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(IC-8)

Suitable flocculant selection and continuous wastewater treatment using Mg-Al layered double hydroxides - a case study targeting mine wastewater containing As and Fe

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Introduction - Mine wastewater treatment

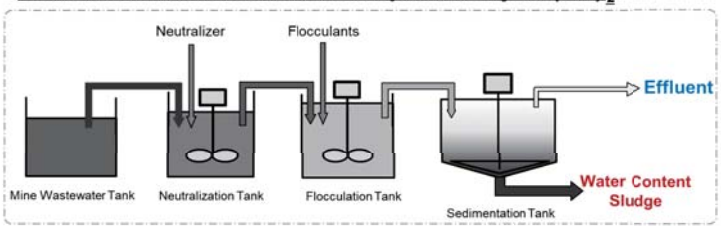
Mine Wastewater

- Highly acid
- Toxic heavy metals

Harmful to humans and environment

Treatment to meet effluent standard is vitally necessary

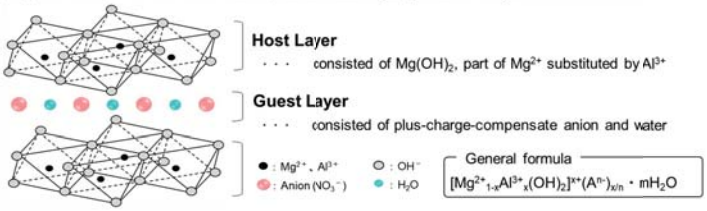
Current method: Chemical Precipitation by $Ca(OH)_2$



▲ High water-content sludge generated
→ Enormous energy and high costs to manage
→ Shortage in intermediate/final disposal sites

Introduction – treatment by Mg-Al LDH

Mg-Al Layered Double Hydroxides (Mg-Al LDH)



Our earlier study [1] : treating mine wastewater 500 mL

Using $Ca(OH)_2$ 70 mL sludge | Using Mg-Al LDH-2 30 mL sludge | Using Mg-Al LDH-4 15 mL sludge

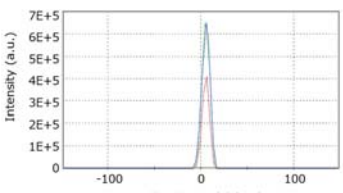
- As, Fe concentration, pH, SS all met Japanese Effluent Standards
- Treatment by LDH reduced sludge volume to a large extent

Objective of this study

- Suitable flocculant selection for LDH treatment
- Continuous treatment operation and cost analysis

Suitable flocculant selection for LDH Treatment [2]

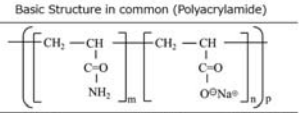
Flocculant candidates



Zeta potential of supernatant after LDH treatment

+ 4.99 mV ⇒ Anionic flocculant is effective

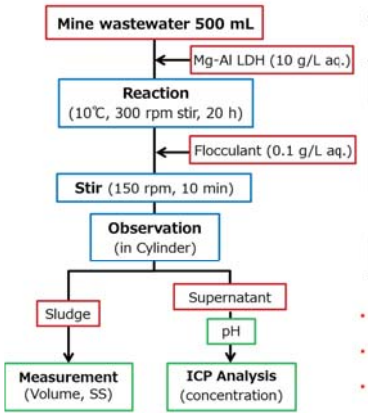
Basic Structure in common (Polyacrylamide)



Type	Ionicity	Solution pH
ACCOFLOC®A-100	Weak-anionic	6 ~ 8
ACCOFLOC®A-110	Medium-anionic	6 ~ 8
ACCOFLOC®A-175	Strong-anionic	7 ~ 9

Suitable flocculant selection for LDH Treatment [2]

Experimental



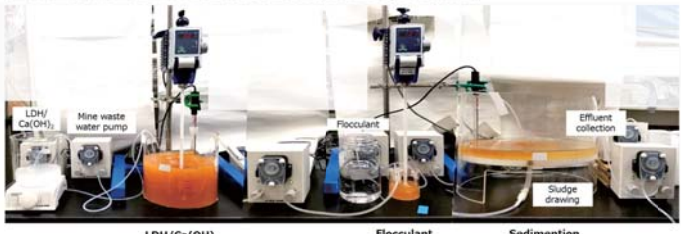
Post-treated water quality

	LDH only	LDH+ A100	LDH+ A110	LDH+ A175
pH [-]	6.78	7.35	7.03	7.43
Sludge [mL]	16	16	20	28
SS [mg/L]	25	9.0	6.5	6.3
Fe [mg/L]	0.080	0.10	0.036	0.26
As [mg/L]	n.d.	n.d.	n.d.	n.d.

- Combination of flocculant reduced SS.
- Water quality parameters all cleared standard.
- ACCOFLOC®-A110 selected as suitable flocculant.

Continuous treatment and cost calculation [2]

Lab-scale continuous treatment aparatus



Calculation equation

Agent cost [JPY/year] = Annual mine wastewater throughput [m^3/year] × [LDHs/$Ca(OH)_2$ unit price [JPY/ton] × dosage [ton/m^3] + flocculant unit price [JPY/ton] × dosage[ton/m^3]]

Sludge transportation cost [JPY/year] = Annual mine wastewater throughput [m^3/year] × Sludge volume [m^3/m^3] × transportation unit price [JPY/m^3]

Comparison between treatment using LDH and using $Ca(OH)_2$

		Using LDH	Using $Ca(OH)_2$
Agent Dosage	LDH/$Ca(OH)_2$ [ton/m^3]	7.8×10^{-3}	1.2×10^{-3}
	ACCOFLOC®A-110 [ton/m^3]	1.6×10^{-6}	2.0×10^{-7}
Water Quality	As, Fe concentration	Complies with Japanese Standard	
	SS [mg/L]	3.3	5.3
	pH [-]	6.49	7.51
Sludge	Final volume [mL/L]	40.3	68.2
	Water content [%]	58.9	84.7
Cost	LDH/$Ca(OH)_2$ unit price [JPY/ton]	150,000	40,300
	Agent cost [JPY/year]	2,284,342,285	97,888,795
	Sludge transportation cost [JPY/year]	144,754,267	244,711,913
	Total cost [JPY/year]	2,429,096,551	342,600,708

※Chinese shopping site

- Treatment using LDH: less sludge, lower water content, cut transportation cost

Conclusion

- Combination of ACCOFLOC®A-110 reduced SS after treatment
- Treatment by LDH generate less sludge and low water content ⇒ landfill and energy saving
- Treatment by LDH could save sludge transportation cost up to 40%
- Lower unit price of LDH (< 12,819 JPY/ton) is expected ⇒ lower agent cost

[1] X. Yang, M.T. Rahman, T. Kameda, Y. Masaki, Y. Saito, S. Kumagai, T. Yoshioka, *Mine Water and the Environment.*, DOI:10.1007/s10230-020-00697-4, 2020.
[2] X. Yang, H. Osawa, T. Kameda, Y. Masaki, Y. Saito, S. Kumagai, T. Yoshioka, *International Journal of Environmental Science and Technology*, 2020 (under review).