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Evolution and distribution characteristics of fluorine during the incineration of fluorine-containing waste in a hazardous waste incinerator

Key words: Fluorine emission; Hazardous waste incineration; Fluorine-containing waste; Release behavior; Distribution

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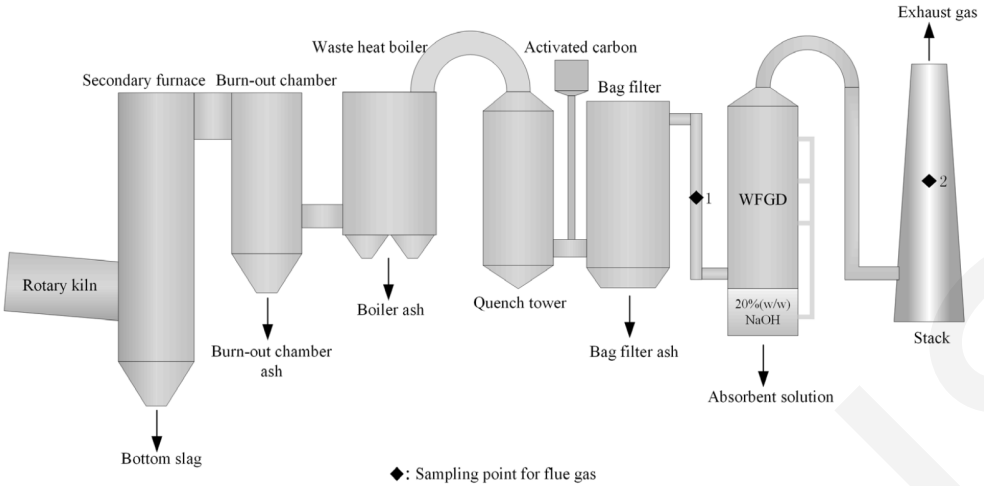
Background

- With the rapid development of the fluorine chemical industry, large amounts of fluorine-containing wastes have been produced.
- Fluoride discharged during the incineration of fluorine-containing waste will endanger human health and cause environmental pollution.
- A high incidence of endemic fluorosis related to atmospheric fluoride contaminant has been reported in China.

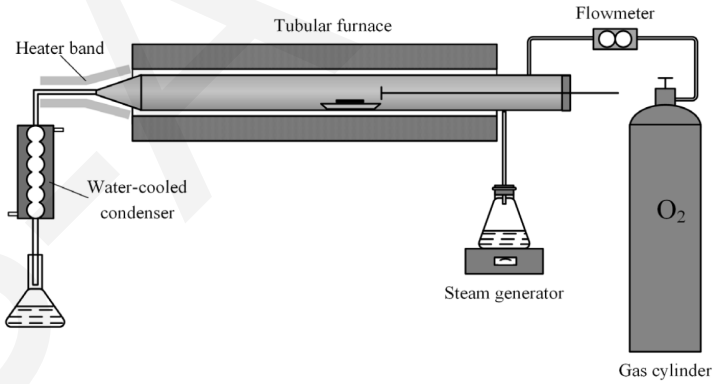
In the present work, we investigated:

- (1) the evolution characteristics of fluorine during the incineration of fluorine-containing waste;
- (2) the distribution characteristics of fluorine in the incineration systems;
- (3) the occurrence form of fluorine in the incineration residues.

Method



- The samples were obtained from a hazardous waste incineration plant.



- The fluorine contents in the ashes were determined using a combustion hydrolysis/ion chromatography method.

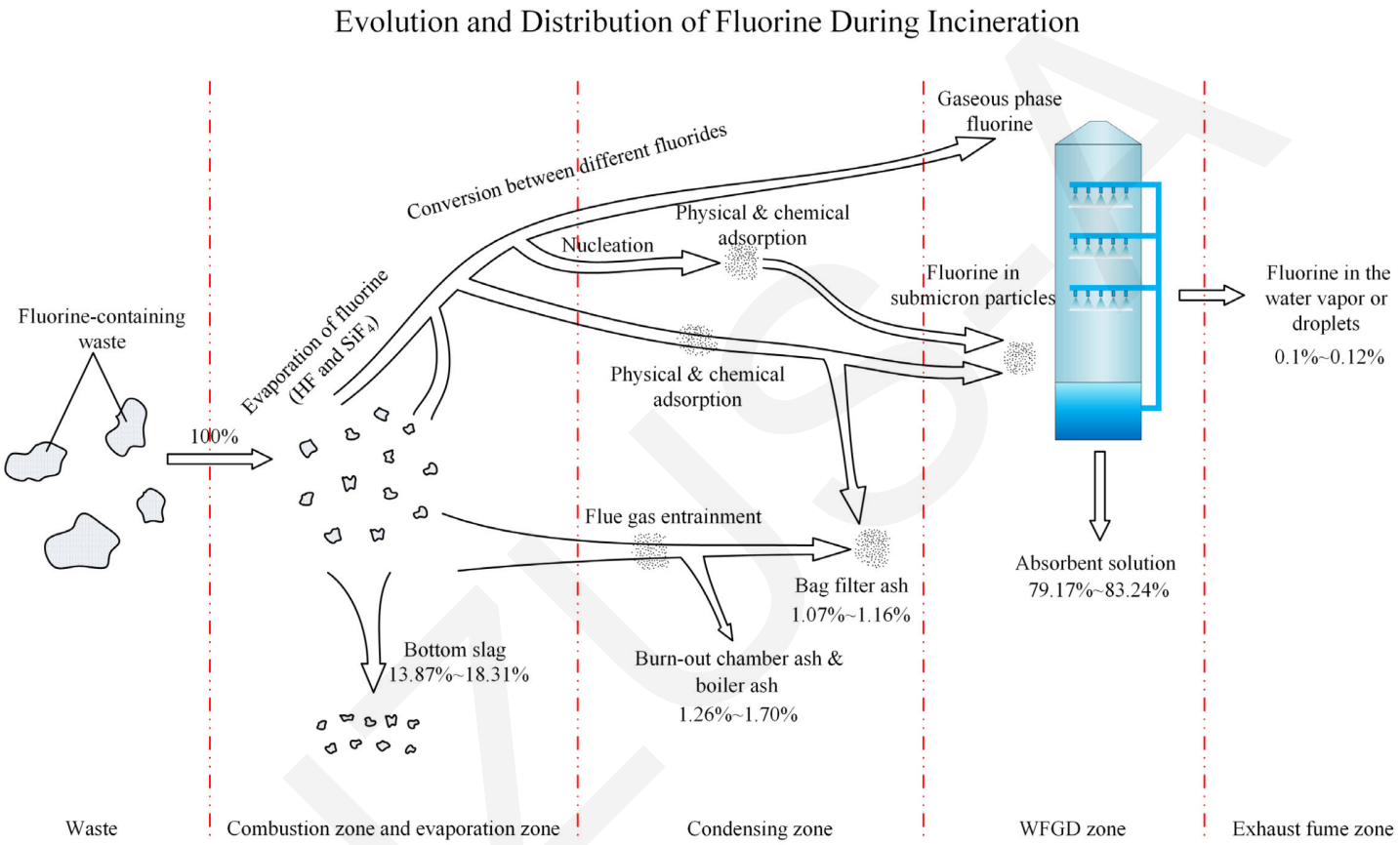
- The evolution characteristics of fluorine during the pyrolysis of the waste was investigated using TG-FTIR analysis.

  Instrument model: Netzsch STA 499 F3 Jupiter® (Selb, Germany) coupled with a Bruker Tensor (Billerica, MA, USA)

- A modified sequential extraction method was employed to analyze the occurrence form of fluorine in the incineration residues.

Step	Speciation	Reagent	Conditions
1	Water-soluble	Deionized water	70 °C, rotating oscillation, 3h
2	Exchangeable	1 mol·L^{-1} $MgCl_2$	25 °C, rotating oscillation, 6h
3	Acid-soluble	0.04 mol·L^{-1} NH_2OH·HCl in 20% (v/v) HNO3	60 °C, rotating oscillation, 6h
4	Organically bound	Pretreat the sample with 0.02 mol·L^{-1} HNO_3 and 30% H_2O_2. 3.2 mol·L^{-1} CH_3COONH_4	25°C, rotating oscillation, 3h
5	Residual		105°C, drying in the oven, 2h

Results and conlusions



- Fluorine in the waste was mainly released in the form of HF and SiF_4 during pyrolysis.
- Less than 20.73% of the fluorine was retained in the incineration residues. More than 79.17% of fluorine was absorbed into the absorbent solution of the WFGD system.
- The fluorine in the bottom slag and burn-out chamber ash mainly existed in the residual form.
- The proportions of water-soluble, exchangeable, and acid-soluble fluorine in the boiler ash and bag filter ash were both over 80%.

Highlight

- The present work systematically investigated the evolution characteristics of fluorine during the incineration process and the mass flow of fluorine in the whole incineration systems.

- The present work systematically investigated the occurrence forms of fluorine in the incineration residues, which laid a foundation for the further control of fluorine pollution in the residues.