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Optimizing ultrafine grinding performance by manipulating size and shape of media

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Background

In an effort to improve the recovery of rare earth elements from Appalachian coals, ultrafine grinding is being studied as a way to increase the liberation of these elements from the coal source. A primary objective in this research is to find the most cost-effective way to grind ultrafine coal.

Introduction

The feed material for the grinding tests was thickener underflow — F_{80} of 30 µm. Initial experiments had revealed that using fine silica beads, with particle size greater than 420 µm, smaller than 1,190 µm, as grinding media yields good results. In this round of experiments, the goal was to determine which media parameter has a greater effect on grinding performance: media shape or media size. This information can be used to further optimize the media used.

Materials and methods

To test the effects of media shape and size, thickener underflow slurry — F_{80} of 25 µm — was attrition milled using three different types of media. The control group was the same silica with particle size greater than 420 µm, smaller than 1,190 µm that was used in earlier tests. To test the effects of size, smaller silica beads, with particle size greater than 250 µm, smaller than 420 µm, were used as the second media. To test the effects of shape, crushed sand of the same size fraction was used as the third group. To ensure the media was not being degraded during the milling, ash analysis was done on the underflow before and after milling. Particle shape analysis was also done on the media itself to further confirm there was no degradation of the media.

Results

After three tests with each media, an average F_{80} and average energy input was calculated for each media type. The results are shown in Table 1. Ash and shape analysis done on all of the tests showed no signs of media degradation.

Conclusion

Based on the data, media size has a larger effect on final F_{80} but media shape has a larger effect on the energy required for milling.

Media	F80 (microns)	Energy Input (kwh/ton)
Silica +420 - 1190	2.66	185.47
Silica +250 - 420	6.75	231.68
Sand +420 - 1190	4.77	292.14

Table 1 — Results of the tests.