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Removal of Thallium from Aqueous Solutions by Adsorption onto Alumina Nanoparticles

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Statistics and Data Analysis

The data fit of adsorption was carried out using Excel (version Microsoft Excel 2016). The average values and standard deviations analysis of the amount of Tl (%), effects of pH, adsorbent dose, agitation time, and initial concentration on the adsorption of Tl by γANPs were carried out using Excel. Differences were considered significant at p value $< 5\%$.

The reactions of Tl^{+} ions in water are as follows:

$$Tl(OH)^{i-1+m} + H_2O \rightleftharpoons Tl(OH)_i^{m-i} + H^+$$

$$i=1,\ m=1 \text{ for } Tl^+$$

$$\text{In basic medium, } Tl^+ + H_2O + 0H^- \rightleftharpoons Tl(OH) + H^+ + 0H^-$$

$$Tl^+ + 0H^- + H_2O \rightleftharpoons Tl(OH) + H_2O$$

$$\Longrightarrow Tl^+ + 0H^- \rightleftharpoons Tl(OH) \text{ and}$$

$$K = [Tl^+].[0H^-]$$

The expression for the solubility constant is as follows:

$$K_{hi}=\frac{[Tl(OH)_i^{m-1}].[H^+]}{[Tl(OH)_{i-1}^{i-1+m}]}$$

For Tl^+,

$$K_{hi}=\frac{[Tl(OH)_i^0].[Tl^+]}{[Tl(OH)_0^{0+1}]} = \frac{[Tl(OH)].[H^+]}{[Tl^+]}$$

$$pK_{h1}= -\log K_{h1}=11.7$$

$$pH=pK_{h1}+\log\frac{[Tl(OH)aq]}{[Tl^+]}$$

The following table summarizes a comparison of surface areas between synthesized alumina nanoparticles and other adsorbents used for thallium removal.

Table S1: Comparison of adsorbents surfaces used for thallium (I) removal

	SSA (m^2/g)	Pore volume (cm^3/g)	Pore diameter (nm°	References
Biochar	3.127	0.015	1.220	[1]
Biochar	4.751	0.016	2.457	[1]
Biochar	3.872	0.004	1.22	[1]
Biochar	14.18	0.031	2.741	[1]
Biochar	13.763	0.145	3.419	[1]
Biochr	33.4	0.18	0.44	[1]
PAAm-B	1.65	0.01	0.77	[2]
Z	10.4	0.07	0.44	[2]
PAAm-Z	2.75	0.03	0.77	[2]
Nano-alumina	187	0.58	9.8	Present study

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