

研究説明資料

Technological Development of an Effective Recycling System for Fly Ash from Municipal Solid Waste Incinerator to be Raw Material in Cement Industry (焼却飛灰のセメント原料化を考慮した都市ごみ焼却システムの構築)

1. Research background

As an application example for Sound Material-Cycle society, we proposed a new recycling system for fly ash——“WCCB”. “W” means washing; the first “C” means calcinating; the “CB” means changing the treated fly ash with bottom ash into raw material in cement industry. The detailed technology flow is in Figure 1. There are two purposes for our research. The first purpose is to cut down the amount of residue as much as possible, and because of the high limitation for chlorine content in cement industry, to reduce the chlorine content in the fly ash is another important purpose. To achieve those purposes, we also compared three kinds of fly ashes in WCCB system: fly ash resulting from injecting NaHCO_3 (NaFA), fly ash resulting from injecting $\text{Ca}(\text{OH})_2$ (CaFA), and raw fly ash from the boiler (RFA), to evaluate which alkaline reagent is better, NaHCO_3 or $\text{Ca}(\text{OH})_2$.

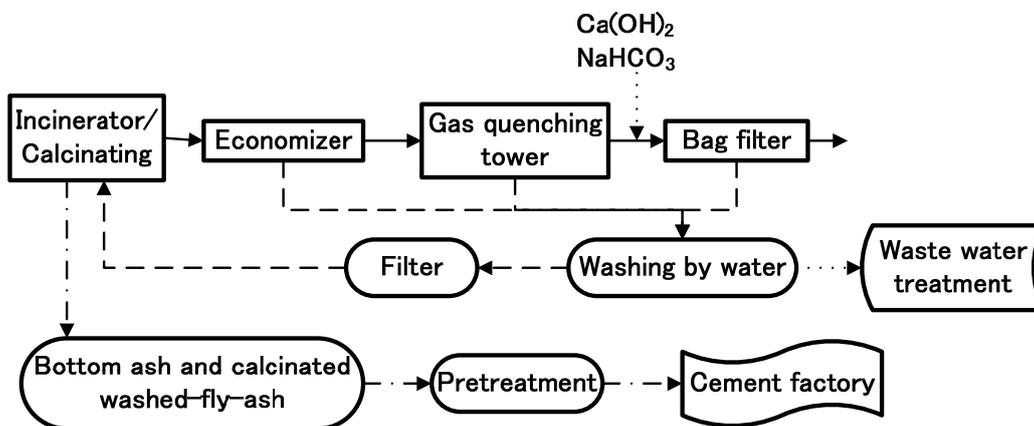


Figure 1 Technology flow of WCCB system

My research includes the study of optimizing the condition of washing process, explaining the chloride reduction mechanism in washing process and the study of optimizing condition of calcinating process.

2. Research content and results

Optimizing condition of washing process

We first carried out single washing experiments, then double washing experiments and last triple washing experiments. We found that washing frequency is more important than liquid to solid ratio, mixing time and mixing speed to reduce the amount of residue and chlorides in fly ash. Except residue mass percent and chlorine content, we also thought about problems of energy, consumption time. At last we decided double washing for washing process: liquid to solid ratio is 3 at the first and second step, mixing speed is 150 rpm at both step, and mixing time is 5 minutes in the first step and 10 minutes in the second step. Under that condition, 15.2% amount of RFA, 23.1% amount of CaFA and 62.9% amount of NaFA can be washed away by washing process, while, about 88% chlorine in RFA, about 87.3% chlorine in CaFA and 95.6% chlorine in NaFA can be removed by washing process. Obviously, both the amount and the chloride of NaFA are easier to be reduced than CaFA.

Chloride reduction mechanism in washing process

We newly adopted an identification approach by combining the method of X-ray absorption near edge structure (XANES) with X-ray diffraction (XRD). With that method we first successfully analyzed the chloride speciation in RFA, CaFA and NaFA. In that process, we found a chloride with similar structure to substitute the insoluble chlorides in fly ash and NaFA has more soluble chlorides than CaFA. Then we analyzed the chloride speciation in the washed residues of those three kinds of fly ashes to explain the chloride behavior in washing process. It is found that after the same treatment there is less chlorides, not only soluble but also insoluble chlorides, left in the washed residue of NaFA than in the washed residue of CaFA. During the washing process insoluble chlorides will change and they are very strongly related to calcium chloride which is much more easily formed in CaFA.

Optimizing the condition of calcinating process

Except to stabilize the washed residue, we would like to reduce the chlorine content. We discussed the influence of heating temperature, atmosphere and dwelling time on mass reduction and chlorine content of washed residue. We found heating temperature of 1000°C, atmosphere of 10% O₂, heating time of 1 hour and dwelling time of 1 hour is better to volatilize the chlorides in the washed residue of fly ash. And similarly as the results in washing experiments, above the critical temperature, the lost amount of chlorides in washed residues of NaFA is more than that in the washed residues of CaFA, while the loss of residue of NaFA is always more than that of CaFA.

3. Future perspectives

To apply WCCB system into reality to be a successful example for Sound Material-Cycle

society, we have to give a comprehensive evaluation of this system to optimize the operating parameters. The comprehensive evaluation includes the calculation of the cost and energy consumption, the evaluation of environmental risk and impact, the analysis of the relationship between cost, energy consumption and environmental risk or impact.

We can apply the concept of WCCB to the wastes which has similar characteristics of fly ash or the system which is similar to incinerators. In other aspects, we can enlarge the resource of raw material for cement industry to utilize cement industry as a good assistant for resolving environmental problems.