KEY TECHNOLOGY
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White Paper

Comparing Optical and Non-Optical Sorters for Potato Processing

Sorters, which include both optical (digital sorters) and non-optical (mechanical sorters), are found throughout potato processing plants. At some points on the production line, either optical or non-optical systems can be used, and the processor should consider his objectives to select the best solution for his application. At other points along the line, there is clearly a superior choice. And in some cases, optical and non-optical sorters are best used in combination with one feeding the other.

This white paper will cover optical and non-optical sorting technologies, highlighting the strengths and the ideal potato processing applications for each, from receiving whole potatoes to packaging finished goods at both potato strip and potato chip/crisp facilities.

Clarifying the Terminology

Optical sorters are increasingly being called 'digital sorters' to reflect the fact that advanced systems can detect product attributes, including some that are invisible to the human eye and thus challenge this limited concept of 'optical.' Like other digital technologies, these sorters rely on computerized devices to perform.

Presently, digital sorters feature cameras, lasers and hyperspectral imaging systems that operate in a wide range of wavelengths within the visible light spectrum as well as invisible infrared (IR) and ultraviolet (UV). Depending on their sensors, lighting systems, software and algorithms, sorters can recognize each object's color, size, shape, structural properties and chemical composition to detect and remove non-conforming products and foreign material (FM) from the product stream and separate product by grade.

Non-optical sorters include a wide range of mechanical equipment such as rotary sizing and grading systems and multi-deck shakers. Unlike digital sorters, these systems rely primarily on mechanics instead of computerized devices to perform various operations such as separating product by length or diameter or removing fines or FM that is either heavier or of a different size than good product.

The Pros and Cons

A digital sorter can achieve the most thorough FM removal and offers the ability to sort for the widest range of product characteristics simultaneously, among many other benefits. The biggest downside to a digital sorter, compared to non-optical alternatives, is the initial cost of the equipment, although improved product quality, increased yields and reduced operating costs often generate a rapid payback.

The question then becomes, where on the production line are select operations effectively performed with mechanical, non-optical sorters? And where do digital sorters add the most value?

Potato Strip Processing

At receiving, the objective is to remove dirt, rocks, golf balls and other undesirable materials, either before or after the whole potatoes are washed. With a throughput of up to 36 metric tons, a mechanical length sizer removes field debris while simultaneously grading whole potatoes by length so small potatoes are sorted out to reduce the production of strips that are too short. A digital sorter could also accomplish these goals while removing a wider range of FM, but it would significantly restrict throughput and the added value of the optical solution may not justify the added cost of the equipment at this point on the production line.

After peeling, a digital sorter adds significant value. It can be designed to reject potatoes with remaining peel, which are redirected back to the peeler for rework. At the same time, data from this sorter can provide feedback to operators to adjust the peeler, or the sorter can be connected to automatically control the peeler in real time. By fine-tuning the peeling operation, the digital sorter helps meet product specifications while reducing the yield loss that comes from over-peeling and the production inefficiencies that result from reworking under-peeled potatoes.

Comparing Optical and Non-Optical Sorters for Potato Processing

A whole potato digital sorter equipped with multi-chromatic cameras is the best solution for use after the peeler. If the sorter features three-way sorting, it can pass good potatoes through while dedicating one reject stream to rework and another reject stream to potatoes with rot, green defects and FM. This sorter can also sort too-long potatoes that can be redirected to a Potato Halver. If the whole potato sorter features a hyperspectral sensor, it can detect and remove potatoes with invisible 'sugar end' defects and measure solid content while simultaneously ejecting FM, remaining peel and other defects.

Non-optical sorters cannot detect peel, 'sugar ends' or solid content, but they are used after peeling, prior to the cutter, often in addition to a digital sorter. Because digital sorters cannot accurately measure diameter, a mechanical diameter sizer is used to remove whole potatoes that are too large to feed the hydro-cutters. If a digital sorter is not grading whole potatoes by length, an upright length sizer can also be used to redirect over-length potatoes to a potato halver to prevent processing strips that are too long.

After cutting whole potatoes into strips, non-optical sorters are often used to remove slivers and small diameter cuts. With its high efficiency, high throughput and affordable cost, a rotary sizing and grading system, such as a sliver sizer remover or precision size grader, is usually the preferred technology at this point on the production line. Compared to drum-style graders, rotary sizing and grading systems offer gentle handling, easy adjustability, simplified maintenance and improved sanitation.

Prior to blanching, drying, frying and freezing, most potato strip processors rely on a digital strip sorter equipped with multi-chromatic cameras and/or an Automatic Defect Removal (ADR) system to remove surface defects on the cut strips. The objective is to remove all non-conforming strips at this point in the line, before investing in the energy-consuming processes that follow. If the ADR features a hyperspectral sensor in addition to cameras, it can detect and cut invisible 'sugar ends' from the strips, along with other visible surface defects, to recover the good product and increase yield.

While this digital sorter could also be programmed to remove slivers and small diameter strips, it is more efficient to combine a rotary sizing and grading system or a multi-deck shaker upstream of the digital sorter and/or ADR. By removing slivers and smalls with a mechanical system prior to the optical system, the digital sorter and/or ADR can focus on FM and/or defects, which improves the accuracy of the operation to enhance product quality, maximize yields and minimize compressed air consumption.

After an ADR, a mechanical sorter removes nubbins that result from the ADR cutting process. This nubbin removal can be achieved with a rotary sizing and grading system or a multi-deck shaker.

After blanching or frying, again some processors often want to remove too-short strips, which they divert to co-product, and too-long strips, which they divert to the ADR to be cut. Here, depending on the number of decks, a multi-deck shaker could remove only too-short strips or both too-short and too-long strips. Some processors use shakers with up to five-decks to separate strips of multiple sizes, which are later combined in the right proportions to achieve product specifications.

The last opportunity to correct product quality problems is after freezing, immediately prior to packaging. If the processor is confident that all FM and product defects have been removed with the digital sorter prior to blanching and no quality problems have been created after that point, then a multi-deck shaker may be sufficient, removing too-shorts, too-longs and possibly separating strips of other sizes to be combined in the right proportions.

Most processors, however require a more robust final quality check using digital sorters equipped with a combination of cameras-and-laser scanners immediately prior to packaging. In addition to removing FM and defects, those digital sorters can be equipped with three-way sorting, sort-to-grade and strip-length-control functionalities to automatically ensure maximum process yield.

Sort-to-grade (STG) targets all FM and critical defects for removal, but minor defects are considered differently, with accept/reject decisions based on how potentially passing each defect will affect the overall final product quality, as defined by the user. The STG-equipped sorter will allow some minor defects to pass and still maintain grade. It ensures product quality while reducing operator intervention throughout the day and increasing yields by one to three percent.

Like STG, strip-length-control is a dynamic tool that analyzes data in real-time and enables the sorter to make intelligent decisions. It removes enough short strips to make grade while passing enough short strips to maximize yields.

Potato Chip/Crisp Processing

Potato chip/crisp manufacturers sometimes use mechanical sorters to size grade whole potatoes, thinking there is an opportunity to make the cutter more efficient by feeding potatoes of a consistent size.

After frying, almost every potato chip manufacturer relies on a multi-deck shaker to remove fines, followed by a digital sorter to remove FM and defects prior to packaging. Lines producing continuous-fried chips are often satisfied with camera-based digital sorters that identify and remove defects such as green, bruises and overcooked black spots. If FM removal is a high priority, a camera/laser combination sorter is preferred because lasers are better than cameras at detecting FM. For lines producing batch-fried kettle-style chips, a camera/laser sorter equipped with application-specific software and algorithms is ideal because the lasers achieve better detection of several common batch-fried defects such as clumps of chips and doubles stuck together, oil soaked chips and blistered chips.

Conclusion

When selecting the ideal sorting technology to meet the specific needs of each application, it's helpful to understand the strengths and weaknesses of both optical and non-optical alternatives. Whether the perfect solution is ultimately found with a digital sorter or a mechanical grading system or a combination of the two, working with a supplier that has a deep understanding of both technologies allows for a thorough analysis. Bringing the art and science of digital sorting and mechanical grading together with a deep processing knowledge and application expertise delivers the most added value.

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