

論文 / 著書情報  
Article / Book Information

題目(和文)	一般廃棄物焼却飛灰のマイクロスケールでの地球化学的特性評価
Title(English)	Micro-scale geochemical characterization of municipal solid waste incineration fly ash
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10841号, 授与年月日:2018年3月26日, 学位の種別:課程博士, 審査員:高橋 史武,吉川 邦夫,日野出 洋文,竹下 健二,時松 宏治
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10841号, Conferred date:2018/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

(博士課程)  
Doctoral Program

## 論文要旨

THESIS SUMMARY

専攻 : Department of	環境理工学創造	専攻	申請学位 (専攻分野) : 博士 Academic Degree Requested Doctor of	(工学)
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This doctoral thesis entitled "Micro-scale geochemical characterization of municipal solid waste incineration fly ash" aims to geochemically characterize municipal solid waste incineration (MSWI) fly ash at micro-scale level. This doctoral thesis consists of seven chapters.

**Chapter 1 "Introduction"** presents research background of this study. MSWI fly ash is classified as hazardous materials owing to considerable amounts of heavy metals. Therefore, characteristics of MSWI fly ash have been investigated by comprehensive approaches. However, any previous researches conjecturally considered MSWI fly ash as homogeneous. In this context, this study aims to geochemically characterize MSWI fly ash at micro-scale level. Furthermore, the impacts of chelate treatment, which is a major intermediate treatment for MSWI fly ash in Japan to immobilize heavy metals, on characteristics of MSWI fly ash is also investigated to evaluate the potential of additional metal immobilization.

**Chapter 2 "Morphological characteristics of MSWI fly ash particles"** presents chemical, mineralogical, and morphological characteristics of raw and chelate-treated MSWI fly ash. XRD analysis showed that raw and chelate-treated MSWI fly ash consists of same minerals. It suggested that chelate treatment did not generate new secondary minerals in detectable level of XRD analysis (approximately 5–10 wt%) for the MSWI fly ash. However, SEM observations of chelate-treated MSWI fly ash showed that morphological characteristics of MSWI fly ash particles changed dramatically by secondary mineral formations. This means that MSWI fly ash particles have mineralogically active surface. Raw MSWI fly ash particles could be categorized into 4 types based on their morphological characteristics. In addition, two more types could be added for chelate-treated MSWI fly ash particles.

**Chapter 3 "Geochemically structural characteristics of MSWI fly ash particles"** presents structural characteristics of MSWI fly ash particles employing three types of leaching experiments; Japan Leaching Test 46th (JLT46), Toxicity Characteristic Leaching Procedure (TCLP, US EPA Method 1311), and Japan Leaching Test 19th (JLT19). SEM-EDX analysis showed that a MSWI fly ash particle likely consists of three major components; Si-based insoluble core structure, Al/Ca/Si-based semi-soluble matrices inside the body, and soluble KCl/NaCl-based aggregates on the surface.

**Chapter 4 "The impacts of secondary mineral formation on toxic metal immobilization"** presents metal immobilization effects of secondary minerals generated by chelate treatment. Point analysis using SEM-EDX found no metal-rich point in ettringite structure. It means that mineralogical immobilization of heavy metals by the encapsulation to ettringite structure seems to be limited. SEM observation of the same MSWI fly ash particles before and after the moistening treatment showed that transfer of soluble components was inhibited only when insoluble minerals such as gypsum were generated and covered the particle surface. However, such physical immobilization seems to be limited because insoluble mineral formation with surface coverage was monitored only one time of more than 20 observations. According to the results, mineralogical and physical immobilization of heavy metals by secondary generated minerals seem to be limited although secondary minerals are always generated on the surface of MSWI fly ash particle during chelate treatment. Therefore, the durability of toxic metal immobilization by chelate treatment is almost equal to the stability of metal chelate complex.

**Chapter 5 "Possible metal species and their external matrix estimated by micro-scale correlation analysis"** presents estimated dominant metal species and their bonding states with fly ash matrix in each individual fly ash particle. For example, major Ti forms are perovskite ( $\text{CaTiO}_3$ ) in some particles and rutile ( $\text{TiO}_2$ ) in others. Micro-scale correlation analysis also suggests heavy metal behaviors in fly ash formation processes. Metal oxides (Ti, Cu, Fe, Mn and Zn) likely react with and/or are trapped in Al/Ca/Si-based matrix like aluminosilicate in the gas phase and then followed by KCl/NaCl adsorption on the surface. On the other hand, Cr oxide is not incorporated in Al/Ca/Si-based matrix. Zn can possibly form other species depending on combustion condition. Zn chlorides ( $\text{ZnCl}_2$  and/or  $\text{K}_2\text{ZnCl}_4$ ) and Zn spinels ( $\text{ZnAl}_2\text{O}_4$  and  $\text{ZnFe}_2\text{O}_4$ ) are not trapped in Al/Ca/Si-based matrix but adsorbed on the surface together with KCl/NaCl-based aggregates. Because metal oxides basically combine with and/or are trapped in Al/Ca/Si-based matrix, metal leachability might be controlled by not only metal oxide leachability but also leachability of Al/Ca/Si-based matrix around metal oxides.

**Chapter 6 "Intra- and inter-particle heterogeneity of MSWI fly ash particles"** presents heterogeneity of MSWI fly ash particles quantitatively. Heterogeneity analysis suggested that semi-soluble Al/Ca/Si-based matrices around insoluble cores are Ca-based materials including aluminosilicate domains. Inter-particle heterogeneity analysis clearly suggested that insoluble components are not only Si-rich cores but also Al-rich and Ca-rich cores. MSWI fly ash particles have both internal heterogeneities inside their bodies and also are heterogeneous in inter-particle level.

**Chapter 7 "Conclusion and recommendation"** summarized findings from each chapter and outlined recommendations in association with conclusions.

備考 : 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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