absorption step this is at the expense of achieving lower loadings of the component of interest.

Secondly, the unwanted component tends to be stripped from the loaded resin in the elution step in which the loaded resin is stripped with eluant solution containing eluant ion, so that the unwanted component is recovered along with the ion of interest in the concentrated eluate. The unwanted component may be of such nature or present in such concentrations that it renders a subsequent operation of separating the ion of interest from the concentrated eluate more costly than would be the case if a purer eluate could be recovered.

The present invention provides a continuous ion exchange process for recovering a concentrated solution of an ion of interest from a feed solution containing the ion of interest and an unwanted component, comprising passing batches of ion exchange resin particles successively through an absorption column in contact with the feed solution such that the particles become loaded with the ion of interest and the unwanted component; isolating successive uniform batches of loaded particles from the absorption column in a conditioning chamber wherein the ratio of the ion of interest to the unwanted component loaded on the resin particles is increased by passing a predetermined volume of a conditioning solution through the isolated batch at a controlled flow rate; and transferring each successive batch from the conditioning chamber to an elution column through which the batches are successively passed in contact with an eluant solution containing an eluant ion that strips the loaded materials from the particles.

The conditioning solution may be capable of preferentially removing the unwanted component from the resin and may be contacted with the resin for a predetermined period until equilibrium is essentially complete between the conditioning solution and the resin, thus maximizing the removal of unwanted components. By applying a conditioning solution also containing the ion of interest, maximized loading of the resin can be obtained which increases the purity of and concentration of the ion of interest in the effluent of the elution step.

The above process permits the use of a conditioning solution that will elute the unwanted component more or less completely. This solution need not necessarily contain any of the

ion of interest although it may be found desirable in some circumstances to have such concentration of the ion of interest in this solution as to maintain equilibrium thus preventing any significant stripping of the ion of interest from the resin.

5 Subsequent to the treatment with the condition solution, the conditioning solution is conveniently displaced from the resin by a solution having a high concentration of the ion of interest, such as concentrated eluate obtained from the elution column or any other such solution. 5

10 The conditioning solution used in the process of the invention may be a solution that would be incompatible with efficient elution if contacted with the loaded resin in the course of the elution step, or that could only with difficulty be generated by modification of the concentrated eluate within the confines of the elution column. In the process of the invention such a solution can readily be used without interfering with the subsequent elution step and such a solution may be generated by addition of a modifying agent or agents to the concentrated eluate externally of the elution column, or may be a solution of a material used as an eluant, or can be derived from concentrated materials containing the ion of interest which are generated subsequent to the elution step, e.g. from solids precipitated from the concentrated eluate, or can be obtained from an external source of solution which forms no part of the exhaustion-elution cycle. 15

20 Various examples can be given of the form of activation of the conditioning solutions: The conditioning solution can contain an increased ratio of ion of interest to eluant ion as compared with the concentrated eluate, and particularly can contain a greater molar concentration of the ion of interest than of eluant ion, in contrast to the usual concentrated eluates which normally contain a greater molar concentration of eluant ion than of the ion of interest; where the respective affinities of the resin towards the ion of interest and the unwanted component are found to vary differentially with pH, the conditioning solution can be at such pH as to tend to maximize removal of the unwanted component and replacement by the ion of interest; and, where the unwanted component exists in plural oxidation states, the oxidation-reduction potential of the conditioning solution can be such that the unwanted component is converted to an oxidation state for which the resin has lower affinity. 25

30 The process of the invention can be applied with particular advantage in an anion-exchange resin elution system wherein acidified sulphate is employed as the stripping eluant, the eluant ion being in this case HSO_4 . A highly effective conditioning solution can then be obtained by changing the pH of the concentrated eluate solution by addition of an acid or a base, to achieve a solution having a pH which is found to optimise removal of the unwanted component and replacement by a higher loading of the component of interest. 35

40 In the case where the feed solution is a sulphate liquor, and bisulphate ion is employed as eluant, the efficiency of the process may be improved by mixing the relatively weak feed solution with a sulphatic solution relatively rich in the ion of interest, to obtain an enriched feed solution having an enriched molar ratio of the ion of interest to the unwanted component, and employing the enriched feed solution as the feed to the resin in the ion-absorption step. This increases the degree of loading of the ion of interest in the exhaustion stage. The relatively rich sulphatic solution can conveniently be derived from concentrated eluate, and in the most preferred form the sulphatic solution is obtained as the effluent from the treatment of the loaded resin in the conditioning chamber. 45

An example of a recovery process embodying the above aspects of the invention will now be described with reference to the drawings filed with the Provisional Specification wherein

50 *Figures 1 to 11* illustrate schematically the successive steps of a recovery process using continuous counter-current flow of resin; and

Figures 12A and 12B together show in greater detail apparatus employed in carrying out the process. 50

55 By way of example only, a process will be described for the recovery of a concentrated solution or uranium from an acid leach liquor relatively weak in uranium ion and containing ferric ion as unwanted impurity. In such case the ion of interest is a complex ion containing uranium. 55

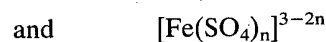
60 The apparatus as shown in detail in *Figures 12A and 12B* employs a multiple-compartment continuous downward counter-current resin flow absorption column A of the construction described in our United Kingdom Patent Specification No. 1,439,396 and a continuous upward counter-current resin flow elution column E, of the construction described in our United Kingdom Patent Application No. 6143/77 (serial No. 1572919), with a measuring chamber M for use in isolating a batch of a predetermined quantity of the resin being connected between column A and the elution column E. 60

65 As described in U.K. Patent Specification No. 1,439,396 a flow of pregnant feed at a volumetric flow rate F is passed upwardly through column A at all times to normally retain respective batches of resin particles in each component of column A and provision (not 65

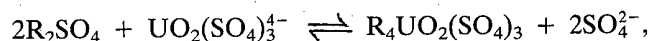
shown herein but described in U.K. Patent Specification No. 1,439,396) is made for transferring batches of resin downwardly from the upper to the lower of any two selected vertically adjacent compartments of column A.

The acid leach liquor is supplied direct to a feed storage tank 22 through a pipe 23. The pregnant feed is withdrawn at a rate F from the tank 22 and passed upwardly through the column A by a pump P_1 normally through a line 24 connected to the bottom of column A.

Within the column A, uranium and iron in the ferric state are absorbed on the anion-exchange resin particles as complexes, e.g.



e.g. through the reaction



and similarly for the complexes containing iron.

Barren solution, typically containing less than 0.001 g/l uranium calculated as U_3O_8 , is withdrawn from the top of column A through a pipe 26, and a proportion is returned to a barren solution storage tank 27.

The process proceeds as a cycle of steps, and as a starting point can be taken the conditions prior to the transfer of a batch of loaded particles from the bottom compartment of column A to the measuring chamber M.

At this point, the chamber M is empty of particles and full of pregnant feed liquid. The column E contains vertically adjacent batches of particles in the levels indicated from a up to d in Figure 12B and is full of eluant liquid. The eluant used in this example is H_2SO_4 supplied from a tank 28. The molar concentration of the acid is selected so that it strips the resin efficiently and typically the eluant may be at 1 to 1.5 molar concentration.

Towards the bottom of the column E the eluant contains progressively increasing concentrations of the ion of interest, the bottom of the column containing concentrated eluate.

Figure 1 Resin Transfer

Loaded resin is transferred from the bottom compartment of column A to chamber M through a pipe 29. This is accomplished by pumping a flow of pregnant liquid in a closed path with a pump P_2 at a flow rate of $0.5 F$ drawn from the chamber M, the flow being withdrawn through strainers 31 and 32 in chamber M, through the pump P_2 , and a line 33 to the side of the bottom compartment of column A through which the flow F from pump P_1 is also temporarily diverted, and through the line 29. This gives a net downward flow of $0.5 F$ through the bottom compartment, which carries the loaded resin through the line 29 into the chamber M.

Figure 2 Resin Measure

When particles no longer flow through line 29, the particles in chamber M are allowed to settle and excess particles are flushed out through a pipe 34 in the top of column M to the bottom compartment of column A, generally as described in our U.K. Patent Application No. 6143/77 (serial No. 1572919), leaving a predetermined quantity of loaded resin particles in chamber M. Downward transfer of resin within column A can be conducted after this step.

Figure 3 Condition Loaded Resin

A conditioning liquid is flowed through the quantity of loaded resin in the chamber M. The conditioning liquid may be modified concentrated eluate withdrawn from a concentrated eluate tank 36 by a pump P_3 and passed through a line 37 into the top of the chamber M through the strainer 31. The effluent from the chamber M is withdrawn through a strainer 38 at the bottom and passed through a line 39 into the feed storage tank 22. The flow through the chamber M is at such flow rate, which may for example be about 3 bed volumes of the resin in chamber M per hour, as to provide sufficient time for the loaded resin to substantially reach equilibrium with the eluate. Unwanted ion is displaced from the resin in chamber M to the feed storage tank 22, and the flow is continued until a desired quantity of the ion of interest has been added to the feed storage tank 22, to maintain the molar ratio of ion of interest to unwanted ion in the tank 22 to a desired level.

Figure 4 Elute in Series

The column E and chamber M are eluted in series with a predetermined volume of sulphuric acid withdrawn from the eluant tank 28 by a pump P₄ and passed through a line 41 into the top of column E, eluate withdrawn from the bottom of column E through a strainer 42 being passed through a line 43 into chamber M and the concentrated eluate from chamber M being fed into the concentrated eluate tank 36 through a line 44.

The process thereafter follows generally the scheme described in our U.K. Patent Application No. 6143/77 (serial No. 1572919).

10 *Figure 5 Resin Transfer* 10

The resin in chamber M is slurried into the bottom of column E with concentrated eluate withdrawn from tank 36 by pump P₃ and passed into the chamber M through the strainers 31 and 32. The resin leaves through a pipe 46. After transfer, the presence of the freshly introduced resin in the column E results in the resin level in column E being raised to the level e. In the transfer operation, any fresh eluant that may be displaced from the top of column E passes through a line 47 and is collected in the fresh eluant tank 28.

Figure 6 Drain M and displace carrier liquid

Chamber M is drained down into the concentrated eluate tank through pipe 44, and fresh eluant is pumped into the top of column E with pump P₄ through the line 41, in order to displace the concentrated eluate which entered in the previous step. The displaced eluate passes through a line 48 into the tank 36.

Figure 7 Fill M with eluant

The air in chamber M is displaced with eluant drawn by pump P₄ and passed through a line 49 into the bottom of chamber M through the strainer 38.

Figure 8 Resin transfer

Resin is flushed from the top of column E by pumping fresh eluant with pump P₄ in a closed cycle through the line 41 and a line 51 into the top of column E, the flushed-out particles entering chamber M through a line 52, and liquid being withdrawn through the strainer 38 and recirculated to the pump P₄ through a line 53.

Figure 9 Displace Eluant in series

When particles no longer flow through line 52, eluant is displaced from the particles in chamber M using barren solution pumped with pump P₄ through a line 54 and through the line 37 connected to the upper strainer 31 in chamber M. If the eluant displaced from the chamber M contains too high a concentration of uranium to be returned to the fresh eluant tank 28, the outflow from the strainer 38 in chamber M is passed through the line 49 into the lines 47 and 41 to the top of the elution column E, the concentrated eluate which is displaced from the bottom of column E being passed to the concentrated eluate tank 36 through line 48. Otherwise, the procedure of Figure 10 is followed.

Figure 10 Displace Eluant

The outflow from strainer 38 of chamber M displaced by the barren solution is passed direct to the fresh eluant tank 28 along the line 49 and a line 56, until the concentration of the outflowing eluant is too dilute for recovery.

Figure 11 Resin Transfer

The particles are then slurried out of chamber M with barren solution pumped by pump P₄ from the barren solution tank 27 through the lines 54 and 37 to the strainers 31 and 32 in chamber M. The particles slurried out of the chamber pass to the uppermost compartment of the absorption column A through a line 57 extending from the bottom of chamber M.

The cycle of operation can then be repeated.

It will be appreciated that the above-described example is merely illustrative of one sequence of operations that may be employed, and that other forms of process can be used instead. Thus, for example, in the step of draining chamber M and displacing eluate from column E, as illustrated in Figure 6, the eluate may be displaced from column E either by pumping fresh eluant into the top of the column or by opening an air inlet at the top of the column E and allowing eluate to drain from the column under gravity.

Instead of transferring an eluted batch of resin from the upper part of column E to the intermediate measuring chamber M before returning it to the absorption column A, the batch may instead be transferred direct to the absorption column A. In such case, after draining chamber M and displacing eluate from column E as illustrated in Figure 6 or as described above, the air in chamber M is displaced with pregnant feed liquor drawn by a

line (not shown) connecting the tank 22 to the pump P_4 and passed by the pump P_4 to the bottom of chamber M through the line 49 and the strainer 38. The transfer of eluted particles from column E to column A is then carried out by flushing the particles from the top of column E by pumping barren solution drawn from tank 27 along line 53 with pump P_4 , the solution being passed into the top of column E through the lines 41 and 51. The flushed-out particles enter the top of column A through a line (not shown) connecting the outlet line 52 direct to the uppermost compartment of column A. This operation is conducted while the liquid level in column A is low to avoid loss of resin particles, as described in U.K. Patent Specification No. 1,439,396. When particles no longer flow through the line to the uppermost compartment of column A, the pump P_4 is stopped and a gravity flow of barren solution is allowed to continue through the line from chamber E until the flow ceases. The cycle of operations commencing at Figure 1 can then be repeated.

The step of conditioning the batch of loaded resin that is isolated in chamber M can be carried out at or prior to the stage indicated in Figure 3.

In the example illustrated in Figure 3, the loaded resin is contacted with concentrated eluate which is modified in its chemical composition or in its pH by addition of reagents through an addition line 58.

Other conditioning solutions may, however, be employed and the conditioning solution need not necessarily contain any or any significant quantity of the component of interest.

With a strong base ion exchange resin loaded with uranium and with ferric iron as an unwanted component, it has been found that a significant degree of removal of the iron loading can be obtained employing a sulphuric acid solution.

The conditioning solution may thus be clean water or feed liquor to which sulphuric acid has been added, preferably in an amount to produce a concentration of approximately 0.3 molar acid. The stronger the acid solution, the faster and more complete is the elution of iron but this is accompanied by a disproportionate increase in the amount of uranium which is lost in the strip liquor.

This loss can be reduced by adding uranium to the conditioning solution along with the acid, but this results in an increased utilization or recycling of uranium. The optimum concentrations can be determined for any particular set of conditions by those experienced in the art and under typical conditions the acid concentration would be in the region of 0.2 to 0.5 M. After the treatment with the acid solution, the loaded resin may be contacted with a rich uranium-containing solution, e.g. concentrated eluate which is adjusted in pH. This treatment can serve to significantly increase the uranium loading. The conditioned resin can thereafter be subjected to elution.

Some examples applied to uranium extraction are given below:

Example 1

A volume of strong base ion exchange resin loaded with uranium and with ferric iron was contacted over a period of 60 mins. with five volumes of 0.3 molar sulphuric acid (pH approx. 0.6). The acid was then displaced over a period of 10 mins. with one volume of concentrated eluate containing 16.5 g/l. U adjusted with sulphuric acid at approx. pH 0.6.

The results were indicated in Table 1

TABLE 1

	Resin before Conditioning	Resin after Conditioning	% Change
Uranium (U)	59.6 g/l.	60.4 g/l.	+ 1.34
Iron (Fe^{3+})	9.9 g/l.	2.88 g/l.	-70.9
Fe^{3+} as % of U	16.6%	4.7%	-71.7

Example 2

A volume of strong base ion exchange resin loaded with uranium and with ferric iron was contacted over a period of 39 mins. with 3.6 volumes of an aqueous solution containing 44.3 g/l. U and adjusted to approx. pH 1 with H_2SO_4 .

The results were indicated in Table 2

TABLE 2

		Resin before Conditioning	Resin after Conditioning	% Change	
5	U	70.6 g/l.	130 g/l.	+84%	5
	Fe ³⁺	4.22	0.98	-77%	
10	F ³⁺ as % of U	5.98%	0.75%	-87.5	10

In the procedures of both Example 1 and Example 2 it was noted that the majority of the iron came off the resin while the first two volumes of conditioning solution were being passed through the loaded resin.

The results obtained in Example 2 indicate that a commercially pure yellow cake could be precipitated directly from the eluate of the resin without the need for further purification.

The uranium loadings that are obtained are strikingly high and may indicate that the uranium is being loaded as a divalent complex rather than as the tetravalent complex form which uranium is normally assumed to adopt.

The above Examples have referred to treatments in which a conditioning liquid is employed of pH lower than the eluate.

In alternative procedures, conditioning liquids of increased pH may be employed.

Example 3

Employing a recovery process generally as described with reference to the drawings, the pH of concentrated eluate recovered in the concentrated eluate tank 36, normally about pH 0.7, can be adjusted to a pH in the range of about pH 1 to 3, more typically about pH 1.5 to 2.5, to provide an activated eluate, by addition of a base, e.g. ammonia, or sodium or magnesium hydroxide, or calcium hydroxide if precipitated solids are removed, through the addition line 58, as indicated in Figure 3 prior to flowing the concentrated eluate through the loaded resin in the measuring chamber M.

In the resin saturation step of Figure 3, unwanted Fe³⁺ ion is eluted to the pregnant feed tank 22. However, as the effluent from the chamber M is rich in uranium, the flow can be continued until such time as the flow adds to the tank 22 sufficient uranium to diminish the Fe³⁺ /U ratio to a level, as low as practical and preferably below about 12:1, at which the disadvantages associated with initial saturation of the resin with Fe³⁺ complexes are avoided, or significantly reduced.

In this way, greatly reduced initial loadings of Fe³⁺ can be obtained on the loaded resin passed to the chamber M, and these relatively low loadings of Fe³⁺ can be almost entirely displaced from the loaded resin in the saturation step of Figure 3 prior to recovering concentrated eluate from the loaded resin to the concentrated eluate tank, thus achieving an eluate which is substantially free of Fe³⁺ ion.

Table 3 shows compositions of streams that may be achievable with this process.

TABLE 3

Stream	Uranium gm. U ₃ O ₈ /l	Fe ³⁺ gm/l	SO ₄ ²⁻ gm/l	Molar Ratio Fe ³⁺ /U	Weight Ratio SO ₄ ²⁻ /U ₃ O ₈
Feed (through line 23)	1.00	6.00	40.00	30:1	40:1
Modified feed (contents of 22)	1.518	6.071	41.08	20:1	27:1
Eluate (contents of 36)	45.83	<0.4	84.00	0.044:1	1.8:1

In one example of the practice of the process, with stream compositions as in Table 3, when NaOH is used as the addition 58 to raise the pH of the eluate to pH 2, about 10.11 g of H₂SO₄ would be consumed per gram of U₃O₈ recovered and about 0.97 g of NaOH would be added per gram of recovered U₃O₈.

Example 4

A sample of IRA 400 anion exchange resin in the sulphate form was placed in a column and a pregnant feed solution in the form of a sulphatic feed solution at pH 2.2 containing uranium and ferric ion at a molar ratio of Fe^{3+}/U of 10:1 was flowed through the column until the resin was in equilibrium with the feed solution. The loading achieved on the resin was 83 g/l U_3O_8 .

Thereafter, the loaded resin was treated with a conditioning solution rich in uranium ion. The conditioning solution was obtained by dissolving yellow cake from a conventional uranium recovery plant in sulphuric acid and was adjusted to pH 1.5 by addition of sodium hydroxide.

The conditioning solution contained 22 g/l U_3O_8 , and a volume of the conditioning solution equal to three bed volumes of the loaded resin was flowed through the loaded resin over a period of twenty minutes.

After the treatment, the resin loadings were analysed and were found to be 130 g U_3O_8 /l bed volume of the resin and 0.7 g Fe^{3+} /l bed volume.

In the step of eluting this loaded resin with 1M H_2SO_4 , the first bed volume of eluate contained 26 g/litre U_3O_8 and 0.7 g/litre Fe^{3+} . Substantially the whole of the Fe^{3+} was stripped from the resin in the first bed volume of eluate.

In counter current elution of the loaded resin, six batches of the loaded resin could be substantially completely stripped with about 12 to 15 bed volumes of 1M H_2SO_4 , i.e. one bed volume of the resin could be stripped with about 2 to 2½ bed volumes of the acid.

The resulting strong eluate accordingly has a concentration of U_3O_8 of approximately 50 to 65 g U_3O_8 /l and a ferric ion concentration of less than 0.4 g/l.

Instead of using adjustment of the pH of the concentrated eluate to produce a conditioning solution a similar result may be achievable by dissolving in the eluate additional uranium recycled from the recovery processing conducted on the strong eluate.

Further, examples of conditioning liquids include solutions derived from the subsequent uranium recovery operations which need not have uranium contents as high as are encountered in the concentrated eluate.

Moreover, the conditioning solution may instead be uranium rich solution at such oxidation-reduction potential, achieved by dosing with a reducing agent such as metallic iron particles or sulphur dioxide, that the Fe^{3+} is reduced to the Fe^{2+} state, which is incapable of forming complexes for which the resin has affinity.

Example 5

An increased initial loading of uranium onto the resin can be achieved by recycling concentrated eluate to the pregnant feed storage tank in an amount sufficient to significantly diminish the Fe^{3+}/U ratio present in the feed supplied through the inlet line 23. For this purpose, only small quantities of concentrated eluate need to be recycled, relative to the flow of pregnant liquor.

Such recycling can be effected either in the process of the invention or in other similar processes and, by way of illustration, Table 4 shows the stream compositions that may be achievable, where the process described above with reference to the drawings was conducted with the omission of the resin conditioning step of Figure 3, and with a small volume of concentrated eluate being pumped directly from the eluate tank 36 to the feed storage tank 22 for each unit volume of acid leach liquor added through the line 23.

TABLE 4

Stream	Uranium gm. U_3O_8 /l	Fe^{3+} gm./l	So_4^{2-} gm./l	Molar Ratio Fe^{3+}/U	Weight Ratio $\text{So}_4^{-2}/\text{U}_3\text{O}_8$
Feed (through line 23)	1.00	6.00	40.00	30:1	40:1
Modified feed (contents of 22)	1.495	5.982	40.67	20:1	27:1
Eluate (contentes of 36)	28.33	5.00	77.00	0.88:1	2.7:1

While the above-described process has referred to separation of uranium from uranium and ferric ion-containing liquors, it will be appreciated that the same processing steps may be applied with other feed solutions e.g. solutions containing copper as the ion of interest.

and with feed solutions containing ferric ion and other unwanted components that may load on the resin.

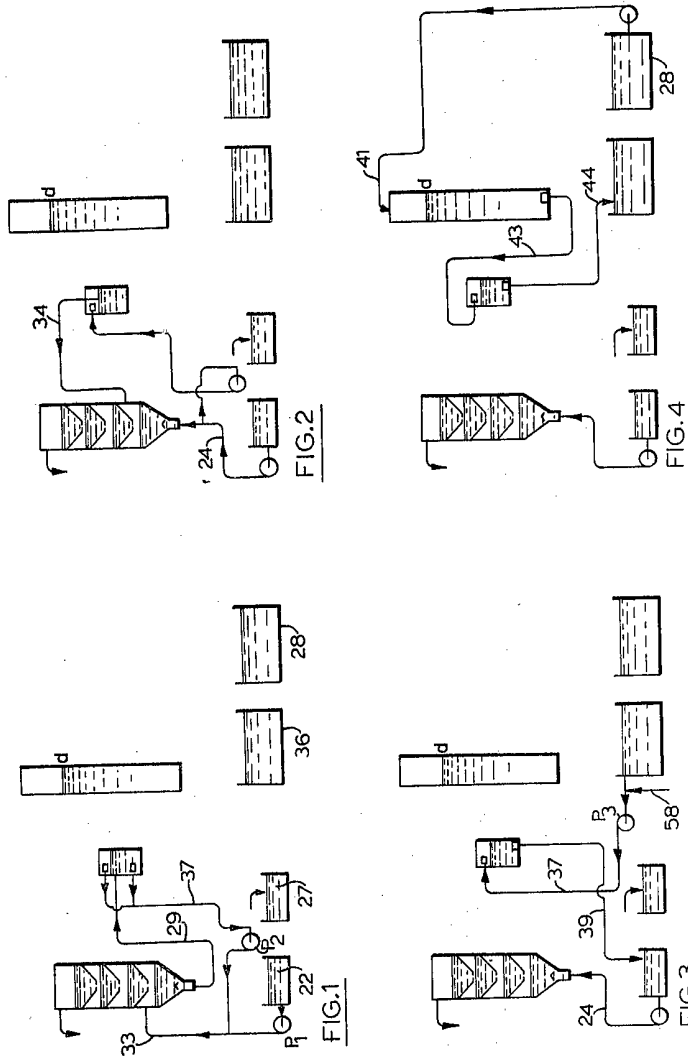
Moreover, the principles of pre-treatment of the loaded resin to reduce unwanted ion loadings and of enriching the feed solution to obtain higher initial loadings are not restricted in their application to anion-exchange processes but may be applied in cation-exchange processes.

WHAT WE CLAIM IS:-

1. A continuous ion exchange process for recovering a concentrated solution of an ion of interest from a feed solution containing the ion of interest and an unwanted component, comprising passing batches of ion exchange resin particles successively through an absorption column in contact with the feed solution such that the particles become loaded with the ion of interest and the unwanted component; isolating successive uniform batches of loaded particles from the absorption column in a conditioning chamber wherein the ratio of the ion of interest to the unwanted component loaded on the resin particles is increased by passing a predetermined volume of a conditioning solution through the isolated batch at a controlled flow rate; and transferring each successive batch from the conditioning chamber to an elution column through which the batches are successively passed in contact with an eluant solution containing an eluant ion that strips the loaded materials from the particles.
2. A process according to claim 1, wherein the feed solution and the eluant solution flow countercurrent to the movement of the resin particles through the respective columns.
3. A process according to claim 1 or 2, wherein the conditioning solution is contacted with the loaded resin for a predetermined period until equilibrium between the conditioning solution and the resin is substantially reached.
4. A process according to claim 1, 2 or 3, wherein the conditioning solution contains the ion of interest and eluant ion and has a ratio of the ion of interest to the eluant ion which is greater than that of concentrated eluate obtained from the elution column.
5. A process according to claim 4, wherein the ion of interest is present in the conditioning solution in a molar concentration greater than that of the eluant ion.
6. A process according to claim 1, 2, or 3, wherein the respective affinities of the resin towards the ion of interest and the unwanted component vary differentially with pH and the conditioning solution is at a selected pH above or below the pH of concentrated eluate obtained from the elution column.
7. A process according to claim 1, 2, or 3, wherein the unwanted component exists in plural oxidation states and the oxidation-reduction potential of the conditioning solution is adjusted so as to convert the absorbed unwanted component to an oxidation state towards which the resin has lower affinity.
8. A process according to claim 7, wherein the conditioning solution is adjusted by addition of a reducing agent thereto.
9. A process according to claim 8, wherein the reducing agent comprises metallic iron particles or sulphur dioxide.
10. A process according to claim 1, 2, or 3, wherein the conditioning solution comprises an acid.
11. A process according to any one of claims 1 to 9, wherein the conditioning solution comprises concentrated eluate obtained from the elution column.
12. A process according to claim 11, wherein the conditioning solution comprises concentrated eluate with a modifying agent or agents added thereto.
13. A process according to claim 12, wherein the modifying agent comprises an acid, an alkali, an oxidizing agent, a reducing agent, eluant ion or the ion of interest.
14. A process according to any one of the preceding claims, wherein each batch of particles in the conditioning chamber is firstly contacted with a solution that is substantially free of the ion of interest and that removes unwanted component from the resin particles, and subsequently contacted with a solution containing the ion of interest.
15. A process according to any one of the preceding claims wherein the ion of interest comprises uranium.
16. A process according to any one of the preceding claims, wherein the resin is a strong base anion exchange resin.
17. A process according to claim 16, wherein the ion of interest is a complex ion containing uranium and the unwanted component comprises ferric ions.
18. A process according to claim 17, wherein the loaded resin comprises complex uranium sulphate ions and complex ferric sulphate ions.
19. A process according to claim 16, 17 or 18, wherein the conditioning solution comprises H_2SO_4 solution.
20. A process according to claim 19, wherein said H_2SO_4 solution is 0.2 to 0.5M H_2SO_4 .
21. A process according to claim 20, wherein said H_2SO_4 solution is 0.3M H_2SO_4 .

22. A process according to any one of claims 16 to 21, wherein said conditioning solution comprises a solution containing uranium sulphate.
23. A process according to claim 22, wherein the resin in the conditioning chamber is first conditioned with H_2SO_4 solution and is subsequently conditioned with uranium sulphate solution. 5
24. A process according to claim 16, 17 or 18, wherein the conditioning solution comprises uranium sulphate solution at pH in the range 1 to 3.
25. A process according to claim 24, wherein said pH is in the range 1.5 to 2.5.
26. A process according to any one of claims 22 to 25, wherein the uranium sulphate solution is a concentrated eluate solution. 10
27. A process according to any one of claims 22 to 25, wherein the uranium sulphate solution is a solution of yellow cake.
28. A process according to claim 1, substantially as described in any one of Examples 1 to 4 herein.
29. A process according to any one of the preceding claims, wherein the feed solution is obtained by mixing a relatively weak feed solution with a solution relatively rich in the ion of interest, to obtain an enriched feed solution having an enriched molar ratio of ion of interest to unwanted component. 15
30. A process according to claim 29, wherein the solution relatively rich in the ion of interest comprises effluent from the conditioning chamber. 20
31. A process according to claim 29, wherein the solution relatively rich in the ion of interest comprises concentrated eluate obtained from the elution column.
32. A process according to claim 29, 30 or 31, wherein said relatively weak solution is a sulphatic solution and said solution relatively rich in the ion of interest is a sulphatic solution. 25
33. A continuous ion exchange process substantially as herein described with reference to the accompanying drawings.

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Agents for the Applicants.



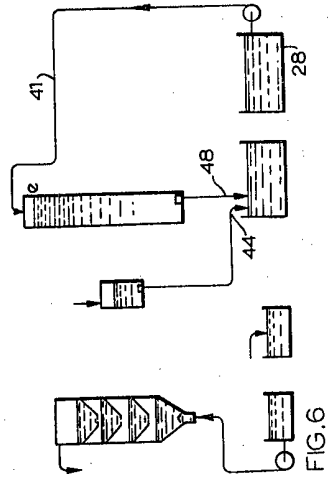


FIG. 6

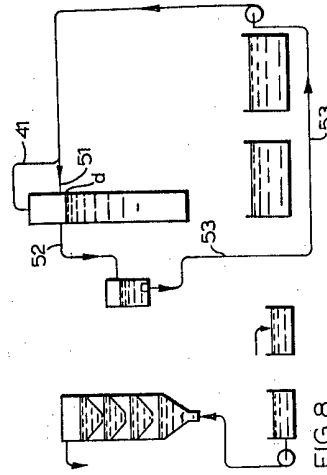


FIG. 8

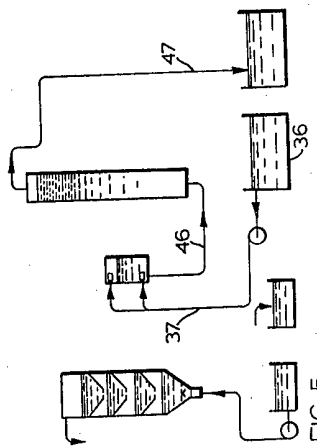


FIG. 5

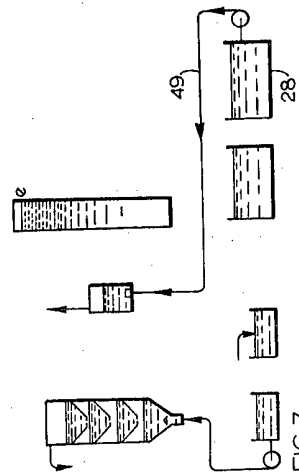


FIG. 7

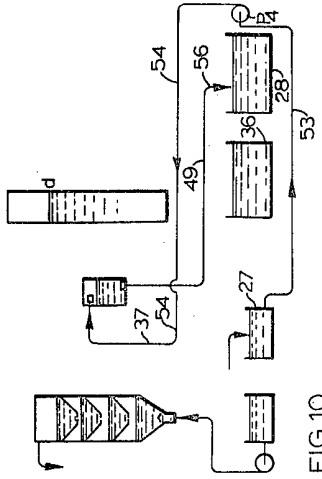


FIG.10

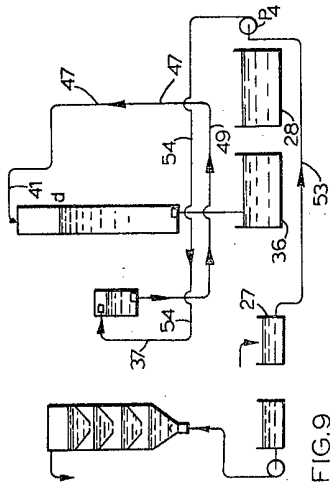


FIG.9

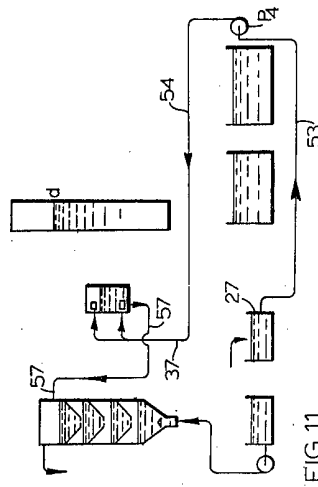


FIG.11

FIG. 12A

