

Conveying Quality

Equipment Spotlight: Conveyor Systems for Roasters

by Karl Seidel

Transforming raw, green coffee beans into a tantalizing, aromatic light cinnamon roast, or a fragrant, robust dark roast is the art and science of coffee roasting. To achieve the desired flavor and blend, coffee roasters use a combination of skill and technology.

Combining learned roasting skills with the ever-evolving technology of roasting equipment is part of the challenge of refining roasting processing skills to make your operation as efficient as possible.

continued on page 54 ►



At the Apffels roasting plant, conveyors move roasted beans to grinders. | photo courtesy of Cablevey



Conveyors connect to hoppers, silos, roasters and grinders at the Apffels plant.
photo courtesy of Cablevey

Smaller roasters, frequently using 12-kilo machines, must lift green beans overhead to charge their roaster hoppers. Often the next equipment addition is a weigh-and-fill machine where the hopper is overhead. Compared with an operation using a four-bag roaster, the considerations of the smaller roaster are dwarfed by comparison in terms of time and cost to process. A larger roasting company simply can't afford to be inefficient. When planning for growth, roasting businesses need to anticipate a growth trajectory from small roaster to a larger operation. Although a bigger roaster may hire a consulting firm to make these decisions, there is almost certainly a list of considerations for the roaster, big or small, about how the coffee will move through the plant and what degree of bean breakage is acceptable. Assumptions typically are concerned with scale, cost and Good Manufacturing Practices (GMP) in the decision-making process.

Thinking About Adding a Conveyor? Elements to Consider

Just as there are trade-offs and considerations between drum roasting versus air roasting processes, there are similar considerations between bucket conveying and air conveying.

The variety of equipment for conveying coffee has evolved from augers to buckets to air and drag systems. The reasons for this

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evolution are typical. Cost considerations come first, and then through improved knowledge, up-front cost becomes a lesser factor. In transporting specialty coffee beans, environment control and process efficiency command the attention of the roaster needing to convey beans with less damage.

Less damage equals control. Controlling roasting processes, in any endeavor, is a key factor in growing a business. A roaster cannot grow well if the business does not have a firsthand understanding of its processes and how to improve them. A conveyor purchase occurs when efficiency and control trump all other considerations.

“Certainly there are economic issues for roasters to consider, such as ... does this equipment offer a financial return that justifies the investment?,” says Vinny Tagliaferro, plant manager, coffee operations at Melitta USA. “But there are other elements that should be considered too—such as food safety, personnel safety, quality and flexibility. These are equally important when evaluating new equipment. In the end, our business is based on delivering our customers a consistent great cup of coffee—produced in a facility that is safe for our employees—while offering our stakeholders a fair return on their investment.”

The logistics of conveying begins with the recognition of the limitations of hand-conveying beans from point to point. Is this



Vertical conveyors move coffee to the roaster at Apffels.
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continued on page 56 ►



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Blender and roaster. | photo courtesy of Cablevey



The blend wall. | photo courtesy of Cablevey



As a business expands, conveyors improve efficiency. | photo courtesy of Cablevey

process the most efficient use of personnel or is there a better way to move roasted beans from the roaster to the de-gassing silo? In smaller operations the silos may be easily accessible by walking up a short flight of stairs. As the operation and roast capacity grows, it may be better served by conveying equipment—especially if the silo inlet is now 10 to 30 feet tall.

“Making the switch from manual to automated conveying is dependent on the size of the roaster,” says Paul Massard, green coffee buyer at The Roasterie Air-Roasted Coffee in Kansas City, Mo. “As the business grows, it becomes harder and harder to move the product to the roaster, and through other process steps.”

Gaining efficiency speaks to the cost of labor, but it also is a matter of safety. As a roasting operation grows, so does its forklift pathways. If your staff is operating in these same pathways there is greater risk of injury.

“Safety is also an issue,” continues Massard. “Once you get past a couple dozen roasts per day, then it really gets taxing on the roaster operator. Manually, the roaster will most likely have to go get the coffee, walk it upstairs and dump it into the roaster. If the employee is doing that much physical labor, moving that coffee, it is going to increase his chances of becoming hurt.”

Despite using the best processing equipment to roast and package the coffee, if the material handling systems being used for moving the coffee beans into and out of the equipment is inefficient, then the quality of the coffee and the throughput volume will be compromised. For example, some conveying systems may contribute to bean breakage more than others. Cost is a factor here—some roasters, upgrading from a manual operation, may initially implement a less efficient conveyor system, or one that has a higher level of bean breakage, simply because the entry cost is more affordable. Speed can also be a factor. Some high-velocity conveyor systems can move whole beans rapidly but also may contribute to a high incidence of bean breakage in the process. In this way, coffee roasters may be using

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conveying equipment that is not ideally suited to the needs of their coffee roasting and packaging applications.

Challenges of Conveying Coffee

Coffee roasters are beset with several critical conveying challenges. One of the most important is ensuring that the finished coffee product, once it has gone through its various roasting process steps, emerges undamaged before its final packaging. Keeping the beans whole can be a challenge. The idea is to get the beans through the roasting process and into the packaging as gently as possible to avoid product breakage.

Coffee roasters know that how their product is conveyed during the entire roasting process plays an important role in ensuring minimum waste as raw goods are transformed into finished coffee products ready for packaging.

Conveying equipment is designed to optimize the movement of roasted beans, and to maintain the optimal grind level that is determined appropriate for roasters' customers.

This optimization is as good as a roaster's decision-making process. In other words, a roaster's relationship with its customers, and their communication about their needs, will impact that roaster's decisions.

"When selecting a conveyor, roasters should look at how the coffee is being treated by that conveying system," explains Massard. "You do not want anything that is going to break the coffee beans or physically harm the coffee. It should be a gentle conveying system. Depending on the type of coffee being used, sometimes the conveyor system has to be cleaned for dust to minimize contamination, or even a fire."

A roasting company does not want a random breakage rate of its whole bean or decaf coffee. But until testing is done, the roaster will not know for sure what percentage of breakage it currently has.

This is where the challenge lies—testing a roaster's processes to determine which conveying machines work best for its environment.

continued on page 58 ►



Inner workings of a conveyor at Apffels. | photo courtesy of Cablevey



First station and steps at Apffels. | photo courtesy of Cablevey



A curve pipe at Apffels. | photo courtesy of Cablevey

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To make an informed decision, the roaster needs to determine relevant criteria. Is 10 percent breakage acceptable? What does this breakage equal in dollars? A roaster conveying 3 million pounds annually with 10 percent breakage would have 300,000 pounds of broken beans. Does breakage, for that roaster, mean waste, or is the broken whole bean reclaimed and ground to specification for coffee offered as “ground”? Are a roaster’s

internal processes defined well enough to reclaim broken material? Determining where each roaster stands on this spectrum is an important step toward understanding what conveying equipment will serve best.

“Our entire coffee processing area was modernized in the fourth quarter of 2010,” explains Tagliaferro of Melitta. “Factors critical to us in the selection of conveyors were: a) protecting the quality of the coffee—

minimizing breakage for roasted whole bean products; b) food safety and organic production requirements—self-cleaning and leaving little residual coffee in the conveying system, for faster changeovers and minimized flush-out requirements for blend changes; c) personal safety—obviously all conveyor systems have to have proper safety devices; and d) ease of maintenance—easy access to areas requiring preventive maintenance.”

Product contamination is another key issue influencing conveying in coffee roasting. In every step of the process, from receipt of raw beans through packaging, precluding any foreign matter from entering the process stream is a critical objective.

The importance of the product contamination issue is magnified with increasingly stringent governmental and industry mandates, and consumer demands for maintaining product integrity and safety. City, state, national and international standards for cleanliness, dust-explosion prevention and GMP vary widely. Roasting standards should align, at a minimum, with a roaster’s local laws and guidelines.

As the coffee industry has grown, roasters have sought greater control over their processes. But age-old considerations about costs, internal decisions and external regulations open up more questions than answers.

For example, with smaller roasters, GMP issues may not come to the surface until the operation is large enough to be noticed and regulated by external agencies. In other words, do a roaster’s internal standards reflect what is required by its local agencies now? Is the roaster working toward an improved standard or simply waiting to be cited?

Line changeovers in coffee roasting are also a factor influencing both cleanliness and speed. Roasting companies run different product lines within a shift or day. Despite these changeovers, processing plants are expected to maintain stringent levels of sanitary operation. This can be a time-consuming challenge when cleaning conveying systems. Every minute spent disassembling a conveyor system for cleaning consumes valuable

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production time. Yet, if they are not cleaned properly, that batch of coffee that needs to be discarded in-process because of contamination is lost profit. Or worse, consumers could be negatively impacted, resulting in potential injury, costly recalls and reduced brand reputation. To resolve these issues, coffee roasters are charged with administering changeovers as quickly as possible while maintaining 100 percent system cleanliness.

“We are committed to being the best, and part of that commitment is our ongoing re-investment in our people, plant and equipment,” says Tagliaferro. “In the end, you have to walk the talk. Everyone talks about quality, but you have to be willing to back that up with positive action.”

For decades, open conveyors, such as flat-belt conveyors and bucket elevators, have been the predominant systems used by coffee roasters to transport coffee beans through the roasting process to packaging. But, because of the limitations of these open conveying systems, coffee roasters have gradually incorporated other conveyor types. Like the open conveyors, they each have design strengths and weaknesses. Following is an assessment of the major types of systems employed in coffee roasting:

Flat-Belt Conveyors

Although this type of conveyor can handle coffee beans gently, the product is exposed to ambient contamination, unless covered. The cover, however, collects coffee residue and must be removed and cleaned between runs to reduce the risk of cross-contamination. The beans, when introduced onto the conveyor, are dropped from a machine during the roasting process, which produces dust and at that point may cause product damage.

Bucket Elevators

Bucket elevators use a continuous line of buckets, either attached to each other on a rubber belt, or attached by pins to two endless chains running over tracks

and driven by sprockets. Centrifugal force tosses the coffee beans out of the buckets into a discharge spout as the buckets pass. This type of conveyor can transport fragile materials with minimized product damage. But the system can be dusty, as dust is generated when beans are loaded into the buckets and while the product is being conveyed, resulting in residue buildup, which can cause cross-contamination. The

dust produced can also open the door for dust explosions.

Pneumatic Conveyors

These systems use air to move coffee beans through the roasting process, by generating air pressure levels that are either above or

continued on page 60 ▶

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below the atmospheric pressure. There are two main types of pneumatic conveyors: the dilute phase conveyor and the dense phase conveyor, which differ by rate of speed and pressure. Both of these systems can be set up as a pressure or vacuum system. Pneumatic conveyors enable flexibility, allowing them to reach many multiple destinations with one system. They are also able to convey beans at very high rates. Dust is accumulated in filters. Depending on sweeps and discharges, roasted whole beans may endure breakage. One of the main considerations with this type of conveyor is its high power consumption. Pneumatic conveying is the most expensive method for moving coffee beans.

Auger Conveyors

Known as flexible screw conveyors, they can transport coffee beans vertically, horizontally and at any angle. They consist of a stainless-steel flexible screw enclosed in a rigid steel tube or flexible plastic tube driven by a motor. The enclosed tube rotates around a central shaft, transporting the coffee beans according to



Packing bins at Apffels. Each conveying system has strengths in moving green versus ground versus whole-bean coffee. | photo courtesy of Cablevey

the screw design and rotational direction. When the beans reach the end of the tube, they are discharged into the next machine in the roasting process, such as a grinder, or container for packaging. These conveyors have a throughput of up to 100,000 pounds per hour. Auger conveyors, however, have limitations on how much product they can transport before effecting product breakage, which can be significant. Also, internal cleanliness can be an issue resulting in a cross-contamination risk, with the need to disassemble the unit on a regular basis for cleaning. However, roasters may determine that the cost of cleaning may be well worth the additional capacity.

Aeromechanical Conveyors

A completely enclosed, high-capacity mechanical conveyor that can move coffee beans vertically and at varying angles. Within a stainless-steel tube, a wire rope with evenly spaced discs travels



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at high speeds, running in sprockets at each end of the conveyor. The high-speed action generates an internal air stream traveling at the same high velocity as the discs. As the coffee beans are fed in, the air stream aerates, or fluidizes them, and carries them to the packaging outlet, where they are discharged by centrifugal force. The system can move up to 80,000 pounds of beans per hour. A drawback to this system is that the flow of product can easily become inhibited, causing the conveyor to run without transporting beans at expected throughput volumes. Downtime is also a factor because the tension on the wire rope needs to be adjusted at regular intervals.

Tubular Drag Chain Conveyors

Tubular drag chain conveyors gently move coffee beans through a sealed tube with a drag chain pulled through it on a loop. Solid circular discs (flights) are attached to the chain, which push the beans through the tube. This system can move up to 45,000 pounds per hour of coffee beans. The chain needs to be regularly



Bean storage at Apffels. | photo courtesy of Cablevey

removed for cleaning, and the chain-drive components need to be regularly adjusted to keep the system in registration, which increases downtime.

Tubular Drag Cable Conveyors

Tubular drag cable conveyors gently move coffee beans through a sealed tube, but instead using a coated, flexible stainless-steel drag cable pulled through on a loop. Solid circular discs (flights) are attached to the cable, which push the beans through the tube. Tubular drag cable conveyors can transport up to 49,000 pounds of coffee beans per hour, at low speed. The flexible design of the enclosed system keeps contamination out. The system must be cleaned, but it can be cleaned in place at multiple points to remove coffee buildup. Cables need to be replaced after about 1 million flexes; if a cable stretches and breaks, it can cause further

continued on page 62 ►

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potential damage. Businesses may want to invest in a backup cable to lessen potential downtime.

There are often debates about chain versus cable conveyors that call into question which conveyor is best suited for green or whole-bean coffee conveying with the least bean breakage.



Conveyors can move thousands of pounds of coffee in minutes.
photo courtesy of Cablevey

Traditional conveying systems have minimally kept pace with the challenging requirements for high quality demands that coffee roasters now strive toward. Additionally, high-volume roasters continually push for more cost efficiency and higher throughput in their processing lines, which are also driving the need for system upgrades and greater process control in coffee processing worldwide.

Conveying systems that were installed in coffee roasting facilities 10 to 15 years ago may have been adequate at that time, but now better technology in conveying system design, controls and automation has brought into place a whole new generation of conveyors for use in the coffee industry, with vastly improved efficiency. Safer, cleaner processes that reduce waste and deliver cost, labor and energy savings are increasingly being factored into equipment selection. Such conveying systems are having a critical impact on coffee roasters' operational costs and plant ROI.



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