Cho, S., Kim, S., Cho, K., Recovery of abrasives from electrical industry sludge.
International Symposium on the Fusion Technology of Geosystem Engineering, Rock Engineering and Geophysical Exploration
Seoul, Korea, Nov. 18-19, 2003

Recovery of abrasives from electrical industry sludge

Sung-Baek Cho, Sang-Bae Kim, Keon-Joon Cho
Mineral and Materials Processing Division, Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea 305-350

Abstract: Abrasive powders were recovered from electrical industry sludge by simple physical separation for their recycling. The raw electrical industry sludge was filter pressed, dried, dispersed and then classified by air classifier at various conditions. The three kinds of particles with different particle size distribution were classified by controlling rotor speed and air volumes of the classifier. The recovered abrasive powders, which are classified at 5,000, 9000 and 13,000 rpm of rotor speed, are almost same properties to raw pumice, garnet and rouge powders, respectively. The results of particle size analysis, X-ray diffraction and SEM observation show that the recovered powders can be reused as an abrasive powders.
Keywords : abrasive, air classification, electrical industry sludge

1. Introduction

CRT manufacturing industry consumes considerable quantities of abrasives such as pumice, garnet and cerium oxide for glass polishing. According to the surface roughness of CRT, different types of abrasives with different particle sizes are used to achieve mirror surface in fabricating CRT. Although most of the abrasives slurry are recovered and reused in polishing procedure, some of them are lost during washing procedure of the CRT after polishing. New abrasive powders are added to the recovered abrasive slurry to control the optimum slurry concentration, whereas both of the washed abrasive particles and polished glass powders from CRT surfaces are collected and precipitated using flocculants in waste water reservoir tank. The precipitated powders are called electrical industry sludge and now used as a raw materials for making industrial cement for compensating clay component. Considering the polishing procedure of CRT, it is thought that new abrasive powders as well as recycled abrasive powders were also wasted in the sludge. In the present study, abrasive powders were recovered with different particle size by simple physical separation for the recycling of them as a abrasive powders in glass polishing procedure.

2. Experiment

Classification is a method of separating mixtures of minerals into two or more products on the basis of with which the grains fall through a fluid medium. In conventional mineral processing, this is usually water, and wet classification is generally applied to mineral particles which are considered too fine to be sorted efficiently by screening. Recently, many kinds of dry type classifier have been developed and commercially used in the manufacturing process of powdered materials. Another advantage of dry process avoids the unnecessary energy consumption. Therefore, the present authors used dry type air classifier to recover abrasives from the electrical industry sludge.

The raw electrical industry sludge cake filtered by filter press contained about 28wt% moisture. First the sludge dried at 105C for 1 day, and then crushed by impact mill for the liberation of the powders each other. After that, dried sludge powders were classified by zigzag type air classifier(laboratory classifier 100MZR, Alpine, Germany) at various conditions. Particle size analysis, X-ray diffraction and SEM observation were done for the characterization of the products.

3. Result and Discussion

Separation is usually achieved by utilizing some specific difference in physical or chemical properties between the valuable mineral and gangue minerals in the ore. Liberation of the valuable minerals from the gangue minerals is accomplished by crushing and grinding to such a particle size that the product is a mixture of relatively clean particles of minerals and gangue minerals. Overgrinding of the ore is wasteful since it needlessly consumes grinding power and make efficient recovery more difficult to attain. Fortunately, the electrical industrial sludge is physically agglomerated particles of various kinds of abrasives by aqueous flocculants. For the effective separation of them, dispersion of the particles in the sludge is important. For this reason we used impact mill at low rpm.

After dispersion by impact mill, the waste sludge was separated by air classifier. Classifier is mainly consisted of feeding, separating and collecting parts. Efficiency of classifier is generally affected by feeding rate, air volume and rotor speed. The most important adjustment for determining the particle size of the collected fine product lies in the rotor speed. By greatly changing rotor speeds, the particle size of the fine materials changes sharply. However, a few rpm, plus or minus will have little or no effect. In the zigzag type air classifier, 100rpm plus or minus will change the particle of the fine materials. Except rotor speed, the particle size distribution of the materials to be classified, its moisture content or other physical characteristics, particle shapes and atmospheric conditions may also make it necessary to deviate from the expect cut point. In this study, effects of rotor speed and air volume on recovery of abrasives are mainly considered since other factors are constant. The volume of air used is an important factor in particle size, capacity and efficiency. At full air volume, the maximum throughput will be obtained but the fine materials collected will be coarser. Air volume must be controlled along with rotor speeds for maximum efficiency. In general, the lower the air volume, the finer the cut point. Often it may become necessary in order to obtain a very fine cut point to reduce the air volume considerably if the required rotor rpm exceeds the rated mechanical limits. Based upon these facts, air volume was controlled along with rotor speeds in order to maintain the highest capacity.

To obtain coarse particles, lower rotor speed is usually used. Fig. 1 shows that particle size distribution of the under flow product recovered at 5000rpm of rotor speed. There is hardly shown smaller than 20μm in size. Figure 2 shows XRD patterns of the raw pumice powders and recovered abrasive powders as shown in Fig. 1. Comparing to the XRD patterns, that of the recovered ones showed amorphous pattern and is almost same to that of raw pumice powders beside low angle diffraction. The pumice powder is glassy phase because the pumice originated from volcanic ash. It is thought that the low angle diffraction pattern in pumice is attributable to clay minerals consisting of very fine particle size.

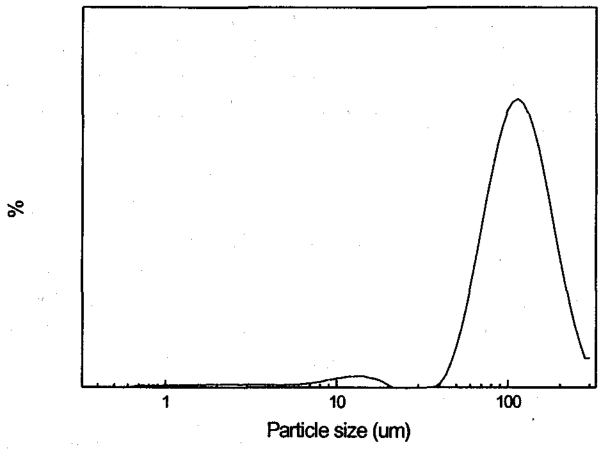

Fig. 1. Particle size distributions of the recovered abrasive powders at 5,000rpm.

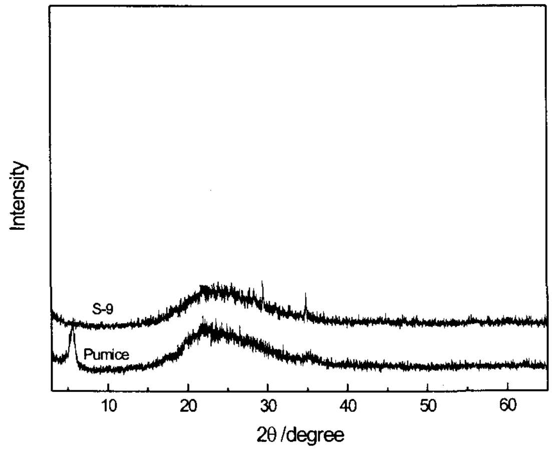

Fig. 2. XRD patterns of the raw pumice abrasive and recovered abrasive powders.

After classification at 5000rpm, the over flow products was re-separated at 9000rpm of rotor speed. Fig. 3 shows that particle size distribution of the under flow product recovered at 9000rpm. It was shown that the particle size ranging from several μm to 20μm was collected at 7000rpm. XRD patterns shown in Fig. 4 indicate that the recovered abrasive powder is garnet. When the overflow product was re-separated at 13,000rpm, the size of the recovered abrasives is below about 10μm and its crystal structure revealed by XRD pattern is same to that of rouge(cerium oxide) as shown in Fig. 5 and Fig. 6, respectively.

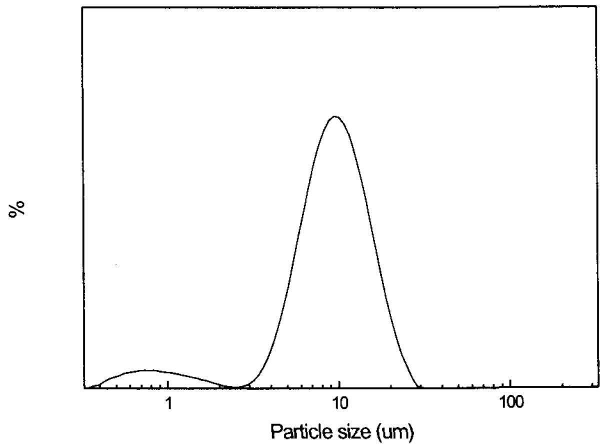

Fig. 3. Particle size distributions of the recovered abrasive powders at 9,000rpm.

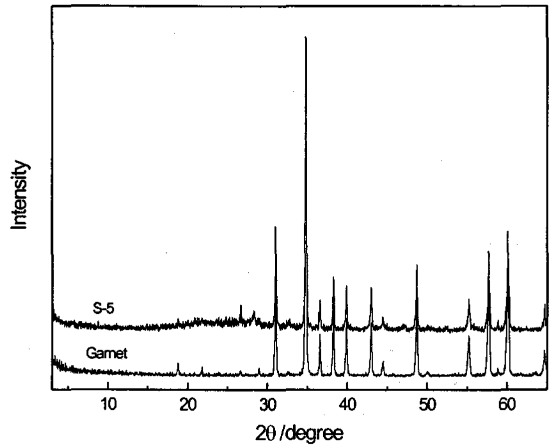

Fig. 4. XRD patterns of the raw garnet abrasive and recovered abrasive powders.

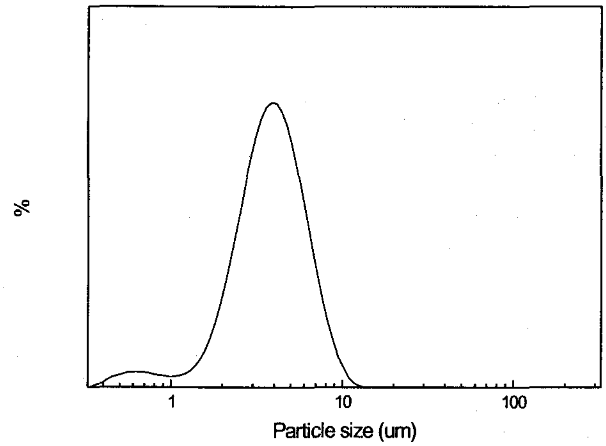

Fig. 5. Particle size distributions of the recovered abrasive powders at 13,000rpm.

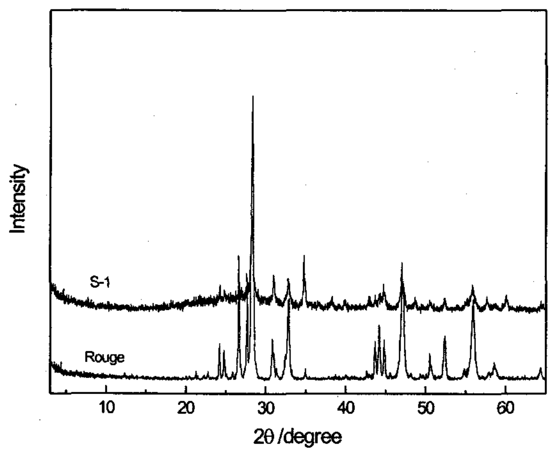

Fig. 6. XRD patterns of the raw rouge abrasive and recovered abrasive powders.

Figure 7 shows SEM photographs of raw abrasives and recovered powders at different conditions. The raw pumice abrasive powder (Fig. 7(*a*)) shows rectangular shape and its corner is very sharp. The recovered abrasive powders (Fig. 7(*b*)) hardly show changes in their size even after polishing, but the shape of them are slightly rounded due to abrasion. According to the results of SEM observation, this phenomena are also shown in the cases of raw garnet powder(Fig. 7(*c*)) and recovered abrasive powders (Fig. 7(*d*)) as well as raw rouge powder(Fig. 7(*e*)) and recovered abrasive powders (Fig. 7(*f*)). Only a small difference between Fig. 7(*e*) and Fig. 7(*f*) is that large amount of fine particles are shown in the former, whereas relatively coarse particles were present in the latter. This is attributable that some of the fine particles, which is assumed to clay minerals showing low angle diffraction in the XRD pattern of Fig. 2, were cannot recovered since the particles too fine to collect. Considering the XRD patterns shown in Fig. 6 and SEM photographs shown in Fig. 7, it can be concluded that the recovered abrasive powder can be reused as an abrasive powders.

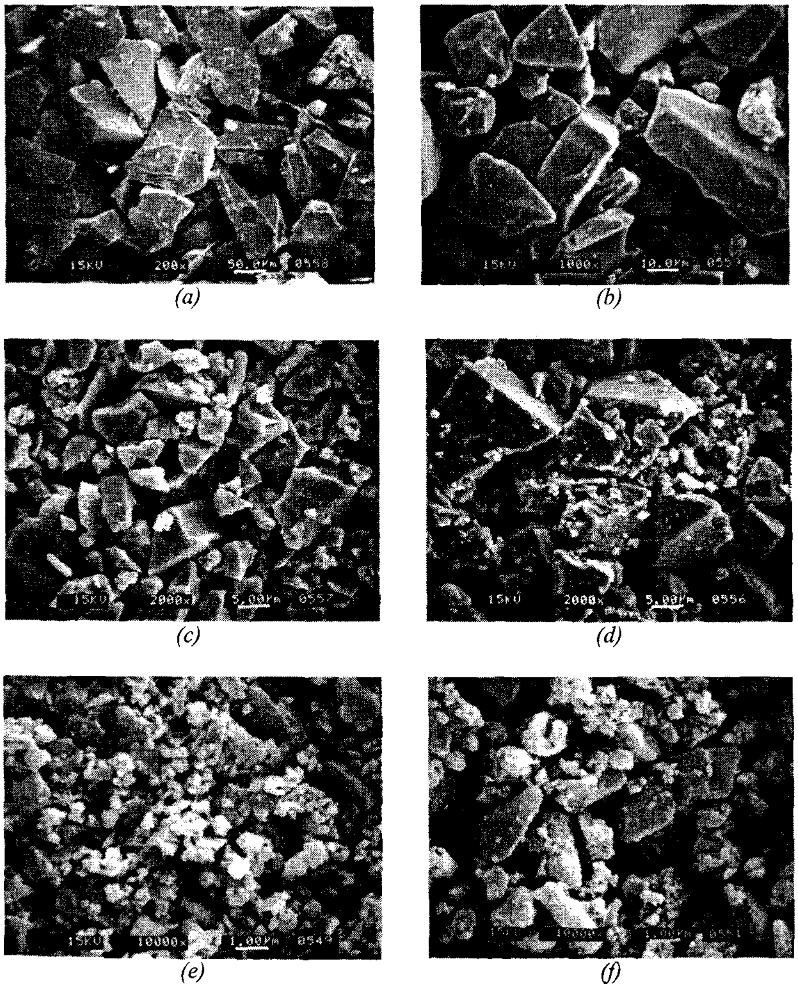

Fig. 7. SEM photographs of raw abrasives and recovered powders.

Acknowledgement

This work was supported by grant No.2D-2-1-1 from the Industrial Waste Recycling Research Center Foundation.