List of tables

**Table 1 Composition of the co-monomers prepared nanocomposites :.**

| Sample | AAM (mol%) | IA (mol%) | $TiO_2$ (mol%) | DAM (mol%) |
|---|---|---|---|---|
| C1P(AAM-co-IA/$TiO_2$) | 69.56 | 17.39 | 4.35 | 8.7 |
| C2 P(AAM-co-IA/$TiO_2$) | 57.14 | 28.6 | 4.76 | 9.5 |
| C3 P(AAM-co-IA/$TiO_2$) | 28.6 | 57.14 | 4.76 | 9.5 |
| C4 P(AAM-co-IA/$TiO_2$) | 17.39 | 69.56 | 4.35 | 8.7 |
| C5 P(AAM-co-IA/$TiO_2$) | 50 | 25 | 8.34 | 16.66 |
| C6 P(AAM-co-IA/$TiO_2$) | 61.54 | 30.77 | 2.56 | 5.13 |
| C7 P(AAM-co-IA/$TiO_2$) | 63.17 | 31.58 | 1.75 | 3.5 |

**Table 2** Surface characteristics of C6P(AAM-co-IA/$TiO_2$) nanocomposite

| Total pore area $m^2g^{-1}$ | Average pore diameter nm | App.density $gL^{-1}$ | Bulk density $gL^{-1}$ | Porosity % |
|---|---|---|---|---|
| 19.73 | 88 | 0.8510 | 0.6215 | 26.97 |

**Table 3** The sorption efficiency (%) and distribution coefficients ($K_d$) of Ce(III) onto P(AAM-co-IA/$TiO_2$ ) nanocomposite

| Sample | Sorption efficiency (%) | $K_d$ $mLg^{-1}$ |
|---|---|---|

| Sample | Sorption efficiency (%) | $K_d$ $mLg^{-1}$ |
|---|---|---|
| $C_1$-P(AAM-co-IA/$TiO_2$) | 53.2 | 454.70 |
| $C_2$ P(AAM-co-IA/$TiO_2$) | 64 | 711.11 |
| $C_3$P(AAM-co-IA/$TiO_2$) | 60.1 | 602.06 |
| $C_4$P(AAM-co-IA/$TiO_2$) | 29.3 | 165.77 |
| $C_5$ P(AAM-co-IA/$TiO_2$) | 61.6 | 641.67 |
| $C_6$ P(AAM-co-IA/$TiO_2$) | **80.11** | **1611.1** |
| $C_7$ P(AAM-co-IA/$TiO_2$) | 42.3 | 309.22 |

**Maximum values are bolded**

**Table 4** Calculated parameters of the studied kinetic models for sorption of Ce(III) onto C6P(AAM-co-IA/$TiO_2$) nanocomposite at pH=6 , v/m =0.4 $Lg^{-1}$ and 298K

| Temp. (°C) | Pseudo 1st order kinetic parameters | | | $q_{e(exp)}$ (mg $g^{-1}$) | Pseudo 2nd order kinetic parameters | | | Elvoich kinetic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $k_1$ ($min^{-1}$) | $q_{e\,(cal.)}$ ($mgg^{-1}$) | $R^2$ | | $k_2$ (x$10^{-3}$) ($gmg^{-1}min^{-1}$) | $q_{e\,(cal.)}$ ($mgg^{-1}$) | $R^2$ | α $mmolg^{-1}min^{-1}$ | β $gmmol^{-1}$ | $R^2$ |
| 25 | 0.056 ±0.08823 | 7.684 ±0.088 | 0.96 | 64.89 | 0.0197 ± 0.0113 | 65.232 ±2.17 x $10^{-5}$ | 0.99 | 61.1 x$10^9$ | 72.202 | 0.96 |

**Table 5** The values of parameters of equilibrium isotherm models fitting for Ce(III) ion sorption onto C6P(AAM-co-IA/$TiO_2$) composite at different temperatures, pH=6 , v/m =0.4 $Lg^{-1}$ .

| Temperature | Langmuir Isotherm model | | | | Freundlich Isotherm model | | | Temkin Isotherm model | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $Q$ $mgg^{-1}$ | $b$ $Lmg^{-1}$ | $R_L$ | $R^2$ | $K_F$ ($mgg^{-1}$) | n | $R^2$ | $A_t$ | $b_t$ $jmol^{-1}$ | $R^2$ |
| 298 K | 76.05 | 0.092 | 0.052 | 0.99 | 14.11 | 3.12 | 0.85 | 1.22 | 184.10 | 0.86 |
| 313 K | 82.64 | 0.209 | 0.023 | 0.99 | 21.105 | 3.71 | 0.88 | 4.12 | 204.86 | 0.90 |
| 333K | 91.41 | 0.356 | 0.014 | 0.99 | 36.83 | 5.68 | 0.94 | 195.6 | 312.13 | 0.86 |

**Table 6** Thermodynamic parameters for the sorption of Ce(III) ions onto C6P(AAM-co-IA/$TiO_2$) at pH=6 , v/m =0.4 $Lg^{-1}$ and $C_o$ of Ce(III) 200$mgL^{-1}$

| Temperature | $\Delta G^o$ , kJ/mol | | | $\Delta H^o$ | $\Delta S^o$, |
|---|---|---|---|---|---|
| | 298 K | 308 K | 318 K | , kJ/mol | J/mol.K |
| | -4.78 | -6.988 | -9.1915 | 60.874 | 220.332 |

**Table 7** Comparison of the maximum sorption capacity of various materials with the sorption capacity of Ce(III) at pH=6 , v/m =0.4 $Lg^{-1}$ and $C_o$ of Ce(III) 200$mgL^{-1}$ onto C6P(AAM-co-IA/$TiO_2$) nanocomposite.

| Sorbent materials | Sorption capacity ($mgg^{-1}$) | | | References |
|---|---|---|---|---|
| | Temperature $^oC$ | pH | Ce(III) | |
| **magnetite (MNP)**<br>**magnetic olive pomace (MOP)** | 25 | 6 | 76.92<br>90.90 | [39] |
| **HESI-SBA-15** | 25 | 6 | 27.67 | [40] |
| **HKUST-1** | 25 | 6 | 353 | [15] |
| **Nitrolite** | 25 | 6.8-6.9 | 4.45 | [41] |
| **MSGC** | 27 | 4 | 369 | [42] |
| **D151** | 25 | 6.5 | 392 | [43] |
| **Grapefruit peel** | 20 | 5 | 159.3 | [44] |
| **C6P(AAM-co-IA/$TiO_2$) nanocomposite** | 25 | 6 | 76.04 | **This study** |

**Table 8** Sorption efficiency of $LRE^{3+}$ and $HRE^{3+}$ onto onto C6P(AAM-co-IA/$TiO_2$) nanocomposite and desorption percentage by 2M HCl eluent for 24 hours

| LREE | | | HREE | | |
|---|---|---|---|---|---|
| **REEs ion** | **Sorption %** | **Desorption %** | **REEs ion** | **Sorption %** | **Desorption %** |
| **La** | 72.25 | 86.02 | **Y** | 75.7 | 94.87 |
| **Ce** | 61.62 | 91.09 | **Tb** | 65.17 | 93.86 |
| **Pr** | 62.14 | 92.93 | **Dy** | 67.72 | 92.26 |
| **Nd** | 38.58 | 96.07 | **Ho** | 71.18 | 89.82 |
| **Sm** | 49.13 | 97.37 | **Er** | 73.14 | 87.946 |
| **Eu** | 32.99 | 96.045 | **Tm** | 74.17 | 86.75 |
| **Gd** | 61.82 | 94.85 | **Yb** | 65.23 | 92.57 |
| | | | **Lu** | 75.237 | 86.71 |
| | 54.08 | 93.48 | | 70.94 | 90.59 |