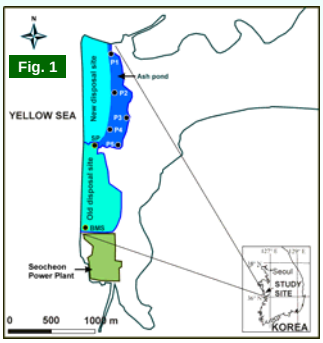
A geochemical study on the saline waters circulating in an ash disposal pond of Seocheon Power Plant, Korea

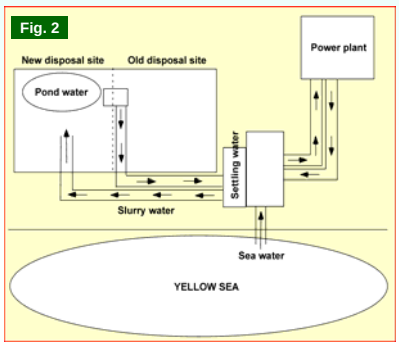
Kangjoo Kim, Seongmin Park, Jinsam Kim, Natarajan Rajmohan, Gab-Soo Hwang, Seong-Taek Yun[1], Hyun Jung Kim and Suk Hwi Kim

School of Civil and Environmental Engineering, Kunsan National University, Kunsan, Jeonbuk 573-701, Korea.
[1] Department of Earth and Environmental Sciences, Korea University, Seoul 136-701, Korea

Abstract

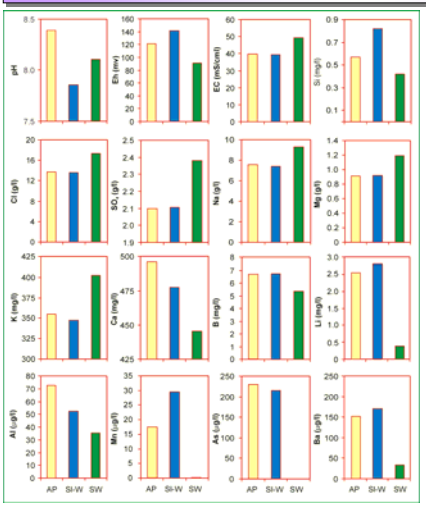
A study was carried out to understand the geochemistry of saline water circulated in an ash disposal pond of Seocheon power plant, Korea. For this study, ash pond water, slurry water and seawater samples were collected and analyzed for major ions and trace elements. Results show that ash pond water and slurry water are alkaline in nature due to high calcium content, and have high concentrations of Ca, B, Li, As, Ba, Al, Si and Mn over seawater. This suggest that these elements leached from fly ash even at high alkaline condition and ionic strength. Slurry water has high concentrations of B, Ba, Li, Mn, Si and Sr compared to ash pond water, expresses that these elements seem to be leaching more frequently at initial stage fly ash-water interaction, and also might be associated with the surface of the fly ash particles. Additionally, PHREEQC program predicted several secondary solid phases, which are also influenced in the leaching of elements into the saline water.



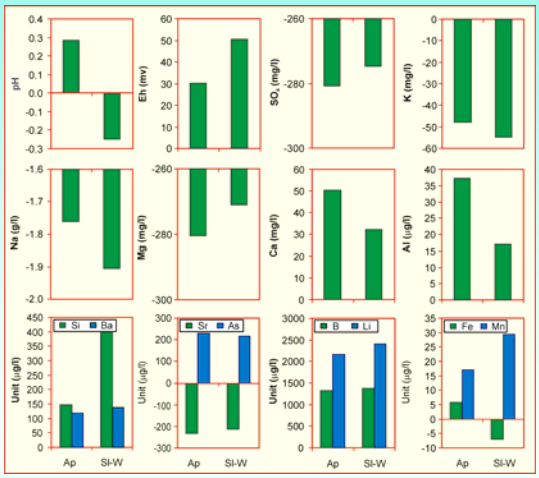


- Fig.1.(△) Location of the study site and sampling point in the ash disposal ponds.
- P – Ash pond water collection point
- SP – Settling pond water collection point
- BMS – Water sample collection point before making slurry

- Fig.2(◁) explains the saline water circulation in the ash disposal site.



- Fig. 3 shows the distribution of elements in ash pond water (AP), slurry water (Sl-W) and seawater (SW).
- Slurry water has high concentrations of B, Ba, Li, Mn, Si and Sr over ash pond water.
- These elements seem to be leaching more frequently at initial stage ash-water interaction (Mattigod et al., 1990).



- Fig. 4 shows the changes in the elements concentration in the circulating saline water by fly ash-water interaction. Positive values indicate the enrichment of elements in the ash pond (AP) and slurry waters (Sl-W) over sea water.
- Even at high alkaline and ionic strength, Ca, B, Li, As, Ba, Al, Si and Mn are leached from fly ash into saline water.

Table 2. Selected secondary solid phases predicted by PHREEQC programme.

Minerals	P1	P2	P3	P4	P5	SP	BMS	Sl-W	SW
Magnesite	0.5	0.4	0.6	0.6	0.6	0.6	0.6	0.0	0.7
Dolomite	1.7	1.4	1.8	1.7	1.8	1.8	1.7	0.6	1.8
Calcite	0.7	0.5	0.7	0.6	0.7	0.6	0.6	0.1	0.6
Anhydrite	-0.7	-0.7	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Gypsum	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6
Aragonite	0.5	0.3	0.5	0.5	0.5	0.5	0.5	-0.1	0.4
$Al(OH)_3$ (a)	-1.7	-1.5	-1.8	-1.7	-1.8	-1.8	-1.7	-1.4	-1.8
Gibbsite (c)	1.1	1.4	1.0	1.1	1.0	1.1	1.1	1.4	0.9
Brucite	-3.1	-3.2	-2.8	-2.9	-2.8	-2.9	-2.9	-3.9	-3.1
Celestite	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7
Barite	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	0.3
Ferrihydrite	2.2	2.0	1.4	1.7	1.8	1.4	1.7	0.5	0.7
Siderite (c)	-1.8	-1.6	-2.1	-1.9	-1.7	-2.2	-1.5	-2.4	-1.5
Witherite	-3.2	-3.3	-3.2	-3.2	-3.2	-3.2	-3.2	-3.7	-3.9
Goethite	7.5	7.4	6.8	7.1	7.3	6.9	7.1	6.0	6.3
Manganite	-4.7	-5.1	-5.5	-5.5	-5.5	-5.4	-5.6	-6.3	NA
Rhodochrs(c)	-1.4	-1.2	-1.6	-1.7	-1.6	-1.7	-1.4	-1.7	NA
Strontianite	-0.7	-0.9	-0.7	-0.7	-0.7	-0.7	-0.7	-1.3	-0.8
Portlandite	-9.7	-9.8	-9.4	-9.5	-9.4	-9.5	-9.5	-10.5	-9.8

Conclusion

- Even at high ionic strength and alkaline condition, Ca, B, Li, As, Ba, Al, Si and Mn are leached from the fly ash into saline water.
- Elements occurrence in the fly ash particles (surface or glass matrix) and initial stage ash-water interaction seem to be the major factors regulating the leaching of these elements into saline water.
- High alkaline condition and ionic strength would reduce the leaching of Cd, Co, Cr, Cu, Ni, Pb, and Zn into the saline waters.

Reference:

Mattigod SV, Rai D, Eary LE, Ainsworth CC (1990). Geochemical factors controlling the mobilization of inorganic constituents from fossil fuel combustion residues: II Review of the major elements. J Environ Qual 19: 188-201.

Acknowledgements:

This study was financially supported by the Saemankeum Environmental Research Center of Kunsan National University.

KUNSAN NATIONAL UNIVERSITY