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Recovery Processes

Options and considerations for processing and removing metal chips.

▶ BY ALAN RICHTER, MANAGING EDITOR

Like sculptor Michelangelo, machinists envision the "work of art" contained within the workpiece and remove all extraneous material until the desired part appears.

The volume of metal that's removed from the workpiece, however, can be greater than that of the part itself, and these chips, or turnings, have value as a raw material. In addition, the chips are often covered with relatively expensive metalworking fluid. Therefore, collecting, processing and removing chips to exploit their resale or reuse value, as well as being able to recover and filter the cutting fluids, will add to your operation's bottom line. The main pieces of equipment used to accomplish these tasks are tub dumps and conveyors, chip shredders, parts separators, centrifuges, briquetters and filtration equipment.

Along the Conveyor

Removing chips from the machine tool starts the process. A shop could have someone manually transport chips to the processing system via a wheeled tub, or cart, or haul them using a forklift.

According to the paper titled "Metal Chip Processing," from Scotts, Mich.-based Chip Systems International Inc., under normal working conditions, multiple dumps occur at a shift change and fewer dumps take place during the shift. If collection systems are not designed for surges, there will be an increase in manual labor, decreased efficiency, system damage or complete failure.

A conveyor eliminates manual transport of chips to the processing system. For moving ferrous materials, magnetic chip conveyors can be effective and economical. A beltless magnetic conveyor is ideal for moving oil-laden and sharp materials, which can damage conventional conveyors with belts, said Michael Wilks, director of sales and marketing, Bunting Magnetics Co. The Newton, Kan., company manufactures MagSlide conveyors that use ceramic or rare earth (neodymium) magnets beneath a stainless steel slider bed to take chips from the machine. Wilks noted that the majority of the conveyors have ceramic magnets, which are effective for normal use. The neodymium magnets are more powerful, he said, but are also more sensitive to severe shocks and less tolerant of extreme temperatures.

Like other markets for labor-reducing equipment, Wilks said the magnetic-conveyor market is growing. "Anything to simplify chip removal is welcome," he said. "It's another automation process that reduces the manpower element. It takes a lot of time to manually clear chips, and it's a filthy environment to work in."

Prab

This chip-processing system, for steel chips and turnings, has a screw conveyor that feeds a two-roll shredder. The chips pass through a tramp-metal separator before loading into a diagonal-shaft chip wringer, or centrifuge. Cutting fluids are discharged into the drag-out settling tank, which automatically removes and recirculates fines to eliminate manual disposal.

Prab

Briquetters transform metal chips into dense pucks, such as these copper, brass, aluminum, and steel and cast iron ones, while recovering metalworking fluids.

A wide variety of chip-removal equipment is available, and there are many levels of automation. A conveyor can connect multiple machines to a central chip-processing system, or processing can be done at the machine with a single-platform unit that combines a conveyor and coolant separation and filtration. One such product is the ConSep 2000 II from Mayfran International, Cleveland. The device was designed to replace standard chip conveyors while occupying the same amount of space. Mayfran reports that the chip-removal/coolant-filtration unit separates 99 percent of fluid from chips and removes contaminants as small as 50µm. A pump-back station can be added for directing coolant to independent filtering stations for further filtration, to 10µm, if required.

Sometimes, machines need to be modified to make a conveyor system work properly. This was the case at Milan (Mich.) Screw Products. Chuck Tellas, company president and owner, said the shop cut holes in the bases of 24 machines to install two in-floor flumes, which replace the coolant sumps. A flume serves each row of 12 machines. He said a chip plow reciprocates back and forth hydraulically, in 4' to 5' strokes, to move the turnings into the conveyor, which is 1' lower than the flumes.

"The flumes also act as heat exchangers, so we don't get the wild fluctuations in coolant temperatures that we used to get," Tellas said. "The maximum coolant temperature we've seen when we ran two shifts in July was 101°."

The layout of the in-floor conveyor system is basically U-shaped. The letter's uprights represent plow conveyors and the base of the U represents a paddle-type, flight conveyor. "The paddle-type conveyor is set a little bit deeper than the plow-conveyor troughs, so the turnings can fall out of the end, down a bit, and be picked by the paddles," Tellas said. "The flight conveyor carries them across the floor and up an incline from which they spill into the chip-processing equipment."

Shredding Stringy Wads

If the machining process generates stringy chips or "bird nests," the chips need to be shredded to an acceptable size before they're fed into a centrifuge or briquetter. The main types of shredders are rotary shear, rip, hammermill and Wadbuster, states Chip Systems International (CSI). The rotary-shear shredder has two or three parallel sets of rotating shearing teeth. According to CSI, the high-torque shredder operates quietly at a low speed and has an opening before the shearing teeth to allow parts to fall out. Parts that do not fall through the parts-separator opening will damage the shearing teeth. In addition, if parts are missed, tramp metal passing through to a chip wringer or briquetter will damage equipment.

The rip shredder, or vertical-shaft crusher, shreds all types of chips, is easily cleaned and has a parts ejector. CSI states that the hammermill design is capable of producing very fine chips, but the high-horsepower shredder is costly to operate, has a high noise level and requires a special foundation.

Although CSI says the chips produced by its patented Wadbuster are not as fine as those from a hammermill, the Wadbuster requires no special foundation, operates quietly and has a low horsepower rating.

Spin or Squeeze

Regardless of whether they were shredded, once the chips are an acceptable size, they can proceed to a centrifuge or briquetter, if further processing is required. Both types of equipment remove coolant from chips, but a centrifuge merely wrings fluid from chips, while a briquetter extracts fluid from the chips as it compacts them into dense, puck- or cube-shaped solids.

Reclaiming swarf

As with oil-laden chips produced during a metalcutting operation, filtering the grinding oil to remove carbide and steel swarf allows an end user to recover metal and reuse the oil. One piece of equipment for accomplishing this task is the Series AFS-8-200 filtration system from International Tool Machines of (Palm Coast) Florida Inc. The system is designed to remove carbide chips and stringy chips associated with grinding HSS, said ITM's Ken Larson.

The system removes particles as small as 3µm, controls the oil temperature to ±1° F and delivers 53 gpm of clean oil at up to 800 psi. In addition, the sludge dryer removes 99 percent of the oil, generating a circular cake that can be reclaimed or disposed of. "Touch it and it turns to powder," Larson noted.

To condense the volume of the dried sludge, a compactor presses the sludge into pucks. This further reduces disposal costs.

Larson added that ITM will sell a dryer as a standalone unit. He said ITM built a special standalone sludge dryer for a major tool manufacturer that needed to dry sludge containing water-soluble fluid. Their existing central coolant system did not dry the sludge adequately, and disposal of the fluid-containing sludge was too expensive, Larson said. *For more information about ITM, call (386) 446-0500 or visit www.itmfl.com.*

—A. Richter

Bunting Magnetics

Beltless magnetic conveyors allow ferrous chips to travel along a steep incline and handle sharp, abrasive parts and scrap that can damage conveyors with belts.

A briquetter reclaims 90 to 95 percent of the metalcutting fluid, depending on the material being processed, and increases the scrap value, said E. Santiago, marketing manager for Amada Cutting Technologies Inc., La Mirada, Calif.

He said unprocessed nonferrous metal sells for about 75 cents/lb. compared to approximately $1.35/lb. for processed turnings. On the low end of the scale, processed carbon steel sells for only 1 cent/lb.

"If not compacted, a customer pays to have someone take contaminated carbon steel chips away," Santiago said. "With a compactor, a customer sells chips to the scrap dealers. The compactor is like a money saver, not a money maker." (He noted that ACT's CCP-100 chip compactor sells for about $55,000.)

Although briquetting reclaims fluid, those performing dry or near-dry machining can also benefit from compacting chips. Revere Copper Products Inc. is a case in point. The company's maintenance supervisor, Craig Romanowicz, said the New Bedford, Mass.-based company cleans its ingots to a 200- to 250-rms finish by dry milling them with a Toshiba 12"-dia. cutter tooled with Iscar coated inserts. Milling at a 0.010" to 0.012" chip load per tooth, 70 cu. in. of metal is removed each minute. The nonferrous chips are returned to Revere's captive foundry to be melted into additional ingots of brass, bronze, copper nickel and other copper alloys. Romanowicz explained that lightweight chips are put in first to form a cushion against impacts to the furnace's refractory lining before heavier pieces are added to begin the melting process.

Having chips for cushioning is good, but having too many posed a problem. The 1.4 million lbs. of chips Revere creates annually is far more than what is needed. "We made more chips than we could use and lost money [disposing of them]," Romanowicz said.

To turn the spiral-shaped chips into briquettes, without requiring any chip conditioning, Revere acquired a CCP-100 chip compactor from ACT. With its reduction-volume ratio of 5:1, the compactor allows more material to be added to the melting furnace's pot, Romanowicz said. "Now we enjoy better melting and an improved quality of ingots."

In addition, the company is saving about $3,000 each month from not having to dispose of the chips. "We paid for the machine in 1 year," he said.

The briquettes Revere sends to its furnace need to be 100 percent free of moisture, Romanowicz added, which isn't a problem since the ingots are machined dry. He explained that any liquid on chips can cause an explosion inside the furnace if the liquid contacts molten metal. "For safety reasons, we don't use fluids when milling," he said. "We don't even leave chips outside."

When shopping for equipment, Romanowicz emphasized that the briquetter is just one part of the total process. He also stressed the need to do your homework. "Present good size samples and look at the samples while the machine is being demonstrated," he said. "You also need to drop a puck from shoulder height. If it doesn't stay in one piece, you need more compaction force."

When the goal is just removing fluid and compacting pucks isn't necessary, a centrifuge is the equipment of choice. Although the percentage varies depending on the fluid type, Dean Dudley, president of CSI, said a centrifuge removes 98 percent of fluid by volume from brass and steel chips, for example. He estimated that briquetters remove only 90 percent. "You can't squeeze off as much as you can spin off," Dudley said. "It's like a washing machine; it has a spin cycle, not a squeeze cycle."

Milan's Tellas concurred: "We found a couple of problems with briquetting. We hoped that the physical pressure of forcing the turnings together would approach the dryness that we got from centrifugation. That was simply not true. There was much more retained oil."

Nonetheless, even the best centrifuge won't function effectively if it's improperly sized. Drawing upon his previous analogy, Dudley stated, "A wringer is like a washing machine. A machine designed for 12 lbs. of clothing can easily be loaded with 24 lbs., but it will not work efficiently, it will not be reliable and life expectancy will be poor."

The following manufacturers contributed to this article:

Amada Cutting Technologies Inc.
(800) 877-4729
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Bunting Magnetics Co.
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Mayfran International
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These companies also contributed:

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Revere Copper Products Inc.
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