Cement Particle Size Classification

A major cost component in cement production involves grinding and separating fine and coarse cement particles. Now, through research under a cost-shared effort with Construction Technology Laboratories, a subsidiary of the Portland Cement Association, DOE found that these costs can be substantially reduced by using controlled particle size distribution cement, by applying high-efficiency classifiers, and by implementing mill configuration and operating changes. Full implementation of this technology would produce a superior cement product and save the average U.S. producer $400,000 per year in finish-grinding costs alone. In addition, plant finish-grinding capacity would be increased by more than 25%. Thirty-seven plants are currently using the new technology and saving an estimated 1.01 trillion Btus per year. Annual energy savings from use of this technology are expected to be 20.5 trillion Btus in 2010.

Coatings for High-Speed Cutting Tools

Improved tooling systems for automated machining operations can increase production rates, reduce tool replacement times, and improve energy use. These new tooling systems for high-speed machining can be developed based on an improved understanding of tool wear mechanisms. A cooperative effort funded by DOE has developed processes for depositing hard coatings. It also developed a theoretical understanding of the wear behavior of hard coatings, which explains the differences in performance of one coating over another in cutting operations.

The two commercially viable processes are the high-rate reactive sputtering and the activated reactive evaporation processes. Cutting performance tests indicated that sputtering coatings outperform uncoated tool inserts by factors of between 3 and 10, depending on coating composition. Activated reactive coatings were found to outperform uncoated inserts by a factor of 3. Two patent applications were filed covering the high-rate reactive sputtering processes, and two licensing negotiations are under way.

The theoretical model includes the effects of chemical dissolution of the tool into the workpiece in addition to the effects of mechanical wear. Cutting test results with high-speed steel (T-15) inserts coated with carbides and nitrides of titanium and zirconium showed that wear resistance increased about 3 times for zirconium nitride compared with titanium nitride, verifying predictions made using the theoretical model.

This research has advanced understanding of tool wear to a point where it is feasible to use computer searches of a data base on thermodynamic and mechanical properties with the objective of identifying the best coating compositions for wear resistance. As a result, industry should be able to systematically implant less expensive substrate materials with coatings that have low friction and wear properties.

High-Efficiency Welding Unit

Improving power supply efficiency is the key to achieving significant energy savings in welding processes. Conventional arc-welding power supplies use a low-frequency transformer, which is responsible for their inefficient use of power and for the large size and weight of the units. Because current continuously flows through the transformer, considerable energy is wasted when the unit is idling between steps in a welding job.

With funding from DOE, Cyclomatics has applied a new inverter technology to arc welding power supplies, bringing significant savings to the welding industry. The DOE/Cyclomatics inverter technology uses a silicon-controlled rectifier and a high-frequency, high-efficiency transformer, which together dissipate little energy. The rectifier shuts off power to the transformer when the system is idling, greatly reducing electrical energy consumption.

Typical power losses for the high-efficiency welding unit are 15%, compared with 45% to 55% for a conventional unit. Power supply size and weight are drastically reduced as well, improving the portability of the unit. This joint effort is a good example of what can be achieved through cooperative government/industry R&D activities.

In 1988, there were more than 48,600 of these high-efficiency welding units in operation, saving an estimated 3.06 trillion Btus per year. In addition, the technology was recently applied to plasma cutting devices; more than 2500 of these high-efficiency cutters had been built and sold by the end of 1988. By 2010, this technology could save about 12.2 trillion Btus annually.