

The Proposition of Using Dimpled Surface Vibratory Conveyors in Confectionery Industries for Product Movement

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ABSTRACT

The confectionery business in the overall food and beverage sector has been gaining popularity and growing at an exponential rate, with many new companies entering the market to embrace the untapped market and supply customers with higher quality products like gum, chocolate, chilling plates, candy, gummy candy, enrobers, etc. One of the significant challenges faced by all the companies in this sector is to manage the movement of the product, whether bulk or packaged, from one part of the production line to the other effectively and efficiently. Various companies traditionally rely on conveying systems procured from Original Equipment Manufacturers (OEM) or designing them in-house to fulfill this requirement. The capital investment in these conveying systems was kept to a minimum in the past as they were not considered critical to day-to-day operations. However, there has been a shift in the business strategy, and nowadays, companies do extensive research and allocate significant capital to deploy an effective and efficient conveying system to support their production. In this theoretical study, we explore different available conveying technologies used in confectionery companies and their challenges in day-to-day operations. We also review a new and upcoming technology of using a vibratory conveying system with a dimpled surface texture of the conveyor itself to support gentle handling of the product and how it is advantageous over the traditional conveying system. This study aims to aid confectionery companies in identifying and selecting the most effective and efficient conveying solution for their production lines to move products within the facility.

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Introduction

Conveyors in the food confectionery industry are critical in connecting one part of the production line to another. The companies in this sector strive to motivate and challenge their employees to improve productivity by increasing Overall Equipment Efficiency (OEE) while maintaining the highest standards for safety and sanitary requirements to keep the people and product safe to deliver a quality product to the consumer. At the same time, the companies aim to meet the regulatory standards set by the country's government in which they are located regarding the direct handling of food products. To achieve all the above targets, companies must explore and research the evolving domain of the ever-growing technological advancement of conveying solutions offered by various OEMs. The conveying system has become vital equipment, especially in food and beverages. Previously, less attention was given to choosing a correct conveying system to satisfy the company's needs while creating correct maintenance strategies to reduce failures and improve machine reliability. The trend has changed drastically as companies focus more on selecting the right conveying solution for their business needs. The trend of giving less attention while performing maintenance and repair activities has also evolved. Any failure could lead to catastrophic loss in production if requirements are not maintained regularly. Since most of the conveying system acts as a connecting link between two different nodes in a production line, it becomes

susceptible and critical to the overall operation as it restricts the company from providing an alternate option to connect various production units in case of failures to the existing conveyors. Any company in the food and beverage sector is also challenged to maintain equipment hygiene as the conveyors are in direct contact with the product. Any contamination, whether metal contamination, product spillage, or smearing, can lead to extended downtime to get them cleaned and sanitized before being cleared for production. This eventually leads to operational loss and affects overall OEE. Therefore, deploying simple and effective conveying solutions is critical to improving operational efficiency while maintaining quality standards.

Types of Conveying Solutions

Based on the type of product being manufactured in different confectionery companies, the conveying system is selected to support the production lines. The conveyors are built with materials that comply with food safety and hygiene regulations, reducing the risk of contamination. Table 1 shows some of each conveying solution's significant pros and cons. Each conveyor option offers solutions to specific needs, providing smooth and safe product transfer movement. Conveyor solutions are pivotal to the movement of products in the food industry. These help the food confectionery industry make correct decisions when selecting a conveying solution for their product transfer. The various types of conveying options that have been widely used in food confectionery companies are mentioned below

• Pneumatic Conveyor

Pneumatic conveyors use compressed air to move materials along the conveyor line. They often move powders and granular materials like sugar, flour, and cement. Pneumatic conveyors are commonly used in the food processing industry to transport ingredients from one location to another. The movement is assisted by creating a pressure difference between two points.

• Belt Conveyor

Belt Conveyors are used for material handling systems that use continuous belts to move products or materials. The belt is installed as an endless loop between two end pulleys and is usually supported through a combination of drive and idler rollers underneath. Belt conveyors are typically powered and can be easily managed by varying speed to match the line speed. These conveyors can be operated horizontally or can be inclined as well. Belt conveyors can be troughed for bulk or oversized materials.

• Bucket Elevator Conveyor

The bucket elevator conveyors consist of buckets that ride a chain, cables, or belts to carry products from one point to another. They are mainly used when movement is required in a vertical or inclined plane. They are used in parts, bulk material, or food processing and handling applications. This system can be used for varying load capacity. The buckets used for this kind of system are metal-detectable to quickly detect any metal contamination when pieces of buckets get damaged during operation and mixed with the product.

• Screw Auger Conveyor

A screw in an open trough, whereby rotation of the screw causes product or material to slip down the front face and move forward through a discharge port towards the next point. They consist of a helical blade mounted in a tube or trough. Rotating the blade allows liquid and semi-solid material to travel up the blade. A vital benefit of the auger conveyor is its ease of controlling the material flow.

• Metal Belt Conveyor

The wire mesh conveyors use a mesh belt made of stainless steel or other materials to move products along the conveyor line. They are often employed in confectionery industries that transfer solid or semi-solid products from one part of production to another. They are durable, can withstand harsh washdown applications, and have less resistance to the product.

Table 1: Pros and Cons of Different Conveying Options

Conveyor Types	Pros	Cons
Pneumatic Conveyor	Able to handle the transport of products over long distances in a production line.	Not suitable for delicate products in confectionery industries like candy, gum, chocolates, etc.
	Assist in the movement of products in both horizontal and vertical directions.	Adds to a noisy environment.
	Easy to clean and maintain hygiene.	It needs a constant supply of air at a certain pressure to function.
Belt Conveyor	Adaptable for conveying multiple material-type products.	It is not suitable for extremely hot or cold materials.
	It can be customized with additional features.	Not for tight floor spaces.
	Easy to clean and maintain hygiene.	Not for vertical or steep-angle conveying.
Bucket Elevator Conveyor	Energy efficient.	Extremely difficult to clean and maintain.
	Adaptable to a broader range of materials and capacities.	Can compromise blends.
	Ideal for vertical conveying.	It is not the best choice for horizontal conveying.
Screw Auger Conveyor	Energy is efficient at low inclines.	Causes high material degradation.
	The enclosed design helps restrict product spillage	Risk of contamination through oil leakage from the gearbox
	Compact and adaptable to congested locations.	It needs periodic maintenance and inspection.
Metal Belt Conveyor	Reduce the need for frequent replacements.	Difficult to clean and maintain hygiene.
	Available for washdown during cleaning.	Chances of metal contamination during failures.
	It is durable and can withstand the harsh conditions of the hardening process.	Higher maintenance cost.

Problem Statement

Using the above traditional conveying system in confectionery industries leads to various issues that cause downtime and affect productivity. The soft candies or gummies usually stick to the belt surface, reducing the product's flow. Sometimes, when using a belt conveyor, the products get by the side of the guides, causing the product to smear and damage the rollers and sprockets. To compensate for the above issues, most of the time, the speed of the conveyor is increased, but it leads to problems of candy spilling out of the conveyor or creating build-up at certain conveyor sections. All these problems cause extensive downtime and more frequent needs for cleaning and sanitation activities to keep the

equipment running and free from product build-up. When a belt conveyor is used for the transfer, the excessive build-up of candy at certain conveyor sections causes damage to the internal guides and sprockets and eventually wears out the belt itself. Using a bucket elevator conveyor also creates the problem of being unable to manage the quantity of the gummy product being transferred due to the sticky nature of the product. Sometimes, the candy gets into the chain, causing jams, leading to broken parts in the conveyor system, excessive downtime, and production loss. All the abovementioned issues have challenged organizations to look at new scientific techniques to manage the movement of confectionery products effectively.

Proposed Solution

There have been various technological advancements in the field of conveying systems, which have enabled OEMs to understand the root cause of the issues faced on the production lines of a confectionery company and come up with innovative solutions to address them. These new technical advancements have been based on specific trends that have recently become popular. They are

• Improved Design to Match Regulations

The current market's focus on the conveying system in the food confectionery industry has shifted towards developing and using conveyors that emphasize food safety and hygiene maintenance. This eases up the process of cleaning and reduces the risk of contamination from foreign material. It also helps to set benchmarks for material handling for other areas of the production line and helps companies maintain those standards throughout the facility.

• Use of Automation

With the advancement of Industrial Revolution 4.0 and 5.0 in recent times, many industries have embraced the idea of using automation and robot applications in their day-to-day operations. Automated conveyors using sensors, actuators, and programmable logic control have become popular among companies that provide precise product handling solutions.

• Customization for Varied Applications

The Conveyors in the Food Market are witnessing a trend towards customization to accommodate varied applications within the food processing industry. Conveyor systems are now designed to meet the specific requirements of different food products, including size, weight, and processing needs. This trend reflects the industry's recognition of the diverse nature of food products and the need for conveyor systems that can adapt to the unique characteristics of each item.

• Sustainable Design

In response to growing environmental concerns, a trend in the Conveyors in Food Market is adopting sustainable and hygienic materials. Conveyor systems are increasingly being manufactured using materials that are both environmentally friendly and easy to clean. This trend aligns with the broader industry push toward sustainability and underscores the importance of minimizing the ecological impact of conveyor systems in the food processing chain.

• Implementation of Hygienic Conveyor Belts

The Conveyors in the Food Market are witnessing a trend towards implementing hygienic conveyor belts. These specialized belts are designed with materials that minimize the risk of bacterial growth, facilitate easy cleaning, and comply with stringent food safety standards. This trend underscores the importance of maintaining the highest cleanliness levels in conveyor systems, particularly in environments where food safety is paramount.

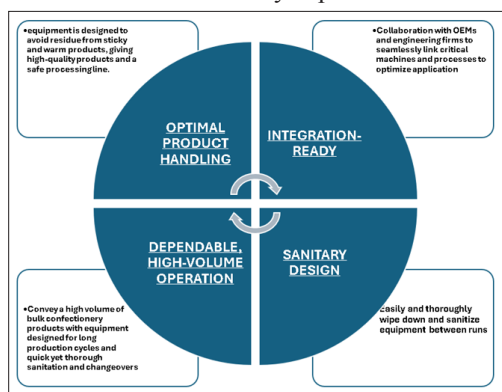


Figure 1: Four pillars of Selection and Design of Conveyors for Food Confectionery Industries

The most advanced and reliable technology in the food confectionery sector that has been gaining popularity is vibratory conveyors. Unlike traditional conveyors, a vibratory conveyor uses an electromagnetic drive that produces low amplitude and high-frequency movements. The design includes a metallic pan and a trough of food-grade stainless steel to service food safety and hygiene regulations. Additional parts of this type of conveyor include frame-mounted drives and spring arm assemblies for distributing the energy to the conveyor bed while producing a diagonal and harmonic motion that, in turn, moves the product forward through the trough. It is majorly used when the movement is in the horizontal direction or slightly inclined angle. It is unsuitable for vertical movements unless modifications are on the trough to have pockets or guides to hold the product when moving upwards efficiently. These conveyors are highly durable and suitable for heavy-duty applications in any food confectionery sector. They are relatively maintenance-free and thrive in various environments. Vibratory conveyors offer better hygienic maintenance and cleaning aids than other traditional conveying solutions, as the surface of the conveyor that comes in direct contact with the product is made of stainless steel, which is easy to clean and wipe down for sanitizing. It also reduces the need for constant maintenance to perform preventive maintenance and repair activities, thus lowering the cost of ownership over the life of the conveyor.

The conveying surface is usually made of a smooth trough with vibratory components attached to cause this trough to shake lengthwise. Smooth surface has presented challenges in many confectionery industries with soft and fragile products. The product sticks to the surface of the smooth trough and usually restricts movement from one point to another. This also leads to product accumulation in certain areas, eventually damaging the electromagnetic drive and springs responsible for creating vibration to move the product. The solution to overcome this situation is to use a dimpled pattern surface on the trough bed of the vibratory conveyor. The dimpled pattern reduces the surface contact between the product and the conveyor surface. This helps in restricting the sticking of products onto the surface and assists in smooth movement through vibration.

Some of the significant advantages of using a vibratory conveyor are as follows

• Reduction in product spillage

The design of a vibratory conveyor keeps the product secured as it moves from point A to point B through the trough, saving time and energy in cleaning up spilled debris. In addition to the trough containing materials, hoods can be added to keep dust and fines from exiting the conveyor.

• Resistant to extreme conditions

Unlike traditional conveyors, where a brave chemical composition of the product or use of hot water for cleaning applications leads to premature belt degradation, leading to more downtime and increased cost of maintenance, the vibratory conveyors are heat and wear-resistant because of the use of heavy-duty stainless-steel material. There is a provision for adding liners in specific locations where the load capacity or impact is more significant to provide more durability to the conveyor.

• Lower Maintenance cost

The vibratory conveyor is durable and needs low maintenance. The constant vibration leads to fasteners becoming loose on the conveyors, so periodic inspection is required to ensure these are tightened and don't come off, leading to significant failure or damage to the equipment. Keeping spare parts, including the

drive and springs, should suffice for most of its lifetime as they are durable and last long.

• Significant Impact on Food Safety

The vibratory conveyor offers more control over detecting contamination during product transfer. Metal detection and multi-directional product discharge contribute to increased profitability and purity of conveyed materials.

Figure 1 Explains the four central pillars that any food confectionery business should consider when designing or selecting a vibratory conveying option to support their production line.

Conclusion

The selection of a suitable conveying system in the food confectionery industry is a critical aspect of achieving production goals and meeting the standards set by the management. Nowadays, companies are researching and looking into various options before committing to a specific design for their product transfer needs. Companies are evolving at the same time to prioritize hygiene, sustainability, and efficiency in food processing and handling. Using automation and robotics under the growing umbrella of Industrial 4.0 and 5.0 revolutions has helped confectionery businesses evolve and meet ever-growing customer demands while delivering safe products with enhanced sanitary design. As the market continues to advance, understanding and adopting these trends will be crucial for businesses aiming to improve productivity, ensure food safety, and stay at the forefront of innovation in the dynamic and competitive landscape of the food processing industry. To select the ideal conveyor for each situation, food processors and packers should consider various factors, from costs to performance issues. To determine the total cost of a conveyor system, start with the initial capital cost plus the installation cost and add the projected annual maintenance and sanitation costs over the anticipated life of the equipment. Such a long-term view highlights the relative affordability of vibratory conveyors over belt conveyors. Beyond costs, the strengths and weaknesses of each conveyor type should be considered, as well as the specific applications in which one kind of conveyor excels. The benefits of each type of conveyor must be judged on a product-by-product basis. Using the vibratory conveyors, any food confectionery company can easily manage their product transfer within their production line without worrying about downtime and loss of operational efficiency.

Vibratory conveyors are more durable, easy to maintain, and operate. Although the investment cost of these conveyors is significantly higher when compared to the traditional style, they are more durable and have a longer life when compared to them. More research can be done to find problems in the food confectionery industry and the impact of product chemical composition and physical characteristics over the transfer process. One of the other areas where development and research can be done is using vibratory conveyors for movement in vertical planes.

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