

Magnetic separators bring benefits throughout pulping and papermaking processes and can be built to operate effectively on existing lines without relocating equipment

Magnetic Separators Offer Quality, Uptime and Labor Cost Benefits

By ERIC TAYLOR

For many years, electromagnetic and permanent-magnetic separators have been used to remove unwanted iron from both dry and liquid lines in pulp and paper and various other processing industries. As a result of knowledge gained through this extensive experience, particularly in the recycling of municipal refuse, the easiest fraction to remove is ferrous (magnetic) metals. Electromagnets require a power supply to operate the magnet. These magnets can be turned “off” to clean the magnet. Permanent magnets are always “on” and require no external power supply.

Unwanted iron occurs throughout the pulping and papermaking process. Examination of the sources of tramp iron indicates there is a probability of tramp iron being present in all material flow lines, including: (1) chips to pulp mill; (2) coal being fed to pulverizers in the power house; (3) additives such as starch, clay colored pigments, dry chemicals, etc., being fed or dumped into lines; and (4) chemical recovery plants.

Many sources have reported that the majority of iron comes

from accidental or intentional metal entry within the mill itself. A familiar and simple form of sabotage or accident is “throwing a monkey wrench” — or other hardened steel tool — into the flow line.

A Supplement to Conventional Cleaning

Technological advancements in magnets enable today’s manufacturers to build magnetic separators as strong as required for the application. When properly engineered and applied, these powerful separators can remove virtually any damaging iron that passes through their magnetic fields. For this reason, and because of the prevalence of ferrous metal and the damage it can do to refiners, pulpers, pumps, jordsans — and to board mill presses, platens and wood hogs — mills are installing more magnetic separators to supplement conventional cleaning equipment.

Type and style of magnet depends on the location within the process. Material size and burden depth require larger magnets. Suspended and pulley magnets are designed to

remove larger tramp iron such as hand tools, scrap iron, etc. Drums, plates and traps are designed to remove smaller material such as nails, wire and hex nuts from smaller material within a process. Rare earth magnets are designed to remove fine metal such as iron flakes, bits of wire and iron chips. The development of rare earth magnetic circuits allowed processors to provide an even cleaner product by removing weakly magnetic particles.

Paper mill consultants and designers now recognize the many advantages of incorporating magnetic protection in the initial design, especially in situations where qualified and capable maintenance and repair personnel are in short

A manual clean suspended electromagnet installed over a conveyor belt in a lumber plant



supply. However, magnetic separators can typically be built to operate effectively on existing lines, without the necessity of relocating major equipment. Retrofitting may require engineering services and outside contracting services to determine what steps are required to install a magnet and if the benefits of the magnet outweigh the cost. Companies must decide if they have the time and experience for this type of project.

The essence and application of magnetic separation equipment can be broken down into three major categories of wood products users: (1) paper mills; (2) secondary fiber mills; (3) particleboard, hardboard, plywood, insulating board and roofing-felt mills.

In each of these operations, it is tremendously beneficial to remove damaging tramp iron as early on in the process as possible, followed by additional magnetic protection in front of at-risk equipment (on an as-needed basis).

Steel armor-piercing bullets are a type of unwanted iron found early in the process that can be particularly troublesome for mills. These are frequently found in trees near military installations. Steel bullets are also commonplace in areas used for hunting of deer or bear. These bullets become embedded and hidden in the wood and often are not freed in the chipping process. In some instances, magnets eradicate the embedded bullet along with the chip concealing it. However, electronic metal detectors are more regularly used to detect the presence of embedded metal in logs ahead of the chipper.

Common Magnetic Workhorses

In the initial processes of paper mills, suspended magnets or magnetic head pulleys are frequently utilized in conjunction with belt conveyers to move chips or coal. A magnetic drum on the discharge of hoppers is another typical method for automatically eliminating tramp iron from woodchip and coal lines. A magnetic head pulley is an inexpensive way to create a magnetic separator using an existing belt conveyor. Drum magnets are typically used to separate tramp iron from smaller particle sizes in a dry material flow. Installation may require repositioning or removal of existing equipment to make room for different types of magnetic separators. Suspended magnets need a support structure to “hang” the magnet above a belt conveyor or material flow.

Powerful electromagnets requiring rectifiers are often used on suspended applications. A rectifier changes alternating current (AC) to direct current (DC). Typically, electromagnetic devices require DC voltage to create a magnetic field. Nevertheless, in pulleys and drums, permanent magnetic-powered elements provide effective, economical removal of ferrous contaminants.

Purchased Chip Quality Issues

The growing trend toward purchased chips, which hold a greater chance of being contaminated, means more chip conveying, screening and cleaning is needed in advance of digesters and chip-refining systems. Suspended magnets and magnetic pulleys are used to remove tramp iron from an “open” material flow introducing chips to the process via conveyor or chute. Traps are used to remove tramp iron from a “closed” system such as piping.

Even though most fine paper mills use Type 304 and 316 stainless steel (which is non-magnetic) in liquid lines, magnetic traps and grate separators are used ahead of the digester in many cases. The liquid traps (commonly called T-traps) are made up of a series of magnetic tubes through which the slurry must pass. Besides magnetically removing tramp iron and nonmagnetic heavies such as stainless steel and stones by gravity, these units also collect minute particles of black ferrous materials and oxides that could affect paper brightness, an increasingly important characteristic in today’s markets.

Waste Paper and Bagasse Problems

In secondary fiber mills where most equipment is carbon steel, absolute cleanliness is practically impossible to attain. Consequently, these mills have more tramp iron. Complicating the situation further, wastepaper is often loaded with stones, dirt, rags, string and metal. Additionally, bales and batts use steel strapping and tie buckles that are problematic to entirely remove prior to the pulper.

Large tramp iron must be prevented from entering the “closed” system. This is accomplished effectively and easily using suspended magnets and head pulleys on conveyors feeding material into pulpers. Equipment damage and excessive downtime can be drastically reduced by removing these contaminants before material enters a “closed system.. Magnetic traps should be inspected often, which requires a material flow stoppage.

Bagasse, the fibrous residue remaining after the extraction of juice from the crushed stalks of sugar cane, is used as a source of cellulose for some paper products. Mills using bagasse face their own unique problems. While many sugar mills use magnetic separators before the rolls that squeeze juice from cane, a substantial quantity of small tramp iron remains. The open mill tandems shed ferrous parts. It is extremely challenging to keep bagasse free of trash when in open storage ahead of baling.

In some cases, bagasse mill operators can persuade sugar mill management to magnetically clean the bagasse, which is also used for heating fuel and cattle feed. If not cleaned, unwanted iron can damage boiler feed equipment.

Pulpers and Refiners

In most instances, pulpers maintain a trap for heavy trash that is cleaned by hand. In some scenarios, a rope cleaner that mechanically fishes out debris from the agitated pulp is used. It should be noted that neither one nor the other of these methods is 100% effective.

Furthermore, the pulper frees thousands of staples and paper clips. Needless to say, it is desirable to remove large and small tramp iron before it reaches the close-clearance suction pump that draws the slurry from the pulper. A self-cleaning magnetic drum following a weir in the pulper can sometimes be used to remove medium and small iron as well as reduce pump damage. Nevertheless, some clips and staples still get through the unit. A drum magnet consists of a rotating outer shell turning around a fixed magnetic element. This magnetic element covers about half of the circumference of the drum face. Tramp iron is attracted to the outer shell and pulled through the magnetic field. Clean, non-magnetic material continues through the system and tramp iron is discharged from the material flow to a predetermined collection point. Ferrous nuts, bolts, nails and such are easily removed.

A manual clean suspended electromagnet installed at the discharge of a conveyor belt at a company making medium density fiberboard (MDF)



Stock preparation machines (refiners, jordans, or Clarlins) run at such close settings that a paper clip or staple can wreak havoc with refiner plates or bars. Most secondary fiber mills have discovered through experience that placing a magnetic T-trap ahead of the pressurized refiners or jordans is a very useful practice. The carefully designed T-traps have strong magnetic fields emanating from a number of 1-in-dia tubes that are strategically positioned in a way that causes even small wire staples to bump into them. With this arrangement, these elements are trapped while the clean pulp flows on.

Other pieces of magnetic separation equipment regularly

used in both paper mills and secondary fiber mills include: plate magnets on the discharge end of chip screens; magnetic humps on pneumatic conveying lines handling chips, lap pulp, clay, starch and paper trimmings; and grate magnets to clean bag or bulk colored pigments going into the system. Magnetic grates have been built especially for open slurry flow lines of white and black liquor.

Plate magnets can be suspended but typically are installed in chutes where material flows over the magnet face. Hump magnets are plate magnets in a manufactured housing or "hump" and take advantage of gravity and direction change to remove tramp iron. Material travels through a chute with an approximate 45° bend. Material hits one plate magnet and then passes through the bend where it hits another plate. Tramp iron is removed at each impact point. Grate magnets are designed for small free flowing material to pass through a series of tube magnets typically spaced on 2-in centers. Material hits the tube magnets and tramp iron is attracted to the tube magnet. Clean non-magnetic material passes through the tubes. Frequent inspection is necessary to prevent the tramp iron from blocking material flow.

Value of Magnetic Protection

How can mill operators justify an investment in magnetic protection? First, one should estimate yearly savings on removing unwanted metal in the following areas:

- Reduction of equipment maintenance and repair
- Reduction in downtime and production loss
- Reduction in paper rejects due to black specks
- Reduction in labor costs attendant with all of the above
- Improvement in brightness factor.

Cost to retrofit depends on the scope of work required. This could be as simple as cutting out a section of chute to install a plate magnet. Suspended magnets require support structures and equipment to lift and position the magnet. Large trap magnets require plumbing modifications and pipe fitting for installation.

Ideally, management personnel will authorize a complete mill survey by an experienced magnet separation specialist. With the help of operating and maintenance supervisors, answers to factors involved in engineering magnetic separator installation can be determined along with practical points of installation.

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