Analysis on the Efficiency of the Air Classification of Fly Ash

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1. 서론:

The most common method of representing classification efficiency is by a performance curve, or Tromp curve. Since the mass split is not usually measured directly by mass flow of the steam, it is calculated from three size distributions around the classifier (Klimpel, 1980). These calculations can be done easily if the size consist is mostly in the sieve size range. However, since there are considerable amounts in the subsieve size range in fly ash, the sieve size analysis only does not give a detailed information on the size distribution. Consequently, it is common to use screening down to 500 mesh (26 μm) and a subsieve sizing method for that fraction below 500 mesh. In this way, the maximum information can be obtained by analyzing the complete size-composition matrix above 500 mesh and the size distribution below 500 mesh. But the size definition is different between the two size measuring devices, and the size distributions obtained by two methods is not directly comparable. Therefore, it is necessary to have methodology for joining the two experimental determinations together with a consistent definition of size. In this paper, the detailed analysis on the separation efficiencies of the various air classifiers using the size inter-conversion method developed by Cho et al. (1988).

2. Experimental

Fly ash samples were taken from an air classifier currently used in commercial scale. Size analyses were conducted separately for the three samples taken from the feed, the coarse, and the fine stream. About 50g of fly ash sample was wet screened at 500 mesh utilizing a water spray to remove fine materials. After drying, the +500 mesh fractions was screened on a sieve shaker using screens of 150, 200, 270, 400, 500 mesh sieve sizes. The wet screened -500 mesh fraction was combined with the dry screened -500 mesh and subjected to a laser diffraction size analyzer (Cilas, Model 1064). Loss on ignition tests were conducted on each size fraction and the whole sample in accordance with ASTM C311.

3. Results and Discussion

Table 1 shows the size distribution and LOI of the fly ash samples. It can be seen that the feed fly ash samples are mostly finer than 150 μm but majority (61%) is in the

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size range of -26 μm. Analysis of LOI content of the size fractions showed a definite trend that LOI content decreased as the size decreased. Also, it can be clearly seen that LOI of the -26 μm fractions is less than 3%. Therefore, the size separation at 26 μm can produce a clean fly ash with LOI content less than 3%.

However, the separation results of the air classification shows that the separation is not perfect: misplaced particles (eg. fine in the coarse stream, coarse in the fine stream) are present. The fine stream contains about 23% of the particles larger than 26 μm and conversely about 33% of particles is finer than 26 μm for the coarse stream. Figure 1 shows the sieve size distribution down to 26 μm and the size distribution of -26 μm measured by Cilas. It can be seen that the two size distributions deviate from each other and do not join correctly at 26 μm.

In order to convert the Cilas size distribution to the equivalent sieve size distribution, the sieve size fraction of 400x500 mesh was analyzed in the Cilas size analyzer. The results are seen in Figure 2. It can be seen that the distributions are not limited to the corresponding sieve size range but instead spread over the wide size range from 100 μm x 0 μm. The amount reported in the size range of under 20 μm is assumed to be false, since these fractions consistently appeared for all the other samples analyzed regardless of the particle size range. The size distributions were corrected and the corrected size distributions were found to be represented well by lognormal distribution as shown in Figure 3. It can be seen that the size distribution of the coarse product is quite different from those of the feed and the fine product. From Table 1, it can also be seen that LOI of the 270x400 mesh fractions of the coarse product is lower than those of the other two products. It indicates that although they are the same size in the sieve analysis, they consist of the particles with different compositions and different physical properties. The carbon rich particles in fly ash are lighter and blocky which will settle slower than the denser, and round pure ash particles of the same size. Therefore, the 400x500 mesh fraction of the coarse product is mainly composed of round, pure-ash particles, whereas that of the fine product contains the irregular and lighter particles.

With this information on how the sieve sizes appear to the Cilas size, the Cilas data for the -26 μm sieve size fractions of the feed, the fine and the coarse product were converted. The results are shown in Figure 4. The Tromp curve predicted from the data is shown in Figure 5. It can be seen that the cut size is around for the 45 μm and the classification value does not go to zero, but exhibits a by-pass value of 0.15.

References

1. Klimpel, R. R., 1980, "Estimation of Weight Ratios Given Component Make-up Analyses of Stream," *Trans. SME-AIME*, Vol. 277, pp. 1882-1886.
2. Cho, H., 1998, "The Conversion of Sedigraph Size Distributions to Equivalent Sub-Sieve Screen Size Distributions," *Power Technology*, Vol. 95, pp. 109-117.

Table 1. Size Distribution and LOI of the the feed, the fine and the Coarse Products.

입도 (㎛)	Raw Ash(%)		Fine Ash(%)		Coarse Ash(%)	
	wt%	LOI	wt%	LOI	wt%	LOI
+150	3.96	37	0.47	41	9.99	44
150~105	5.53	21	2.27	25	11.05	19.7
105~74	6.44	11	1.73	24	11.82	10.3
74~53	8.1	8.5	5.11	11.5	14.9	5.1
53~38	3.49	8.0	4.68	9.8	9.23	4.2
38~26	11.27	5.0	8.55	5.0	9.96	2.7
-26	61.21	2.3	77.19	2.4	33.05	2.3
Mean		5.72		3.87		8.78

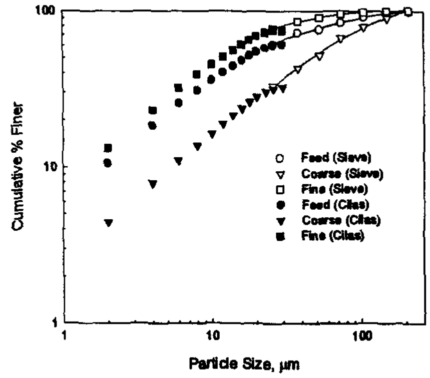

Fig. 1. Sieve and Cilas size distributions.

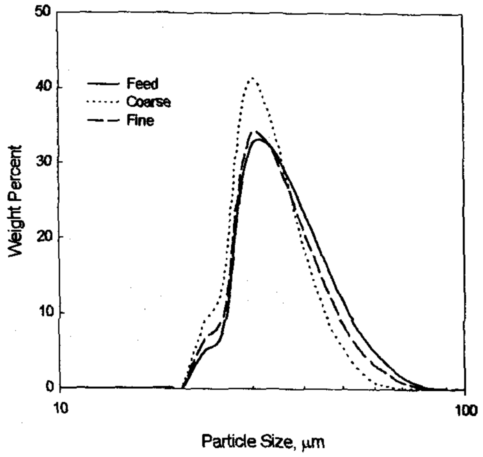

Fig. 2. Cilas size distribution of the 400x500 seive size fraction.

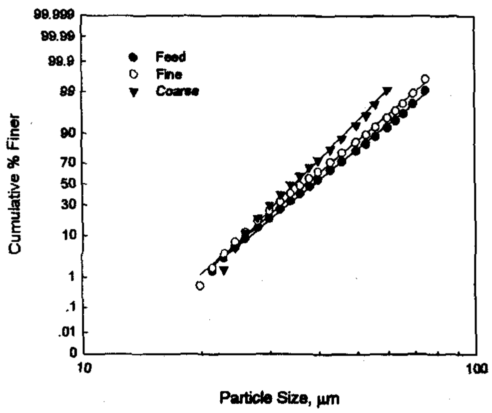

Fig. 3. Lognormal represention of the Cilas size distribution of the 270x400 mesh.

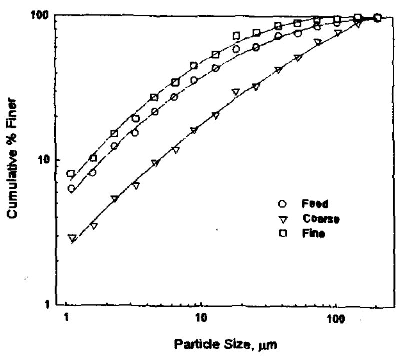

Fig. 4. Combined Size Distribution

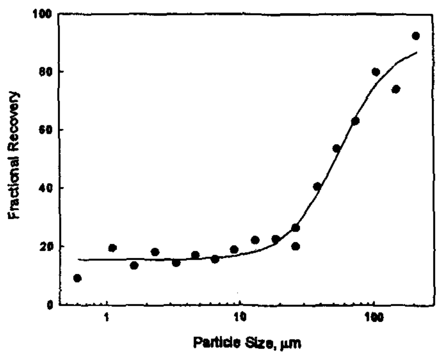

Fig. 5. Tromp curve.