

(US Dept of Energy, 12/20/2000-7/31/2005)

Grinding mills in iron ore concentrators are major users of energy, and it is estimated that only 1-2% of this energy is actually used to generate new particle surfaces, with the rest dissipated as noise and heat. There is therefore tremendous scope for improving energy efficiency of grinding. Given the poor energy efficiency of grinding, it is particularly important that ore not be ground to any finer size than is strictly necessary. However, iron ore concentrators that use hydrocyclones for size control in their grinding circuits suffer from a problem where the high-density iron oxide particles are retained in the circuit at a finer size than the lower-density particles of gangue minerals. Therefore, in order to grind to a sufficiently fine size that the gangue can be separated from the iron oxides, the iron oxides must be “overground” to a size finer than necessary.

In this study, it was determined that overgrinding of iron oxides was wasting a considerable amount of energy, with almost 30% of the feed to the grinding mill consisting of recycled fines that should have been removed from the circuit. So, alternative grinding circuit designs were developed and simulated to determine how best to reduce overgrinding without degrading the overall plant performance. Studies with the hydrocyclone showed that there was no feasible way to use a single stage of hydrocycloning to reduce the tendency to retain the high-density iron oxides. However, plant operating data provided by the industrial co-sponsor showed that two-stage cycloning could be used to generate three products: (1) a coarse stream where all the particles needed to be recycled for further grinding; (2) a fine stream where all of the particles were small enough to be removed as final product; and (3) a narrowly-sized intermediate stream that required only a small amount of further grinding to reach the target size.

Simulations of the circuit showed that the intermediate stream could be sufficiently ground in a single pass through a grinding mill, with no need to classify it again by hydrocycloning after that single pass of grinding. Since this stream contained all the particles that would normally be retained and overground by the circuit, this eliminated the major source of grinding inefficiency. It was estimated that incorporating this change into the circuit could reduce circulating loads from 250% to only 42%, allowing the capacity of the circuit to be increased by 50% without using any additional grinding energy.