Co-benefit of hazardous trace elements capture in dust removal devices of ultra-low emission coal-fired power plants

Cheng-hang ZHENG

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Characterization of ESP/EFF ash

- The volatility order was Hg>Se>As.

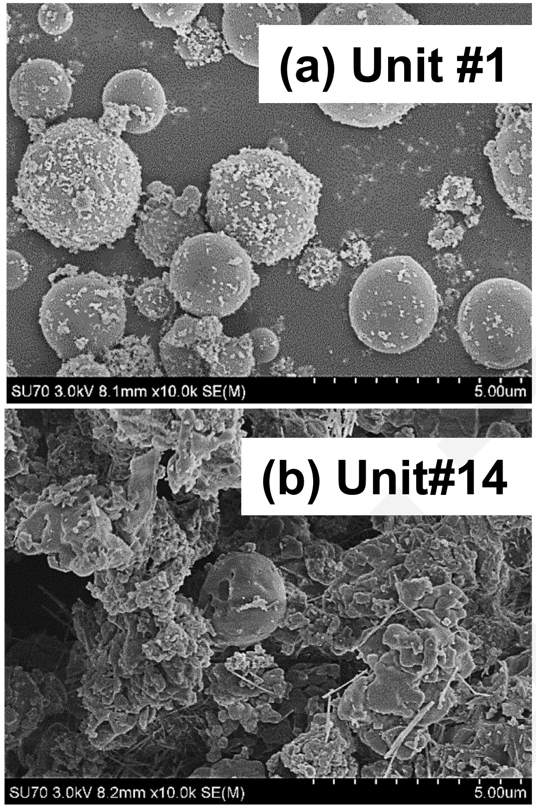


Fig.1 Photo-micrographs of fly ash

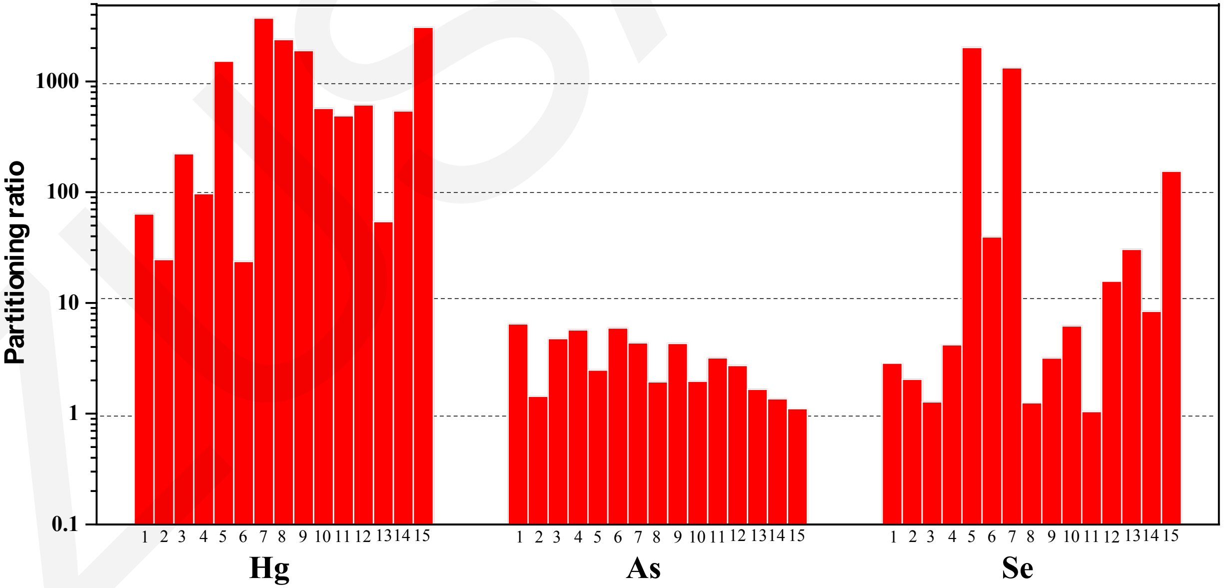


Fig. 2 Partition ratio of Hg, As and Se between fly ash and bottom ash

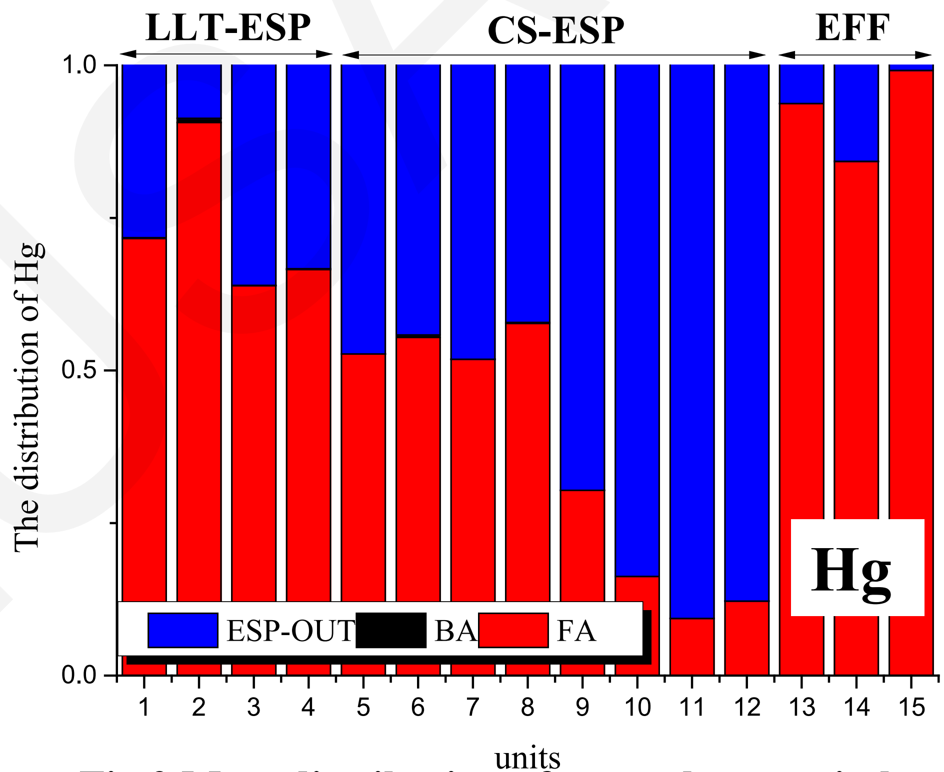
Abatement capacity of Hg, As, and Se in dust removal devices

■ LLT-ESP and EFF had great abatement capacity for Hg compared with normal CS-ESP

$$\mathrm{MD_{FA}} = \frac{C_{i,\ \mathrm{FA}} \times Mass\ flow\ of\ FA}{C_{i,\ \mathrm{coal}} \times Mass\ flow\ of\ coal} \times 100\%,$$

$$\mathrm{MD_{BA}} = \frac{C_{i,\ \mathrm{BA}} \times Mass\ flow\ of\ BA}{C_{i,\ \mathrm{coal}} \times Mass\ flow\ of\ coal} \times 100\%,$$

$$\mathrm{MD_{ESP\text{-}OUT}} = (1 - \mathrm{MD_{FA}} - \mathrm{MD_{BA}}) \times 100\%.$$



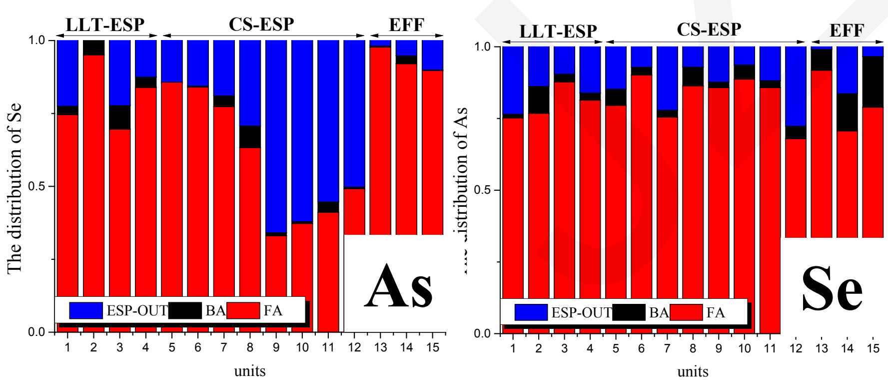


Fig.3 Mass distribution of trace elements in bottom ash, fly ash, and ESP-OUT: (a) distribution of Hg; (b) distribution of As; (c) distribution of Se

Pearson correlation analysis

Table 1 Results of Pearson Correlation Analysis

|R|	Degree of correlation	Hg	As	Se
0.8–1.0	Highly strong	*T*>particle size	–	Particle size>*T*
0.6–0.8	Strong	REF-S>S	Cl> Cl/S	–
0.4–0.6	Moderate	Cl/S>Cl>Fe_2O_3	S	REF-S>Cl/S>S
0.2–0.4	Weak	CaO	T>particle size	Cl>Fe_2O_3>CaO
0.0–0.2	Very weak	–	REF-S>CaO>Fe_2O_3	–

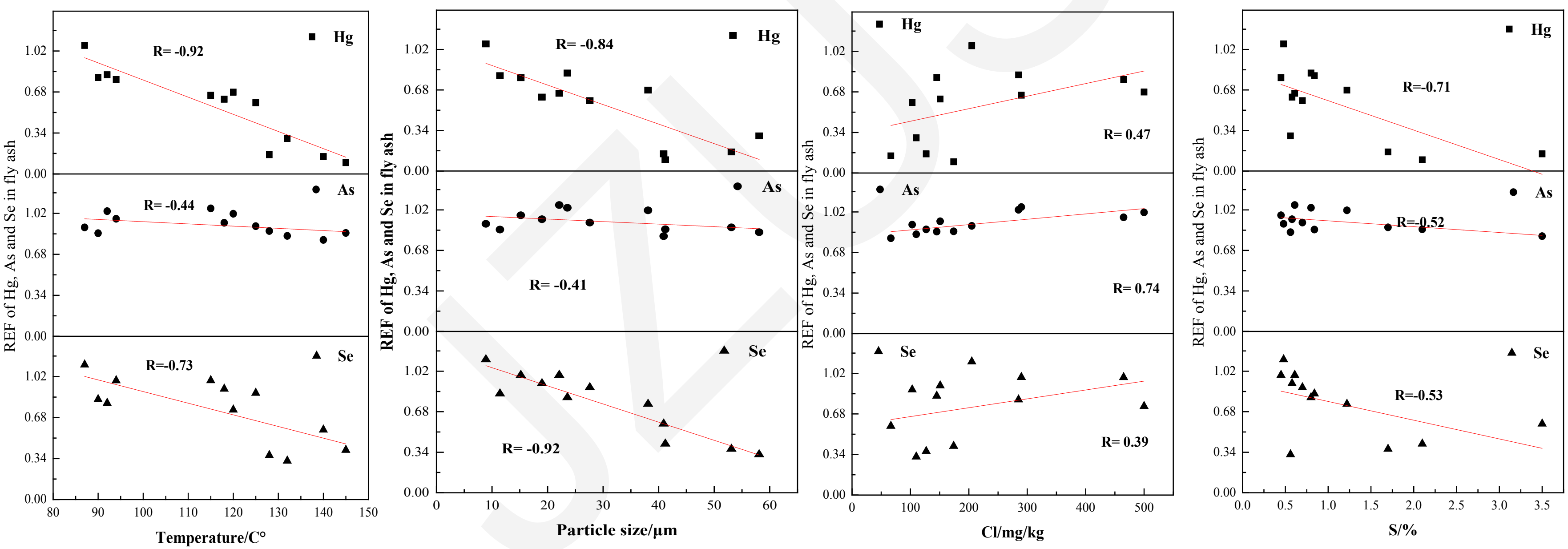


Fig. 4 Correlations between REF values of Hg, As, and Se in fly ash and influencing factors (a) Temperature; (b) Particle size; (c) Cl; (d) S

Grey relational analysis

■ **The grey relational analysis offered a more comprehensive analysis**

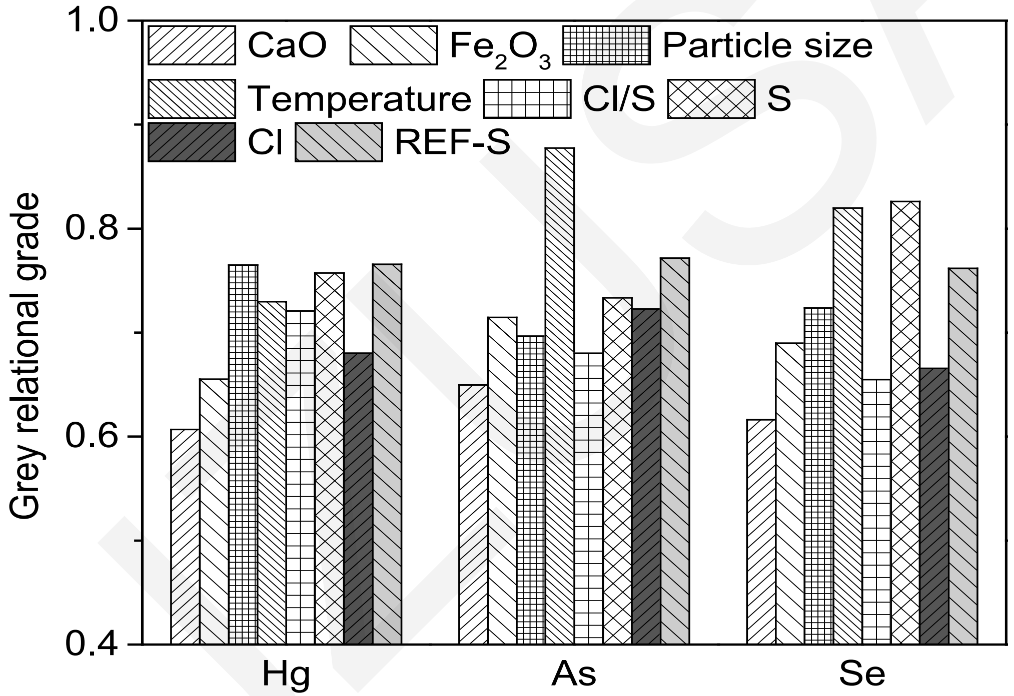


Fig. 5. Grey relational analysis for REF values of Hg, As and Se with influencing factors

Conclusions

- LLT-ESP and EFF had great abatement capacity for Hg compared with normal CS-ESP. Only 0.8%–36.1% of Hg escaped from LLT-ESP and EFF, whereas 42.1%–90.6% of Hg escaped from CS-ESP.
- With the employment of EFF and ESP (inlet tem-perature <125° C), 72.3%–99.1% of As and 70.7%– 100% of Se could be removed before the WFGD system.
- Inlet temperature of ESP has a significant effect on the enrichment of higher volatile elements. The simultaneous removal of SO3 and trace elements could be achieved in LLT-ESP.
- The particle size of fly ash also has a great influence on the adsorption of Hg, As and Se. The inhibitory effect of sulfur content was significant for Hg and Se. Higher content of chlorine and lower content of sulfur in coal can be conducive to the accumulation of Hg, As and Se in fly ash.