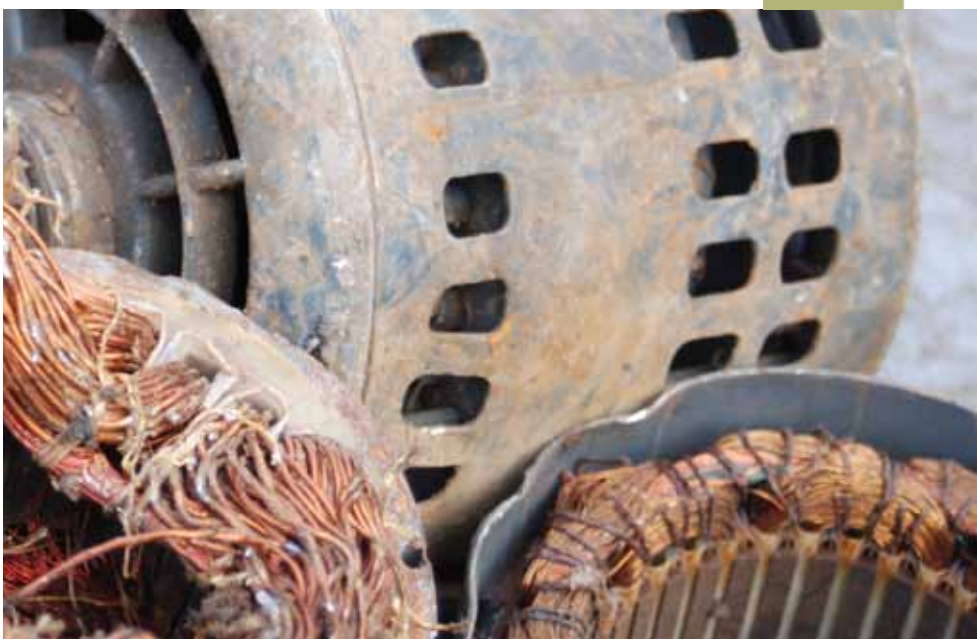
MEATBALL SEPARATORS | MEATBALL SEPARATOR

ELECTRIC MOTORS OR "MEATBALLS" IN THE SHREDDER STREAM CAN CAUSE HEADACHES FOR BOTH SCRAP PROCESSORS AND STEEL MILLS. NEW SEPARATION SYSTEMS PROMISE TO TURN THESE POTENTIAL LIABILITIES INTO LUCRATIVE ASSETS WHILE REDUCING THE NEED FOR HAND SORTING. **BY JIM FOWLER**



Copper is a valuable metal in many applications, but it can be poison in the steelmaking process. Too much copper in a heat can either soften or embrittle the steel batch—depending on the type of steel the mill is producing—and affect the surface quality of the finished metal. The effect of copper in steel is cumulative, and "there is no … modern economically viable chemical process that readily removes copper once it is alloyed within steel," according to the Steel Recycling Institute (Pittsburgh). Copper's negative effects in steelmaking are a major concern for steel mills and the scrap processing companies, most notably shredder operators, that supply them. To address this problem, many recycling facilities are stepping up their efforts to cull the largest copper-containing culprit—meatballs—from their shredded ferrous streams.

Meatballs are electric motors—usually consisting of a steel shell with copper windings inside—from automobiles and white goods. If they end up in the shredded ferrous stream, the copper they contain can cause serious headaches for the consuming mill and, in the end, the scrap company that sold the material. Conversely, if meatballs end up in a recycler's mixed shredded nonferrous scrap, or Zorba, the steel content reduces that product's market value. Meatballs, which can weigh 20 pounds or more, also can damage downstream nonferrous separation equipment and can start fires in piles of shredder residue, or fluff, because they retain heat from the shredding process. For recyclers, meatballs also can represent a lost revenue opportunity: Pound for pound, they are more valuable than shredded ferrous scrap, and there is a ready market for them. In 2006, in fact, ISRI established the Shelmo specification for meatballs (also called shredder pickings) in response to the growing market.

As scrap processors have looked for ways to minimize their meatball hassles and maximize their revenue opportunities, several manufacturers have responded by developing specialized systems to remove meatballs from the shredded material stream.

METALLURGICAL AND MECHANICAL OBSTACLES

With steel mills' low tolerance for copper in ferrous shred—some set the limit for copper at or below 0.20 percent—it helps to understand how the copper gets there and why it's so hard to remove. Copper appears in shredded ferrous scrap in two ways: as an element alloyed within the steel and as "free" copper—items such as loose wires, wire bundles and harnesses, coils, and meatballs from scrap automobiles and white goods. The alloyed, or inherent amount, of copper in even the best steel scrap in North America ranges from 0.10 percent to 0.12 percent, says Rick Comtois of Austin Automation & Instrumentation (Austin, Texas). That means 1 short ton of ferrous scrap—2,000 pounds—would contain 2 pounds to 2.4 pounds of copper alloyed in the metal. "It's worse in Europe," Comtois says: Ferrous scrap there has an inherent copper value of 0.18 percent to 0.20 percent, or 3.6 pounds to 4 pounds per short ton.

With no way to remove the alloyed copper, scrap processors must remove as much free copper as they can. Most of that copper comes from meatballs and similar heavy spherical objects that contain both ferrous and nonferrous components. More than 95 percent of shredder operators rely on manual sorters, or pickers, to pull meatballs and similar items from their downstream material, Comtois says. The number of pickers can range from two to 10 or more, he says, depending on the size of the shredder, the system's downstream separation equipment, and customer quality demands.

X-RAY VISIONS

The quest for automated extraction of meatballs began in 2005, when OmniSource Corp. (Fort Wayne, Ind.) approached Austin AI with its desire to remove such copper-bearing scrap from its ferrous shred. Austin AI agreed to do some research and found OmniSource's goal achievable. Austin AI later signed an agreement with Innov-X Systems (Woburn, Mass.) as a corporate partner to develop a prototype meatball separator for OmniSource. That partnership did not last, however, and the two companies ended up pursuing the goal separately with new partners: Austin AI signed a licensing agreement with TITECH Systems (Asker, Norway) in 2009, while Innov-X announced in May 2010 that it had partnered with Steinert (Cologne, Germany).

Both partnerships have designed equipment that uses "the same core technology," Comtois says—X-ray fluorescence—to automatically separate

A DIFFERENT APPROACH TO MEATBALLS

The new breed of meatball separators removes these copper-containing devices from the ferrous stream, but for them to work, the meatballs must be in the ferrous stream in the first place. That's not always the case, however. The electro drum magnets that most yards use to separate ferrous and nonferrous streams don't reliably attract them because of their weight (they're often heavier than other ferrous shred of that size), their high copper content, and their spherical shape. Meatballs are "the most difficult type of object to capture magnetically," says Tim Shuttleworth of **Eriez Manufacturing Co.** (Erie, Pa.), a manufacturer of magnetic equipment. "A sphere that is pure iron is harder [for a magnet to attract] than a pure iron cube or rod of the same mass, but it is easier to recover magnetically than an identically sized composite sphere of half iron and half copper—the meatball. The copper is heavier than the iron, and there is half the iron for the magnet to influence."

Further, all meatballs are not alike, Shuttleworth notes. The biggest—such as alternators, starters, and generators—are the size of grapefruit, while the smallest—such as motors that drive windshield wipers and antennas—are the size of lemons. "Some have a lot of copper and a little bit of steel, and some have a lot of steel and a little bit of copper," he says. These irregularities can further complicate the recovery process in a shredding downstream system, sending the meatballs into the nonferrous stream or even into the fluff.

Last May Eriez introduced the P-Rex Xtreme permanent, rare earth drum magnet, its solution to the shortcomings of electro drum magnets in this task. A single P-Rex, which replaces the traditional two electro drum magnets in a shredder's downstream system, captures heavy spherical items such as meatballs and knuckles—typically all-ferrous ball joints—and keeps them with the ferrous scrap stream so they can be culled either by hand sorters or a nonferrous separation system such as those described in the main article. Shuttleworth thinks the 20,000-pound P-Rex drum, which he says has a 40-percent stronger magnetic pull than traditional electromagnetic drums—will pull 80 percent to 90 percent of the meatballs to the ferrous side of the fraction. He concedes, though, that "a few of them that are almost all copper and don't have any steel associated with their construction will go missing to the nonferrous side."

Eriez installed the first two P-Rex magnets—which measured 60 inches in diameter by 96 inches wide—last May as part of the shredder downstream system at **Liberty Iron & Metal Southwest** (Phoenix). According to Joe Plumadore, the plant's operations manager, the material on the shredder's scavenger conveyor—which pulls residual ferrous-containing material from the nonferrous stream—decreased significantly to the point where it was

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copper from shredded ferrous scrap. The differences between the two systems "would be unrecognizable to someone outside the world of XRF," he says. The distinction lies in how TITECH and Steinert put the XRF technology into a separation system.

The Innov-X and Steinert system incorporates Innov-X's X-Stream high-speed XRF sensor technology into a Steinert-designed XSS-F full sorting system. In the system, shredded steel is spread out, or "singulated," on a conveyor belt. The material passes under X-ray tubes that "excite" the molecules in the scrap. Detectors read the fluorescent X-rays coming off the material, identifying each piece by its chemical composition. When a detector identifies copper material on the belt, it signals a number of valves to fire when the piece reaches the end of the belt, removing the material from the stream. The system can eject individual pieces weighing 20 pounds or more, says Nicolle Williams of Steinert U.S. (Erlanger, Ky.). Steinert says it is further developing the sensor to increase processing speed and sensitivity while retaining a high level of reliability.

The Innov-X-Steinert system has a 72-inch belt width, with a maximum throughput of 150 tons an hour of shredded steel at a feeding density on the conveyor of 80 pounds per cubic foot, Williams says. "Based on an overall copper content of about 0.50 percent in the average feed, of which roughly 0.12 percent is inherent copper and 0.38 percent is free copper, we expect to reduce the free copper content to less than 0.17 percent," she says. The remaining free copper includes items such as insulated wire, which the XRF has trouble reading due to its shielding, she notes.

Steinert is testing units in Germany and the United States, Williams notes. The XSS-F pilot system, currently operating at an undisclosed U.S. location, is available for purchase and will be made available for viewing by select parties beginning in January. She declined to provide the system's price and the company's return-on-investment calculations, noting that "Steinert applications specialists are happy to provide an equipment [price] and savings estimate" to interested buyers.

The first unit featuring the TITECH-Austin AI X-Tract XRF technology will soon be operating in Belgium, and the companies expect the first unit to hit the North American market in the first quarter of 2011, says Tom Wendt Jr. of Wendt Corp. (Tonawanda, N.Y.), which will be the exclusive North American distributor of the system. The first North American machine essentially will be "a demo facility for us in the Buffalo area," Wendt says, noting that he watched the X-Tract XRF in trial runs in Germany last September. That 48-inch machine handled 60 tons an hour, so Wendt calculates that a 72-inch machine should process at least 90 tons an hour.

In one test, TITECH peppered a ton of clean steel with meatballs and free copper of different sizes and configurations, and the separator recovered all of the pieces, he says. "The ferrous scrap was pristine—no free copper in it at all." In commercial applications, Wendt says the system will produce ferrous shred with 0.17 percent to 0.18 percent free copper "day in and day out, hour in and hour out. That's where we think we're going to be." Comtois

"hardly carrying anything." To him, those results indicate that the P-Rex magnets are "pulling everything out of the waste stream and increasing the recovery of our ferrous fraction," he says. "We used to see some ferrous go off the scavenger magnet, but we don't see that anymore. We're seeing more meatballs in the ferrous stream, which our pickers are getting."

Typically a shredder's downstream ferrous recovery system has two electromagnetic drums. The first pulls the ferrous shred from the mixed stream and the second flips, or cleans, the ferrous material. The P-Rex performs both tasks, however, because it has in its magnetic circuitry four polarity changes in which the magnet's polarity switches from north to south. That causes the material on the surface of the drum to flip from point to point as it goes from one magnetic pole to another. These multiple "flips" do a better job of cleaning the ferrous shred than electro-axial drum magnets, which only flip the material once, Shuttleworth says. In addition, as a permanent, rare earth magnet, the P-Rex does not use electro coils, so it "does not have electrical heat rise and the associated loss of strength, which can be as much as 30 percent," he adds. The P-Rex "does such a great job of recovery and cleaning on the first drum, we think the ferrous circuit of the future will have only one very strong drum that can highly agitate, or flip, the ferrous shred so it won't have to be handled again," Shuttleworth says.

Eriez is developing new technology it plans to pair with the P-Rex to separate the meatballs from the ferrous shred and make either hand or automated picking easier, Shuttleworth says. "We use the P-Rex drum to do the heavy lifting to get the ferrous separation right as step one, then we will use the next separator to polish up that separation," he explains. "It's going to cost less capital and less operating expense for better ferrous grades." Eriez expects to release the new separator in 2011.

adds that the TITECH technology "will detect and blow a 20-pound meatball off the line. It's been done."

Though the idea is for the X-Tract system to keep pace with the shredder output, Wendt does not want the first installations coupled with the shredder. "We prefer not to deal with the surges from the shredder," he says. As a result, the first few installations will be offline, operated with batch feeders.

Wendt says the first machine will be 72 inches wide, though the company will offer smaller and larger models. After mentioning an initial list price of approximately $900,000 for the system, Wendt adds that "the pricing is fluid at the moment." He explains that "there's a tremendous amount of development cost, so the price is largely going to depend on the market for these machines."

ASSESSING THE PAYBACK

Three factors will determine the return on investment for meatball-removal systems such as the Innov-X-Steinert and Austin AI-TITECH equipment, Comtois says. The first factor is the cost and efficiency of the pickers. "In the U.S., I've heard numbers as low as $30,000 a year and as high as $50,000 a year" for a picker's annual salary and benefits, he says. "Then there's the reliability of the workers. If you have 10 pickers and one decides not to come in, you've lost 10 percent of your capacity in terms of your ability to pull copper. That's far more common than you might think." There's also the issue of efficiency. "You could line up a dozen hand pickers, and they couldn't do the job of the separator in terms of getting the copper out of the steel," Wendt says. Shredder operators that install these downstream separation systems "definitely will not need any hand-picking for copper from the steel," he says, though they still may need "a picker or two to pull out the scrap tires that might be in the mix."

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The second factor is the demand for—and potentially higher payment for—low-copper shredded scrap, Comtois says. "Some shredders have found that if they can prove or continue to deliver a low-copper shred, mills will pay a premium for their material," he says. "The shredder operator has to look at where his material is going to determine if the separator technology is worth the investment." If a shredding facility that produces 20,000 tons a month can earn even a $5-a-ton premium for low-copper shred, then "all of a sudden, $1 million for a system doesn't sound like so much." Comtois says he recently heard about a $30-a-ton premium for low-copper material. "If you have an outlet for low-copper shred at a premium, then this equipment is going to justify itself, just based on that fact, not to mention reducing the number of pickers by maybe 80 percent," he says.

The third factor in the ROI calculation is the value of the meatballs as a separate, saleable commodity from the shredded stream. Meatballs are worth more by weight than shredded steel, and the automated equipment recovers more of the material than manual sorters can, Comtois says. "Whether that increment is 0.05 or 0.10 percent per ton of shred, multiplied times the value of the copper, that is the incremental amount of asset we're creating for the shredder," he says.

When weighing the merits of the various separation equipment, shredder operators should focus on the "efficiency of extraction and the purity of the extract," Comtois says. The manufacturers should let you take the equipment for a test drive: "Take some of your shred, as good as you can get it, and send it to each manufacturer to see who gets what out," he advises. "Then go there and purposely dope in 50 or 100 pounds of meatballs and see how good the extraction is and how much ferrous is coming over with it." Those results, with price considerations, should lead to an objective comparison.

Though shredder operators have been dealing with the problem of meatballs in their ferrous streams for decades, these systems are breaking new ground in finding an automated solution. They might not make economic sense for all shredders, but a few will find it hard to resist the appeal of potentially higher income from their ferrous and recovered meatball streams and potentially lower labor costs. S

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