

1-23 X線回折 (XRD) を用いた石炭フライアッシュおよび 溶出抑制剤中のカルシウム化合物測定

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Determination of Calcium Compound in Coal Fly Ash and Suppressing Material by X-ray Diffraction (XRD)

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SUMMARY

Calcium compounds affected the trace element leaching concentration from coal fly ash through the addition of suppressing material. Suppressing material which is used in this research is paper sludge and filter cake. Paper sludge (PS) is a waste generated by the paper recycling industries. The kinds of paper sludge which is used in this research is PS3 and PS8. Filter cake (FC) is formed by the substances that are retained on a filter. Filter cake come from lime industry. The determination of calcium compound in coal fly ash and suppressing material have been done by using X-ray Diffraction (XRD) analysis. XRD analysis is an instrument that work based on Bragg's law and present the result in peaks therefore each compound has peaks suitable with its characteristic. The result from XRD analysis will give good information about the calcium effect which could be used in controlling leaching of trace element from coal fly ash.

[1] INTRODUCTION

Coal contains significant amount of various trace metals. Most of these trace elements are emitted largely in the fly ash [1]. Fly ash is the finely divided residue that result from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Fly ash is produced by coal-fired electric and steam generating plants [2]. In japan coal-fired power plant sites, the ash storage area usually holds seawater and rainwater (excess water), therefore some elements in the fly ash are leach out into the excess water [3]. One main problem related to coal fly ash disposal is heavy metal content of residue. As lignite burns, toxic pollutants such as arsenic (As), selenium (Se), boron (B) etc. are transferred into the wastes [4]. If the elements concentration in the excess water exceeds the environmental limit, excess water cannot be drained into the sea. In order to prevent health hazard and living environment, leaching control necessary to do. Calcium compound can control leaching process of trace element from coal fly ash [5]. Therefore calcium compound can be use as suppressing materials in leaching process. This paper will give an information about calcium compound which is consists in suppressing material and their effect in controlling trace elements leaching into environments from coal fly ash..

[2] EXPERIMENTAL

Coal fly ash sample were collected from coal fire power plant (600 MWe) and stored in plastic containers. Coal fly ash which had been tested in this research is coal fly ash H (FA-H) and coal fly ash C (FA-C.)

Suppressing materials come from by-product of other industries. Suppressing material which have been tested in this research is PS3, PS8, and FC. Calcium compound such CaO , CaCO_3 , Ca(OH)_2 and CaSO_4 not only used as suppressing material but also as standard to determined calcium compound in suppressing material. The all of sample in this research have been analyzed by XRD. XRD analysis is an instrument that work based on Bragg's law and present the result in peaks therefore each compound has peaks suitable with its characteristic. During the course of X-ray scanning of sample the voltage used to generate x-ray was 40 Kv and current was 30 mA.

[3] RESULT AND DISCUSSION

a. Qualitative analysis

1) Calcium Compound

X-ray diffraction analysis was performed to determined peaks of calcium compound. The CaO analysis were carried out by using Shimadzu LabX XRD-6100X smartlab and the result shown in Fig.1

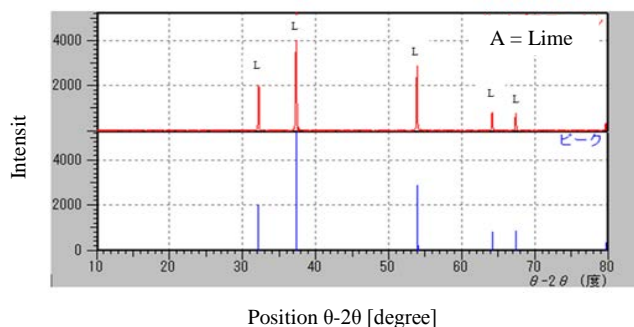


Fig. 1 XRD analysis result of CaO

As can be seen in Fig. 1 the red one (top) is peaks of raw material from CaO, and the blue one (bottom) is selected peaks of lime (CaO). The all of peaks detected as lime (CaO) because of the sample CaO pure. As mention before Calcium compound such CaO, CaCO₃, Ca(OH)₂ and CaSO₄ not only used as suppressing material but also as standard. Inthis research selected peaks used as standard.

2) Coal Fly Ash

The different of H (FA-H) and class C (FA-C) can be seen in Fig.2.

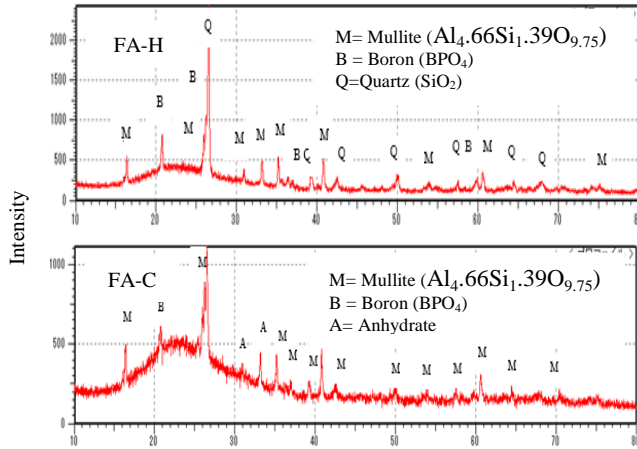


Fig 2. X-Ray Diffraction pattern of coal fly ash FA-H and FAC

X-Ray diffraction indicated that the main consist of FAH is aluminum ($Al_4.66Si_{1.39}O_{9.75}$), Quartz (Q) SiO_2 and BPO_4 (B). Different with FAH, FAC the major consist of aluminum ($Al_4.66Si_{1.39}O_{9.75}$), Boron Phosphate (BPO_4) and anhydrate of $CaO \cdot 7SrO \cdot 3SO_4$. Michael Rafalowski and Gul Akar pointed out that fly ash Class C generally derived from sub-bituminous coals and consist primarily of calcium aluminum-sulfate glass, as well as quartz, tri-calcium aluminate, and free lime CaO [2].

3) Paper Sludge

XRD analysis also was performed to determine the mineralogical properties of the paper sludge. Result for PS3 shown in Fig 3.

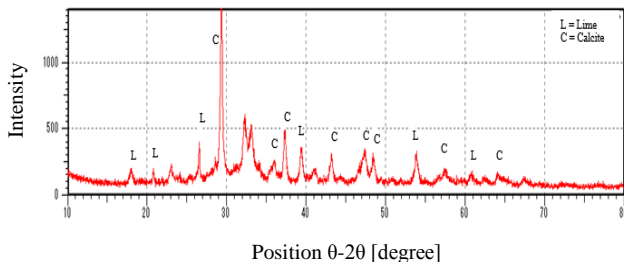


Fig. 3 X ray diffraction pattern of PS3

As shown in Fig. 3 PS3 consists of lime (CaO) and calcite (CaCO₃). CaO and CaCO₃ were detected as the major source of calcium in the PS3. Content calcium compound in

PS3 will be test to controlling leach out of trace element in coal fly ash. The same treatment had been done to other sample and get result as shown in Table 1.

Table 1. XRD analysis result of suppressing material

No.	Suppressing materials	Estimated calcium
(a)	PS3	CaCO ₃ (Calcite) & CaO (Lime)
(b)	PS8	CaCO ₃ (Calcite), CaO (Lime) and Ca ₂ SiO ₄
(c)	FC	CaCO ₃ (Calcite)

b. Before and after leaching

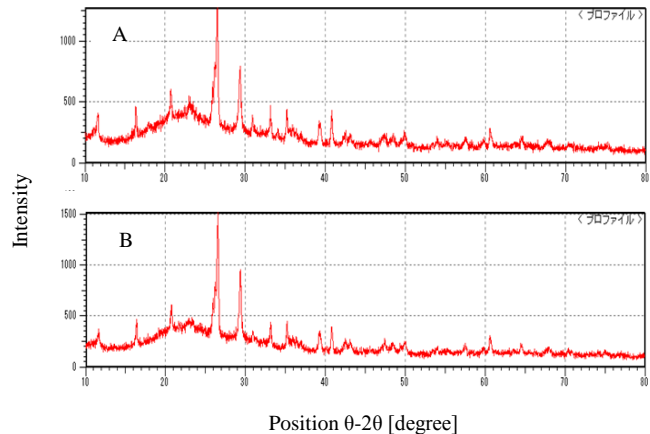


Fig. 4 Diffraction pattern of mix FA-C, Ca(OH)₂ and PS3

Fig 4(A) is X-Ray Diffraction pattern before leaching and 4(B) is X-Ray diffraction pattern after leaching. As can be seen in Fig.4 there is no difference between A and B, it means Ca(OH)₂ and calcium compound in PS3 (CaCO₃&CaO) could be control leaching from fly ash.

[4] CONCLUSION

The variation of peaks in diffraction pattern reveals that intensity depends on the composition of material. Calcium compounds in suppressing material could be control the leaching process. To next research will be found the best addition ratio of suppressing material into coal fly ash.

[References] 1) G.;Jegadeesan, et al.; Influence of trace metal distribution on its leachability from coal fly ash; *Fuel*, (2008) 1887-18932) Michael Rafalowski; Fly Ash Facts for Highway Engineer; American Coal Ash Association (2003)3)Sri H.; S.; Kambara, A.; Takeyama; Direct Quantitative Analysis of Arsenic in Cola Fly Ash; Gifu (2013) 4) A.; Baba.; et al.; Leaching characteristic of fly ash from fluidized bed combustion thermal power plant; *Fuel Processing Technology* 91, 1073-1080 (2010) 5) F.; Jiao.; et al.; Role of calcium compounds on reduction of arsenic and selenium during fluidized bed coal combustion; Chia Laguna Cagliari; Sardinia; Italy (2011)