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# Advanced method for

# Partitioning of Trivalent Actinides

# from Fast Reactor High Active Waste

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**Abstract**

The single-cycle processing methods proposed for the separation of trivalent actinides from high-level liquid (HLLW) involves the separation of trivalent actinides and chemically similar lanthanides as a group, from HLLW followed by the mutual separation of lanthanides and actinides from the loaded organic phase using aqueous soluble complexing agents. The potential solvents identified for the group separation of trivalents from HLLW were 1) 0.2 M TODGA (*N,N,N’N’*-tetraoctyldiglycolamide) + 5% octanol /*n*-DD, 2) 0.2 M TODGA + 0.5 M TBP (tri-*n*-butylphosphate)/*n*-DD, 3) 0.1 M TODGA + 0.25 M HDEHP (di-(2-ethylhexyl)phosphoric acid)/*n*-DD, 4) 0.2 M TDDGA (*N,N,N’N’*-tetradecyldiglycolamide)/*n*-DD, 5) 0.2 M D3DODGA (*N,N*-didodecyl-*N’N’*-dioctyldiglycolamide) /*n*-DD, 6) 0.4 M DOHyA (*N,N*-dioctyl-2-hydroxyacetamide)/*n*-DD. The extraction behavior of Am(III) and the lanthanide representative Eu(III) in all the organic phases was studied. The selective stripping of Am(III) from the loaded organic phase containing Eu(III) was investigated using aqueous soluble bis-1,2,4-triazine (BTP) derivatives such as SO3-Ph-BTP, SO3-Ph-BTBP and SO3-Ph-BTPhen present in dilute nitric acid solution. The results revealed that the separation factor (SF) of Eu(III) over Am(III) decreased with increase in the concentration of nitric acid in all cases. The co-stripping of lower lanthanides (La, Ce, Pr, Nd) was also observed during the recovery of Am(III). Among the various DGA ligands investigated, TDDGA and D3DODGA, developed in our laboratory, offered significant advantages over the TODGA.

## INTRODUCTION

The high-level liquid waste (HLLW) is generated during reprocessing of spent nuclear fuels [1]. Partitioning of long-lived radiotoxic trivalent actinides (241Am and 244Cm) from HLLW followed by transmutation of them into short-lived or stable products in accelerator driven systems or fast reactors is required for the safe management of HLLW [1,2]. At present, the processes being developed for partitioning of trivalent actinides from high-level liquid waste are being focused on single-cycle processing approaches [3,4]. In this approach, a couple of methods have been envisaged for partitioning of trivalent actinides. The first method involves the challenging task of separating Am(III) and Cm(III) directly from high-level liquid waste containing chemically similar trivalent lanthanides, fission products and corrosion products present in 3-4 M nitric acid medium. Based on this approach, few methods are reported in literature [3-8]. However, it is quite difficult to selectively extract trivalent actinides alone from the HLLW containing significant amounts of chemically similar lanthanides.

The second method involves the extraction of lanthanides and actinides together as a group into organic phase, followed by selective stripping of actinides alone from the loaded organic phase [9]. In this method, a couple of variants are available depending upon the composition of organic phase. In the first variant, the organic phase contains a combination of neutral and acidic extractants present in *n*-dodecane (*n*-DD) medium. Such methods have been demonstrated by several authors in the processes such as TRUSPEAK, SMART, ALSEP etc. described elsewhere [9-13]. The second variant involves the group extraction of trivalents from nitric acid medium using a neutral extractant followed by selective stripping of trivalent actinides alone from the loaded organic phase using aqueous soluble multidentate N-donor derivatives [4,14-19]. The process known as innovative-Selective Actinide Extraction (i-SANEX) developed and demonstrated based on this approach.

Nevertheless, all these methods reported in literature have some drawbacks such as they use unconventional diluents and susceptible to third phase formation etc. Several authors have added organic phase modifiers in significant quantities to maneuver the third phase formation [20], even through the solvent system without phase modifier is indeed desirable. Moreover, the alcohol based phase modifiers are undesirable due to safety concerns, whereas the presence of other phase modifiers generate large volumes of organic and aqueous waste. In view of this, it is being envisaged to develop ligands which does not require phase modifier for trivalent actinide separation.

In the recent past, the following solvents have been widely studied for the separation of trivalent actinides from nitric acid solution. They are 1) 0.2 M TODGA+5% Octanol/*n*-DD [14-15], 2) 0.2 M TODGA + 0.5 M TBP or DHOA/*n*-DD [21,22], 3) 0.1 M TODGA + 0.25 M HDEHP/*n*-DD [23] , 4) 0.2 M *N,N,N',N*'-tetradecyldiglycolamide (TDDGA)/*n*-DD [24], 5) 0.2 M *N,N*-didodecyl *N',N'*-di-octyl diglycolamide (D3DODGA)/n-DD [25], 6) 0.4 M *N,N*-dioctyl hydroxyl acetamide (DOHyA)/*n*-DD [26]. The first three solvent systems discussed above contains organic phase modifier, and the last three systems do not have the organic phase modifier. The extraction behaviour of Am(III) and Eu(III) from dilute nitric acid solution (0.1 M to 1 M) containing aqueous soluble nitrogen-donor derivative, SO3-Ph-BTP, was studied in the above solvents. The separation factor of Eu(III) over Am(III) was determined. Since the unsymmetrical diglycolamide D3DODGA in *n*-DD, offered significant advantages over other systems, the selective stripping of Am(III) from the loaded organic phase containing all Ln(III) was investigated using SO3-Ph-BTP as well as other derivatives of BTPs such as SO3-Ph-BTBP and SO3-Ph-BTPhen in dilute nitric acid solution. The structure of ligands, phase modifiers and aqueous soluble BTP employed in the present study are shown in Figure 1. In this paper, the summary of our research and development activities carried out towards the development of advanced methods for partitioning of trivalent actinides from high-level liquid waste arising from fast reactor fuel reprocessing has been presented with a focus on single-cycle processing.



Figure 1: Structures of ligands, phase modifiers and aqueous soluble BTP employed in the study

## experimental

### Materials

The chemicals employed in the present study were analytical (AR) grade. The glycolamide ligands were synthesized and purified by the procedure described in detail in our previous publications [23,24, 26]. The ligands tri-n-butyl phosphate (TBP, >99%), bis(2-ethylhexyl) phosphoric acid (HDEHP, 97%) were purchased from Sigma Aldrich, Mumbai, India and purified by the procedure described elsewhere [21, 27]. The diluents, *n*-dodecane (n-DD, 98%) and 1-octanol (>99%) were purchased from Alfa Aesar, Mumbai, India and they were used without any purification. The sodium salt of 2,6-bis(5,6-di(sulphophenyl)-1,2,4-triazin-3-yl)-pyridine (SO3-Ph-BTP) (>98%) was synthesized and characterized by the standard procedure reported in the literature [14]. All other chemicals were of AR grade and their solutions were estimated by standard procedure. The 241Am(NO3)3 in dilute nitric acid (~0.1 M) was obtained from Bhabha Atomic Research Centre, Trombay, India and (152+154)Eu(NO3)3 in dilute nitric acid was purchased from Board of Radiation and Isotope Technology, Mumbai, India. The purity of these tracers was ascertained by alpha spectrometry for 241Am and gamma spectrometry for (152+154)Eu.

### Extraction studies

The extraction behavior of Am(III) and Eu(III) from nitric acid solution was studied by batch equilibration procedure at 298 K. The equilibration experiments were performed in duplicate and in some cases triplicate. The organic phase was composed of one of the following solutions namely, 1) 0.2 M TODGA+5% octanol/*n-DD*, 2) 0.2 M TODGA+0.5 M TBP/*n-DD*, 3) 0.1 M TODGA+0.25 M HDEHP/*n-DD*, 4) 0.2 M TDDGA/*n-DD*, 5) 0.2 M D3DODGA/*n-*DD, 6) 0.4 M DOHyA/*n-*DD. The aqueous phase was composed of a nitric acid solution containing 0.02 M BTP spiked with either 241Am or (152+154)Eu tracer. The concentration of nitric acid in aqueous phase was varied from 0.01 M to 1 M. The extraction procedure involved initial pre-equilibration of the organic phase with equal volume (2 mL each) of 4 M nitric acid. The pre-equilibrated organic phase was separated and contacted with equal volume (1 mL each) of aqueous phase. After one hour, the equilibration was stopped and an aliquot (0.1 mL) was taken from both organic and aqueous phases. The radioactivity of 241Am or (152+154)Eu present in aqueous and organic phases was measured using a well-type NaI(Tl) scintillation detector coupled with a single channel analyzer. The distribution ratio of trivalent metal ion and separation factor (SF) of Eu(III) over Am(III) was determined using equation 1. The fast reactor simulated high level waste solution (FR-SHLLW) was prepared based on the waste generated during reprocessing of fast reactor fuel irradiated to the burn-up of 80 GWd/Te and 2 years cooling. The analysis of metal ions in FR-SHLLW was carried out using ICP-OES analyzer from Spectro Arcos GmBH, Ametek, Germany.

 and  (1)

## results and discussion

### Distribution of Am(III) and Eu(III) in TODGA-modifier systems

The distribution ratio of Am(III) and Eu(III) from nitric acid medium containing 0.02 M SO3-Ph-BTP was measured in a solution of 0.2 M TODGA /*n-*DD+ 5% octanol and the results are shown in table 1, along with the separation factor of Eu(III) over Am(III) achieved in this system. It can be seen that the separation factor of Eu(III) over Am(III) in the absence of SO3-Ph-BTP is in the range of 1.4 to 2.4. The addition of SO3-Ph-BTP to the aqueous phase decreased the distribution ratio of both the metal ions at all nitric acid concentrations. However, it is important to note that the distribution ratio of Am(III) is lowered to a significant extent as compared to Eu(III). Therefore, the separation factor achieved in the presence of SO3-Ph-BTP is found to vary between 90 and 324 depending upon the concentration of nitric acid, and the separation factor reaches a maximum value at 0.5 M nitric acid.

TABLE 1. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor of Eu(III) over Am(III) achieved in 0.2 M TODGA/*n-*dodecane + 5 vol% 1-octanol. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]ini.aq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 0.1 | 27.2 | 0.025 | 64.2 | 2.45 | 2.4 | 98 |
| 0.5 | 95.6 | 0.156 | 144.3 | 50.6 | 1.51 | 324.4 |
| 1 | 175.3 | 1.216 | 247.4 | 185 | 1.42 | 152.1 |

The distribution ratio of Am(III) and Eu(III) determined in a solution of 0.2 M TODGA + 0.5 M TBP/*n-*DD at various concentration of nitric acid are shown in table 2. It can be seen that the distribution ratio of Am(III) and Eu(III) achieved in the absence of SO3-Ph-BTP is similar to those achieved in 0.2 M TODGA + 5 % octanol/*n-*DD, and the separation factor is marginally higher. In the presence of SO3-Ph-BTP, the separation factor achieved is approximately three times higher than that achieved in octanol medium at 0.1 M nitric acid. In 1 M nitric acid, the separation factor is lower than that achieved in octanol medium. At 0.5 M nitric acid the separation factors are comparable.

In contrast to the conventional TBP and octanol phase these modifiers, the bis(2-ethylhexyl) phosphoric acid (HDEHP) is regarded as a reactive phase modifier, in which the HDEHP synergistically participates in the extraction of trivalent metal ions, in addition to minimizing/preventing third phase formation [27-29]. In view of these advantages, the extraction behavior of Am(III) and Eu(III) was studied in a solution of 0.1 M TODGA + 0.25 M HDEHP/*n-*DD and the variation in distribution ratio of Am(III) and Eu(III) at different concentration of nitric acid in the presence and absence of SO3-Ph-BTP are shown in table 3. In the presence of SO3-Ph-BTP, the distribution ratio of both Am(III) and Eu(III) are reduced significantly and the distribution ratio of Am(III) is reduced to a large extant. Therefore, the separation factor of Eu(III) over Am(III) achieved in this case falls in the range of 110 to 130, when the concentration of nitric acid is varied between 0.01 M and 1 M as shown in table 3.

TABLE 2. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor of Eu(III) over Am(III) achieved in 0.2 M TODGA + 0.5 M TBP /*n-*dodecane. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies.

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| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]ini.aq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 0.1 | 19.45 | 0.021 | 75.25 | 5.9 | 3.9 | 280.9 |
| 0.5 | 108.94 | 0.17 | 202.45 | 54.8 | 1.8 | 322.4 |
| 1 | 360.63 | 1.95 | 622.47 | 191.84 | 1.7 | 98.4 |

TABLE 3. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor of Eu(III) over Am(III) achieved in 0.2 M TODGA + 0.25 M HDEHP /*n-*dodecane. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies

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| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]iniaq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 0.01 | 72.66 | 0.16 | 100.28 | 20.73 | - | - |
| 0.1 | 84.2 | 0.12 | 102 | 14.29 | 0.72 | 129.6 |
| 0.5 | 99.6 | 0.15 | 129 | 19.89 | 1.3 | 132.3 |
| 1 | 93.4 | 0.49 | 187 | 57.8 | 2 | 117.96 |

### Distribution of Am(III) and Eu(III) in modifier-free DGA systems

So far, the extraction behavior of Am(III) and Eu(III) was studied in a solution of TODGA in *n-*dodecane containing organic phase modifiers such as 1-octanol, TBP and HDEHP. Even though these phase modifiers have been added to maneuver the third phase formation during the solvent extraction of Am(III) and Eu(III), the solvent phase without the need of any phase modifier is indeed desirable reprocessing applications. Table 4 shows the variation in the distribution ratio of Am(III) and Eu(III) in a modifier-free solvent phase composed of 0.2 M TDDGA/*n-*DD. As expected, the distribution ratio of Am(III) and Eu(III) increases with increase in the concentration of nitric acid. The separation factor of Eu(III) over Am(III) achieved with 0.2 M TDDGA/*n-*DD in the presence of SO3-Ph-BTP is significantly high as compared to previous systems discussed above. The separation factor increases with increase in the concentration of nitric acid from the value 361 at 0.1 M to the value 406 at 0.5 M. This is followed by a sharp decline in the separation factor to the value of 116 at 1 M nitric acid. Similarly, the extraction behavior of Am(III) and Eu(III) was studied in a modifier-free solution of 0.2 M D3DODGA/*n-*DD in the presence and absence of SO3-Ph-BTP, and the results on the distribution ratio of Am(III) and Eu(III) as a function of nitric acid are shown in table 5. The separation factor achieved in this case in the presence of SO3-Ph-BTP is quite similar to those obtained in TDDGA/*n-*DD. The separation factor initially increases from 359 at 0.1 M nitric acid reaches a maximum value of 489 at 0.5 M nitric acid, followed by the decrease in separation factor at 1 M nitric acid. Comparing the separation factor of Eu(III) over Am(III) achieved in all systems investigated in the present study, the solvent phase composed of 0.2 M D3DODGA/*n-*DD and 0.2 M TDDGA/*n-*DD provides the highest separation factor at 0.5 M nitric acid.

TABLE 4. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor achieved in 0.2 M TDDGA /*n-*dodecane. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies

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| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]ini.aq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 0.1 | 10.12 | 0.013 | 39.34 | 4.7 | 5.39 | 361.5 |
| 0.25 | 13.18 | 0.02 | 35.95 | 7.84 | 2.73 | 386.2 |
| 0.5 | 60.77 | 0.104 | 76.32 | 42.25 | 1.25 | 406.25 |
| 1 | 90.92 | 1.15 | 133.79 | 85.57 | 0.94 | 116.33 |

TABLE 5. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor achieved in 0.2 M D3DODGA /*n-*dodecane. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]ini.aq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 0.1 | 3.12 | 0.00214 | 14.29 | 0.77 | 4.58 | 359.2 |
| 0.25 | 6.6 | 0.0091 | 28.98 | 3.77 | 4.39 | 414.3 |
| 0.5 | 22.26 | 0.025 | 78.84 | 12.23 | 3.54 | 489.1 |
| 1 | 178.84 | 0.39 | 370.28 | 153.23 | 2.07 | 392.9 |

### Am(III) / Eu(III) Separation in modifier-free hydroxyacetamide system

*N,N*,-dioctyl hydroxyacetamide (DOHyA) in *n-*dodecane in another modifier-free solvent system studied for trivalent actinide separation in the recent past. The advantages of using DOHyA over diglycolmide are described elsewhere [26,30]. The extraction behavior of Am(III) and Eu(III) was studied in a solution of 0.4 M DOHyA/*n-*DD from nitric acid solution containing 0.02 M SO3-Ph-BTP. The concentration of nitric acid in this case was fixed at 1 M and 2 M in this case, since, the Am(III) and Eu(III) are inextractable in 0.4 M DOHyA/*n-*DD phase at nitric acid concentrations lower than 1 M and therefore the mutual separation of Am(III) from Eu(III) could not achieved below 1 M nitric acid concentration. The distribution ratio of Am(III) and Eu(III) in 0.4 M DOHyA/*n-*DD from nitric acid solution containing 0.02 M SO3-Ph-BTP is shown in table 6. The separation factor of Eu(III) over Am(III) achieved in the presence of SO3-Ph-BTP is ~ 50, which is lower than the separation factor achieved in all the other systems investigated in the present study, perhaps, due to the employment of high concentration of nitric acid. Among the modifier-free ligands, the separation achieved in case of D3DODGA is marginally higher and therefore further studies with simulated waste were carried out only with D3DODGA

TABLE 5. The variation in the distribution ratio of Am(III) and Eu(III) and the separation factor of Eu(III) over Am(III) achieved in 0.4 M DOHyA /*n-*DD. Aqueous phase: Nitric acid with or without 0.02 M SO3-Ph-BTP. Organic phase was pre-equilibrated with 4 M nitric acid before the distribution studies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **[HNO3]iniaq. /M** | **DAm(III)** | | **DEu(III)** | | **SF Eu(III)/Am(III)** | |
| **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** | **Without**  **SO3-Ph-BTP** | **With**  **SO3-Ph-BTP** |
| 1 | 1.52 | 0.0045 | 1.21 | 0.24 | 0.795 | 53.33 |
| 2 | 16.75 | 0.105 | 13.43 | 5.07 | 0.802 | 48.29 |

### Studies with other lanthanides

In single-cycle separation methods, it is proposed to extract Am(III) and Ln(III) from HLLW into the organic phase followed by the recovery of Am(III) alone from the loaded organic phase using the aqueous phase using aqueous soluble SO3-Ph-BTP and its other derivatives such as SO3-Ph-BTBP and SO3-Ph-BTPhen [14,31], shown in figure 1. Since the extraction and stripping behaviour of Ln(III) is quite similar to Am(III), it is necessary to understand the back extraction behaviour of Ln(III) that are likely to be present in HLLW during the stripping of Am(III) from the loaded organic phase. For this purpose, the extraction of Ln(III), Am(III) and Y(III) was carried out from the FR-SHLLW. The organic phase was separated and contacted with the aqueous phase composed of 0.02 M SO3-Ph-BTP or SO3-Ph-BTBP or SO3-Ph-BTPhen in 0.5 M nitric acid. The percentage stripping of these trivalent lanthanides along with Am(III) and Y(III) are shown in figure 2.



Figure 2: Stripping of trivalent metal ions from the loaded organic phase containing 0.2 M D3DODGA/n-DD. The organic phase was pre-equilibrated with FR-SHLLW before stripping. Aq. Phase: 0.5 M HNO3 containing bis-1,2,4-triazine derivatives

It can be seen from figure 2 that the stripping of Am(III) is more than 90% in a single contact irrespective of the nature of aqueous soluble complexing ligands. However, it is noted that the stripping of early Ln(III) (La, Ce, Pr, and Nd) are quite significant. About 40-60% of La(III), Ce(III), Pr(III), and Nd(III) are stripped along with Am(III) from the loaded organic phase; whereas less than 20% of Gd(III) and Sm(III) are stripped in to aqueous phase. The stripping of other Ln(III) is quite small. The presence of some Ln(III) in Am(III) produce could minimize transmutation of Am. However, it should be noted that back extraction in this case was carried out in a batch mode and single stage. In real conditions, the aqueous phase obtained after batch extraction is subjected to the re-extraction in the counter-current industrial scale mixer-settler operations. On such occasion, it is quite likely that the Ln(III) present in aqueous phase could be re-extracted in to organic phase and the aqueous phase product obtained after the counter-current run could have minimum contamination of Ln(III) in the Am(III) product. In addition, the neutron absorption cross-section of the early lanthanides are significantly low as compared to the later lanthanides beyond Nd(III). Therefore, the contamination of early Ln(III) in Am(III) product could not be a serious concern during transmutation of actinides. However, more studies are needed to understand the extraction behavior of lanthanides and actinides using 0.2 M D3DODGA/n-DD in the presence of other metal ions that are present in the real waste solution as well as the stripping behavior of actinides alone from the loaded organic phase using BTP derivatives. Such data would provide complete understanding on the feasibility of employing single cycle processing method for partitioning of trivalent actinides from HLLW.

## Conclusions

The extraction behaviour of Am(III) and Eu(III) was studied in six potential solvent systems to evaluate the feasibility of using them for the single-cycle separation of trivalent actinides from high-level liquid waste. Baring DOHyA, all the other solvent systems contained the diglycolamide ligands with octyl or decyl or dodecyl substituents attached to the amidic nitrogen of DGA. The solvent systems containing TODGA required an organic phase modifier. The extraction was carried out from the aqueous nitric acid solution containing 0.02 M SO3-Ph-BTP to facilitate the mutual separation of Am(III) and Eu(III). Depending upon the relative affinities of Am(III) and Eu(III) with SO3-Ph-BTP present in aqueous phase and the amidic ligands present in organic phase, the distribution ratio of Am(III) and Eu(III) achieved in these organic phases were significantly different. Except the solvent system containing HDEHP, the distribution ratio of both trivalents increased with increase in the concentration of nitric acid. In the presence of SO3-Ph-BTP, the distribution ratios of Am(III) and Eu(III) lowered significantly and the DAm(III) was lowered to a greater extent. As a result, the SF of Eu(III) over Am(III) achieved in diglycolamide solvent systems initially increased with increase in the concentration of nitric acid (from 0.1 M), reached a maximum SF at 0.5 M nitric acid followed by decrease. Among the different solvents investigated, the separation factor was maximum in case of the solvent phase containing D3DODGA and TDDGA ligands at 0.5 M nitric acid. The ligands, D3DODGA and TDDGA offer a number of advantages over the existing diglycolamides reported for group separation as well as single-cycle separation. A noteworthy feature of these ligands was that they did not require any phase modifier. The extraction can be easily performed with the solvent phase made of *n-*dodecane, which is commonly employed in process applications at the back end of nuclear fuel cycle. Thus the solvent phase composed of 0.2 M D3DODGA/*n-*DD and 0.2 M TDDGA/*n-*DD are recommended for the single-cycle separation of trivalent actinides from high level liquid waste using aqueous soluble BTP. However, more studies are needed to understand the extraction behavior of lanthanides and actinides from real waste solutions in these DGAs and the stripping behavior of actinides alone from the loaded organic phase using BTP derivatives to ascertain the feasibility of employing single cycle processing method for partitioning of trivalent actinides from HLLW.

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