ZINC ADSORPTION EFFECTS ON ARSENITE OXIDATION KINETICS AT THE BIRNESSITE-WATER INTERFACE

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Table 1. Percent As(III)(aq) during As(III) oxidation at the birnessite-water interface as a function of initial As(III) concentrations, various Zn(II) additions (i.e., no Zn(II), Zn(II) pre-sorbed prior to the As(III) addition, and As(III)/Zn(II) simultaneous addition) at pH 4.5.

Time (h)	% As as [As(III)](aq)[1]					
	$[As(III)]_i$ = 100 µM			$[As(III)]_i$ = 300 µM		
	No Zn	Pre-sorbed	Simultaneous	No Zn	Pre-sorbed	Simultaneous
0	100.0	100.0	100.0	100.0	100.0	100.0
0.33	68.5	93.9	91.6	84.3	96.6	92.7
0.67	44.1	89.0	83.4	68.4	90.1	87.1
1	28.0	83.1	74.0	56.2	81.6	76.8
2	2.7	64.5	44.9	36.3	62.9	54.8
4	0.0	32.0	5.9	20.0	39.9	30.9
6	0.0	18.0	0.0	14.6	28.0	19.7
8	0.0	9.6	0.0	8.1	25.2	18.5
10	0.0	2.0	0.0	NA	19.0	NA
24	0.4	5.0	0.0	0.4	11.3	0.8

[1]NA = Not Available

Table 2. Percent As(III)(aq) during the As(III) oxidation at the birnessite-water interface as a function of initial As(III) concentrations and various Zn(II) additions (i.e., no Zn(II), Zn(II) pre-sorbed prior to the As(III) addition, and As(III)/Zn(II) simultaneous addition) at pH 6.

Time (h)	% As as [As(III)](aq)[1]					
	$[As(III)]_i$ = 100 μM			$[As(III)]_i$ = 300 μM		
	No Zn	Pre-sorbed	Simultaneous	No Zn	Pre-sorbed	Simultaneous
0	100.0	100.0	100.0	100.0	100.0	100.0
0.33	79.8	98.6	92.5	90.3	98.0	97.1
0.67	68.5	96.3	92.2	82.9	97.7	95.6
1	55.3	93.3	88.8	80.9	97.7	94.2
2	42.6	90.8	85.2	73.6	94.4	91.4
4	19.5	80.5	75.7	62.9	88.7	87.8
6	16.3	77.8	71.3	55.5	83.7	79.7
8	NA	70.0	62.3	46.7	77.8	74.2
10	NA	65.9	52.8	NA	71.9	68.9
24	3.5	19.6	18.8	25.7	46.8	45.3

[1]NA = Not Available

Table 3. Log of Ion Activity Product (IAP) and Log of Solubility Product (Log K) for Mn(II)- and Zn(II)-arsenate precipitates during the As(III) oxidation kinetic experiments on birnessite.

Time (h)	-log(IAP)											
	$Mn_3(AsO_4)_2$		$Mn_3(AsO_4)_2{\cdot}8H_2O$		$Zn_3(AsO_4)_2$[a]		$Zn_3(AsO_4)_2{\cdot}5H_2O$[a]		$Zn_3(AsO_4)_2$[b]		$Zn_3(AsO_4)_2{\cdot}5H_2O$[b]	
	pH4.5	pH6	pH4.5	pH6	pH4.5	pH6	pH4.5	pH6	pH4.5	pH6	pH4.5	pH6
						$[As(III)]_i$ = 100 μM						
0.67	13.4	NA	13.1	48.0	14.3	14.7	15.4	12.9	13.6	12.7	14.7	10.9
2	11.9	12.5	11.6	9.3	12.9	13.2	13.9	11.3	12.4	12.5	13.4	10.6
4	11.7	11.0	11.4	7.8	12.1	12.2	13.2	10.4	11.8	11.8	12.9	10.0
8	11.8	10.3	11.5	7.1	11.8	11.1	12.9	9.3	11.7	11.0	12.7	9.2
12	11.8	9.9	11.5	6.7	11.8	10.5	12.8	8.6	11.7	10.5	12.7	8.7
24	11.8	9.7	11.5	6.5	11.7	9.5	12.8	7.7	11.7	9.8	12.7	8.0
						$[As(III)]_i$ = 300 μM						
0.67	11.8	17.6	11.4	14.4	13.2	13.9	14.2	12.1	12.7	12.6	13.8	10.8
2	9.9	10.4	9.6	5.2	11.6	12.6	12.7	10.7	11.3	12.0	12.4	10.2
4	9.2	8.9	8.9	4.4	11.1	11.5	12.1	9.6	10.9	11.1	11.9	9.3
8	8.9	7.8	8.6	3.7	10.9	10.3	11.9	8.5	10.7	10.2	11.7	8.4
12	8.8	7.4	8.4	3.5	10.7	9.8	11.8	8.0	10.6	9.7	11.6	7.9
24	8.6	6.9	8.2	3.0	10.7	8.9	11.7	7.1	10.5	9.0	11.5	7.2

For comparison -log(K_{sadiq}) for $Mn_3(AsO_4)_2$ = -8.5, -log($K_{mineql+}$) for $Mn_3(AsO_4)_2{\cdot}8H_2O$ = -28.9, -log(K_{sadiq}) for $Zn_3(AsO_4)_2$ = -8.2, and -log($K_{mineql+}$) for $Zn_3(AsO_4)_2{\cdot}5H_2O$ = -27.6. [a]Pre-sorbed Zn(II) for 24 h prior to the As(III) addition.
[b]Zn(II) and As(III) simultaneous addition.

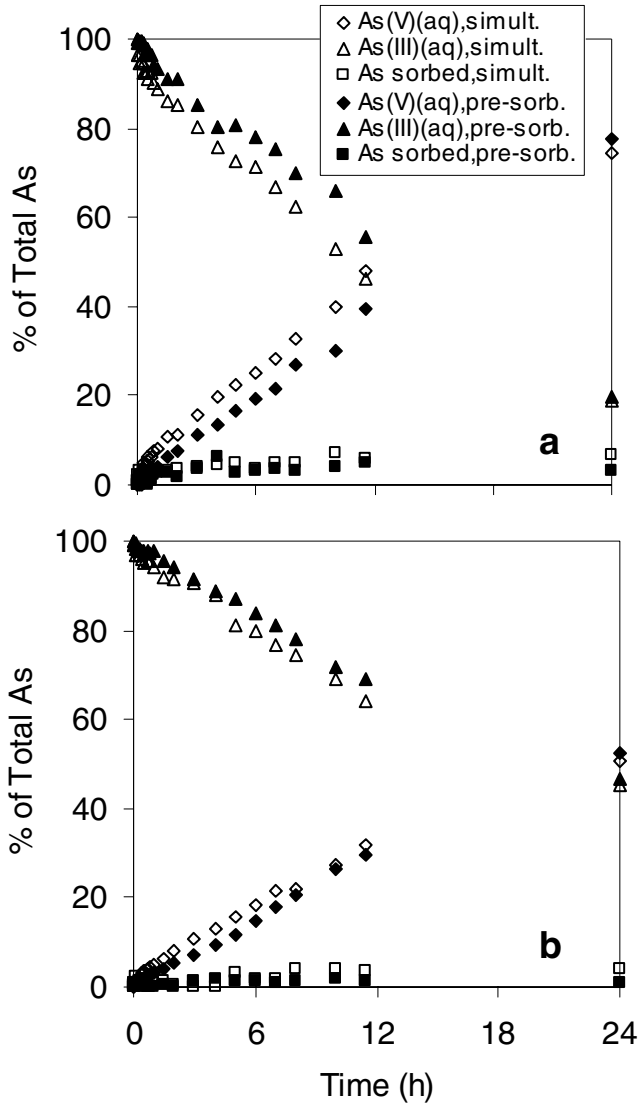

Figure 1. Effects of pre-sorbed Zn(II) vs Zn(II)/As(III)-simultaneous treatment on the As(III) oxidation kinetics on birnessite surfaces (pH 6, suspension density = 0.1 g L^{-1}, I = 0.01 M NaCl, total Zn(II) concentrations: $[Zn]_t$ = 100 μM, and N_2 atmosphere). Percent As(III) depletion, As(V) release, and total As adsorption are shown as a function of time (h). (a) initial As(III) concentrations: $[As(III)]_i$ = 100 μM; (b) $[As(III)]_i$ = 300 μM.

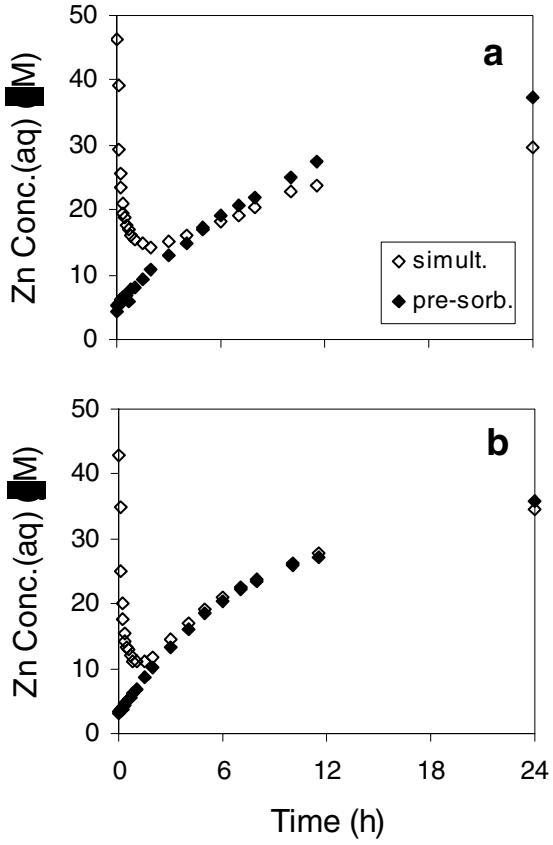

Figure 2. Effects of the pre-sorbed Zn(II) vs Zn(II)/As(III)-simultaneous treatment on the aqueous profiles of Zn(II) during the As(III) oxidation kinetics on birnessite surfaces (pH 6, suspension density = 0.1 g L^{-1}, I = 0.01 M NaCl, total Zn(II) concentrations: $[Zn]_t$ = 100 μM, and N_2 atmosphere). (a) Initial As(III) concentrations: $[As(III)]_i$ = 100 μM; (b) $[As(III)]_i$ = 300 μM.