Arsenic Removal from Well Water using Hydrotalcite -like Compounds

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Introduction
- Background
- Our Approach

Experiments
- Removal of Low content of Arsenic (Flow test)

Results and Discussion
- Comparison to Commercial Adsorbents
- Our Goal

Background

- Well Water in some South East Asian Countries contain As
- As cause various diseases, such as skin disease, neurologic disease ,etc. Number of patients are estimated over tens million.
- As Dr.Yamanoshita reported,Fe^{2+} promote As toxicity.
- Commercial As Adsorbents ,now available, can’t remove Fe^{2+}.

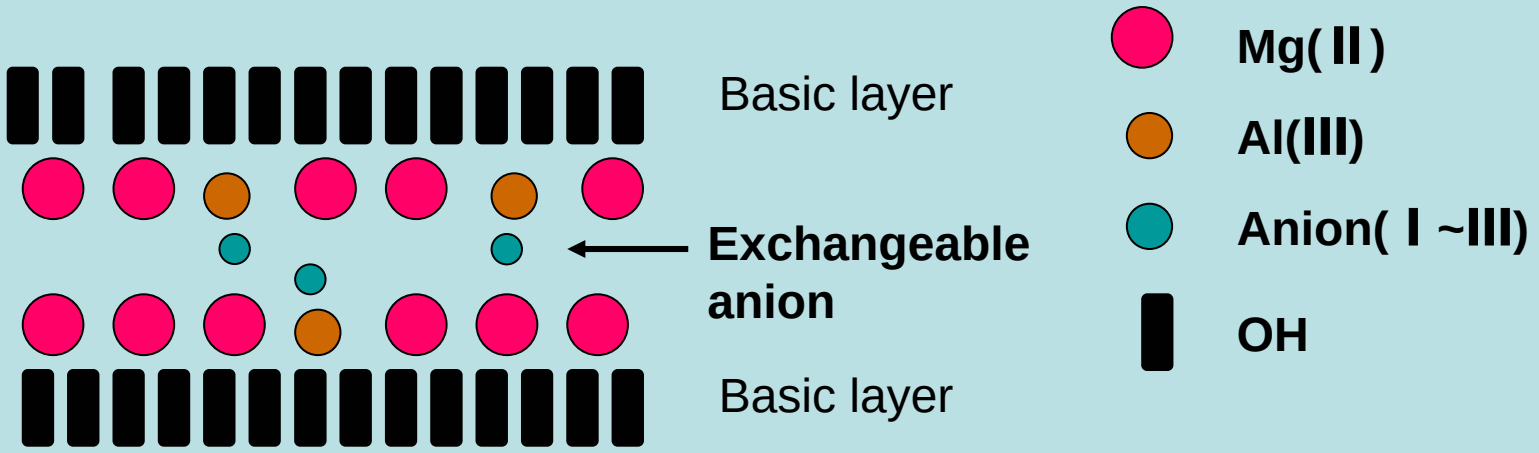
Our Approach

- We select Hydrotalcite -like compounds as Adsorbent

Reason Why we select Hydrotalcite (H.T)

- H.T has anion exchangeability and works as solid base, so it can remove both As and Fe^{2+} simultaneously.
- Components of H.T, such as Mg, Al, Fe, are common and cheaper metals.
- Changing component or composition, we can get various new functions.
- Preparation is easy; ambient temperature and pressure.

Hydrotalcite -like compound (a kind of Layered Clay)



General formula: $[M(Ⅱ)_{1-x}M(Ⅲ)_x(OH)2]^{x+}A^{n-}\cdot yH2O$

M(Ⅱ): Mg, Ni, Co, Cu M(Ⅲ): Al, Fe

M(Ⅱ)/M(Ⅲ)=2~5 atomic ratio

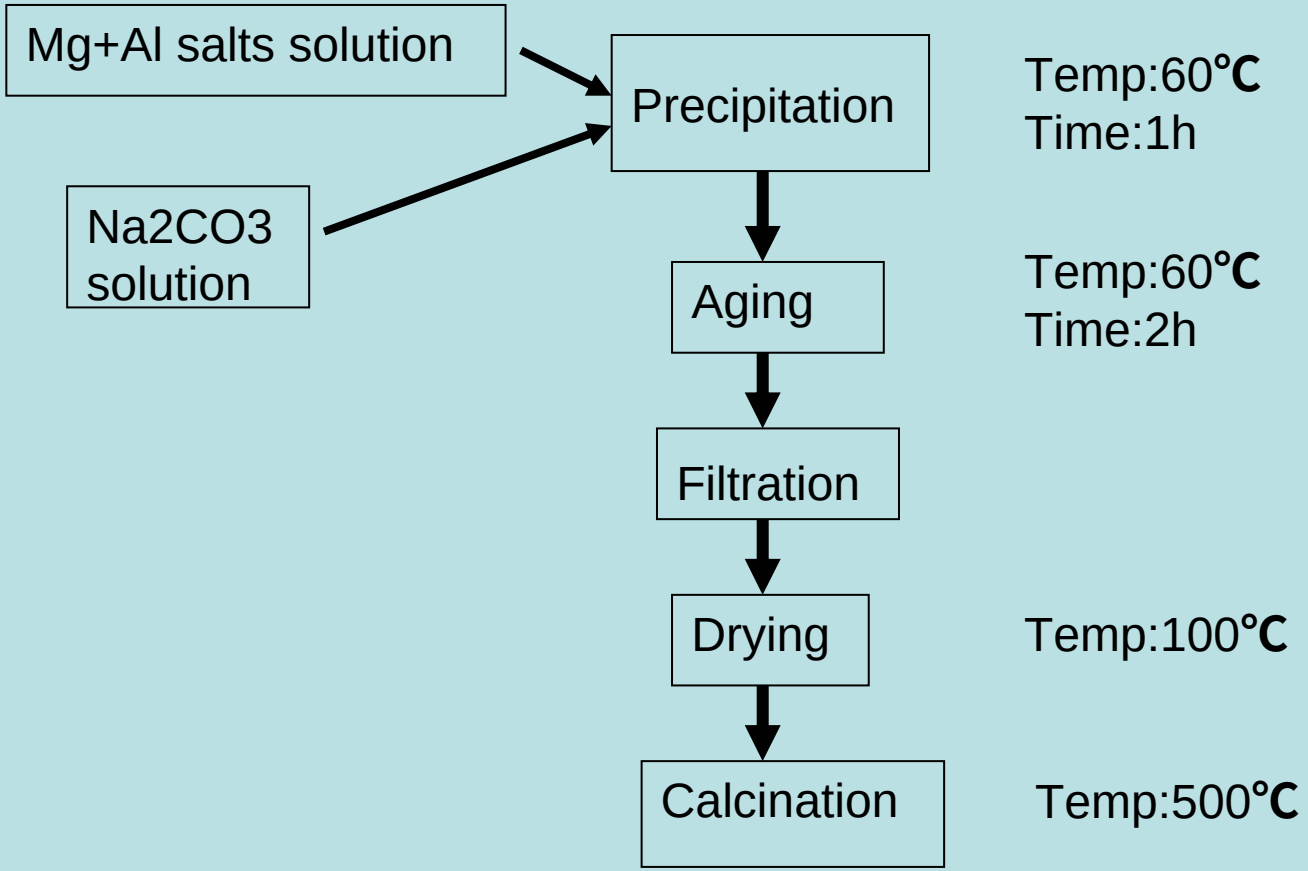
As species in water:

As(Ⅲ)=AsO_3^{3-} As(Ⅴ)=AsO_4^{3-}

Hydrotalcite is basic compound

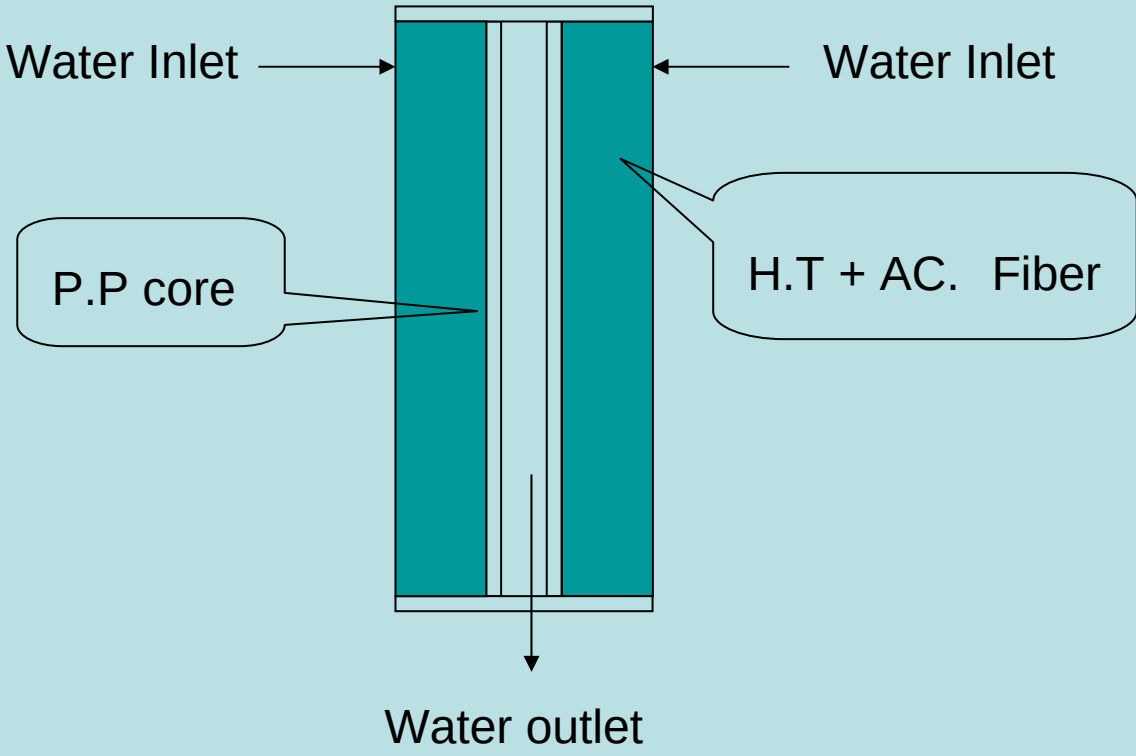
Interlayer anion is exchangeable, such as AsO_3^{3-},AsO_4^{3-}

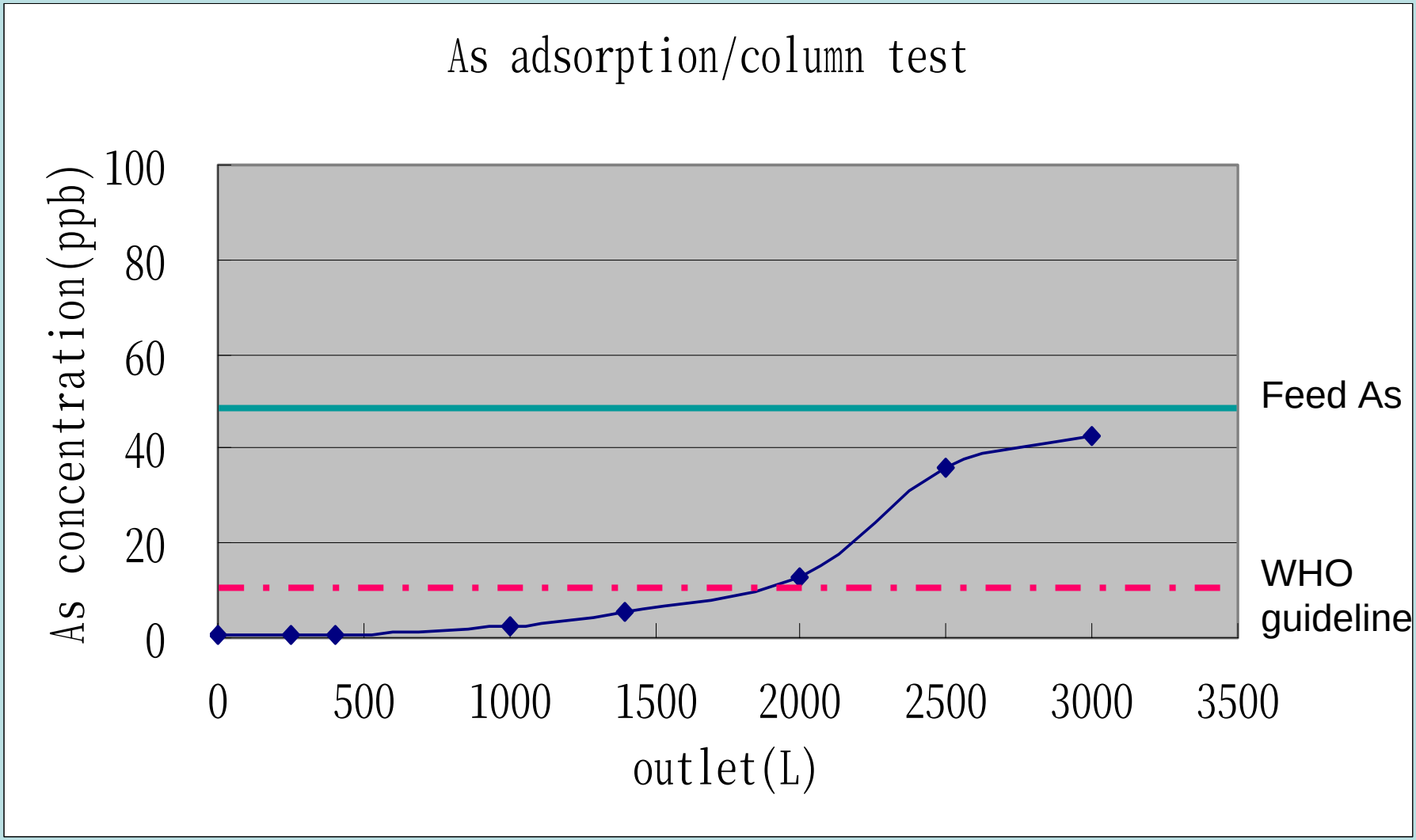
Brock Flow for Preparation of Hydrotalcite (Mg/Al=2)



Experiment-flow test

Adsorbent: Mg-Al Hydrotalcite (Mg/Al=2/1 atomic ratio) 135g+
Activated Carbon fiber 45 g
Equipment: Filter type
Feed: As(**V**)50ppb in tap water
Feed Rate:4L/min.
Test method: Based on JIS S3201
Analyzer: Shimazu AA-6800 (Atomic Absorption)




As adsorption/column test
As concentration(ppb)
100
80
60
40
20
0
0
500
1000
1500
2000
2500
3000
3500
outlet(L)
Feed As
WHO
guideline

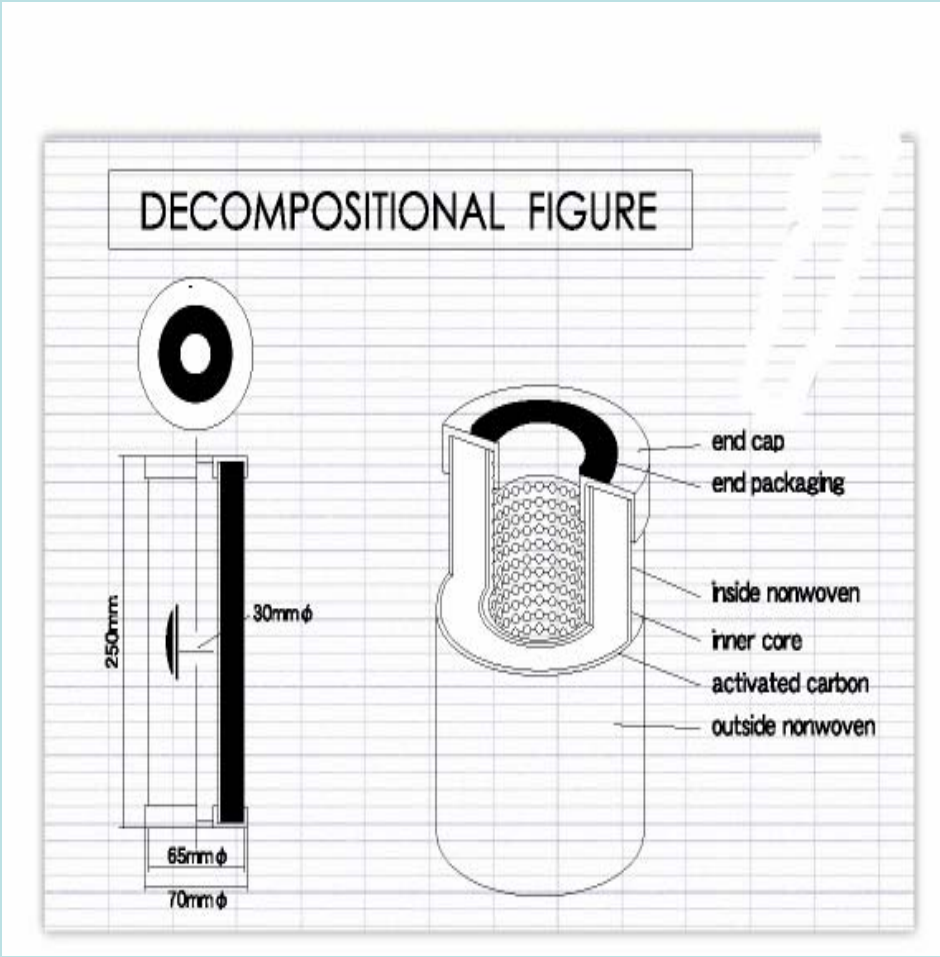
Comparison between H.T and Commercial As Adsorbent

		Ce(OH)4	Fe(OH)3	Al(OH)3	MnO	H.T
Capacity (g/L-ads.)	0.05mg/L in Feed	2	1	0.5	0.5	1
As after Adsorption	mg/L	0.001	0.001	0.001	0.001	0.001
Feed PH		5～8	5～6	4～6	4～7	6～8
Chemicals	Oxidant	No	NaClO	NaClO	NaClO	No
PH control		No	H2SO4	HCl	HCl	No
Regeneration		○	○	○	×	○
Fe^{2+} Adsorption		×	×	×	×	○

Features of H.T Adsorbents

- Simultaneous Removal of As and Fe^{2+}
- Effective both for As(**III**) and As(**V**)
- No PH Control reagent
- No Oxidant for As(**III**) Oxidation
- Low Cost (¥0.5/g)

Equipment for Well Use-Example



Development of Arsenic Removal Technology

Our Goal

Adsorbent

- Low cost
- Easy preparation
- Regeneration at site
- Remove not only As (**III**)(**V**), but Fe^{2+}

Equipment

- Low Cost
- Easy Operation or Handling
- Well Use and Home Use

Final Goal

- Transfer this technology to the countries which have Arsenic issue.

Removal of Organic pollutants

	Compounds	WASA 2009.7.30	After AC Adsorption	Japanese Regulation
1	1,1-dichloroethylene	0	0	<20ppb
2	Dichloromethane	0	0	<20ppb
3	trans-1,2-dichloroethylene	0	0	
4	cis-1,2-dichloroethylene	0	0	<40ppb
5	Chloroform	29.818	0.884	<60ppb
6	1,1,1-trichloroethane	0	0	<300ppb
7	Carbontetrachloide	0	0	<2ppb
8	1,2-dichloloethane	0	0	<4ppb
9	Trichloroethylene	0	0	<30ppb
10	Bromodichloromethane	2.457	0	<30ppb
11	1,1,2-trichloloethane	0	0	<6ppb
12	Tetrachloroethylene	0	0	<10ppb
13	Dibromochloromethane	0	0	<100ppb
14	Bromoform	0	0	<90ppb
	total trihalomethane	32.275	0.884	<100ppb

Metals in Well Water (ppb) in pollution area Analysis: ICP

	As	Fe	Cr	Cd	Pb	Mg	Ca	Ba	Sr
PID1	92.3	2121	0.1	0.0	0.0	18397	66398	116	177
PID2	183.5	2105	0.2	0.0	0.1	15731	73337	115	174
PID3	86.5	373	0.0	0.0	0.0	20538	67651	107	184
PID4	328.1	2685	0.0	0.0	0.0	25026	97458	205	244
PID5	249.3	1901	0.0	0.0	0.0	21103	80506	149	193
PID6	363.9	1205	0.0	0.0	0.1	17526	72518	97	150
PID7	259.0	1900	0.0	0.0	0.1	20756	91229	125	189
PID8	183.7	2193	0.0	0.0	0.0	19321	65976	147	168
PID9	244.4	1735	0.0	0.0	0.2	16026	67325	107	153
PID10	104.3	1530	0.0	0.0	0.2	23141	88819	117	167
PID11	373.4	2140	0.0	0.0	0.0	15782	70422	191	176
PID12	459.3	2024	0.0	0.0	0.0	21513	69554	172	182
PID13	295.8	2000	0.0	0.0	0.0	19154	85542	207	230
PID14	380.6	2150	0.0	0.0	0.1	17590	75072	142	199
PID15	319.1	2956	0.0	0.0	0.1	26128	83145	137	216
max	459.3	2956	0.2	0.0	0.2	26128	97458	207	244
min	86.5	373	0.0	0.0	0.0	15731	65976	97	150
average	262.6	1935	0.0	0.0	0.1	19849	76997	142	187