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Pumps in FOOD & BEVERAGE Processing

Hydro-Transport Food Pumps

By Dave Young, Cornell Pump

Correct pump configuration solves product damage problems.

Processing plants look for continuous and trouble-free operation from a pump that is capable of transporting even the most delicate whole food products or processed foods, while keeping product damage to a minimum. Pumping food products has an overriding issue—any food product damage can result in degradation to the final product and profit losses at the plant.

While damage is a concern, hydro-transport systems do provide an advantage lacking in other mechanical conveyance. They can be used, with a consistent level of product safety, to convey and clean many foods—carrots, cranberries, pickles, cherries, onions, beans, peppers, leafy vegetables, crawfish, shrimp and hatchery fish. Many food products are hydro-transported. In fact, most packaged salad producers use food handling pumps to process and transport their products, without damage, for the fresh pack industry.

System Components

A hydro-transport system involves several components that must function together to safely process and transport food.

Vortex Tank

In a hydro-transport system, the vortex tank is where the product first comes in contact with the hydraulic conveyance medium. It is traditionally constructed of stainless steel to minimize clean-up time and enhance sanitation levels. The tank is designed to receive product on its return from the reclamation system and mix it with water, reducing air injection and entrapment. Solids are mixed with the liquid at a uniform rate—to minimize loss of prime—and vortexed into the pump suction.

The pump must be located sufficiently below the liquid level in the suction bay to ensure that adequate suction head is maintained. The vortex should draw the product uniformly into the pump's suction. Product vortexing is especially important with light foods that normally float.

In addition, the vortex—which should be limited to minimize air entrainment—causes long foods, such as string beans, to enter the stream with their length parallel to the flow. The pump must have an adequate and uniform supply of water to minimize loss of prime and prevent surge.

Materials of Construction

Food handling pumps are traditionally constructed of all iron with stainless steel shaft sleeves. Applications associated with abrasive or aggressive pH values often warrant the use of optional construction materials. Optional materials can also be used to resist attack by soaps, detergents and the germicidal agents used to clean the system. Table 1 shows the recommended materials for each pH value range.

Stainless steel should be avoided for salt brine applications. Monel metal can be used for brines. However, monel metal should be avoided when corn, lima beans or peas are pumped since copper may darken the product. Bronze is fairly corrosion resistant but is not recommended for conveying brines in which foods are canned because of possible product discoloration.

Optional materials for applications associated with abrasive material traditionally include hardened ductile iron. The impeller commonly wears 200 percent faster than the back plate or volute. A hardened impeller with a cast iron volute and back plate will normally sustain a similar life cycle.

Piping

In principle, the transport line should be as short as possible and free of sharp bends, protruding edges and rapid increases or decreases in pipe size. The piping coefficient should be strongly considered to avoid abrasion to the product by the pipe wall. The pipe length is traditionally determined by the retention time required for disinfection, hydro cooling, blanching, etc., or the shortest available route. For practical purposes, horizontal and vertical pipe length should be limited to 250 feet and 65 feet respectively. The first part of the evaluation should focus on determining the appropriate line size, which will allow the

pH Range	Recommended Material
0 – 4	Corrosion resistant alloy steels
4 – 6	All bronze
6 – 8	All iron
10 – 14	Corrosion resistant steels

Table 1. pH value of the materials of constructions

engineer to design a system with optimum line velocity. Water volume should be determined in gallons per minute. This is accomplished by determining the product to be transported in pounds per minute. Then the recommended volume-to-product ratio is applied, which provides the designer with an equivalent volume of water. The water-to-product ratio should be as great as economically possible and should vary depending on the type of food being transported. Traditionally, highly sensitive products require a greater water-to-product ratio. The piping configuration should be designed to maintain optimum line velocities to prevent the product from falling out of suspension, dragging along the bottom of the pipe or stacking up. High line velocities should also be avoided to reduce product impact. Short radius ells, rough pipe joints or heads inside the welded pipe can cause more damage to the product than the pump.

System Design and Pump Selection

The speed of the pump should be selected to meet the head requirements of the system. The system should be designed to keep the head as low as possible. Excess pump speed produces an excess volume of water used. This results in excess line velocity and increases the possibility of impact damage. Pumping excess water is a needless waste of power.

A pump that is too slow produces insufficient water volume, and as a result, a loss of lift capacity, retention time, etc., which may further damage the product.

Although the pump capacity required will depend upon the tonnage to be handled, the pump preferably should be selected so that it will operate at its point of peak efficiency or slightly to the left of this point on the characteristic curve.

Consideration should be given to the choice of a food handling pump with either a standard or expanded volute. Typically, the expanded volute is selected for leafy, stringy, large or fragile products. If a water knife will be used in the system, the product will need to be accelerated considerably for the slicing action to be effective.

At the dewatering screen, products should be carefully separated from the liquid, since this is a common point of product damage. Deceleration prior to dewatering may be required. Careful motor selection is also needed to ensure a non-overloading operating environment. The horsepower characteristics included on a traditional performance curve can be used.

The mounting configuration of hydro-transport food handling pumps is traditionally an overhead V-belt mount. This allows the end user to employ the food handling pumps in different operating environments while maintaining relatively slow operating speeds. Variable frequency drives are also commonly used. This option allows end users to address dynamic operating environments in an automated way.

Selection Guidelines

The following suggestions, based on field experience, are offered as a guide in pump selection and applications.

- The vortex should be controlled so that air is not drawn into the pump.
- Although the pump capacity required will depend on the tonnage to be handled, the pump should be selected so that it will operate at its point of peak efficiency or slightly to the left of this point on the pump curve. This induces a pre-rotation in the suction eye that results in reduced product damage on the leading edge of the impeller.
- The speed of the selected pump should meet the system head requirements. Heads up to 110 feet have been successful with some foods. The system should be designed to keep the head as low as possible.
- The ratio of water to food solids should be as great as is practical or economical. One to 3 gallons per pound is the general range.
- A pump with a single port food handling impeller is recommended for most foods. A pump with a bladed impeller can cause damage.
- Food solids should be carefully separated from the liquid at the dewatering screen because this is a common point of product damage.
- For new uses, the first pumping unit should be installed with a provision for variable speed operation and observation of the product's condition after passing through the pump. Evidence shows that short radius elbows, rough pipe joints or beads inside the welded pipe can cause more damage to foods than the pump. A velocity in the pipe of 5 feet per second should be tried first, because this velocity appears to be above the critical for movement of food suspensions without clogging. When pumping food with hot water, contact the pump manufacturer for the required minimum suction head to obtain performance comparable to pumping with cold water.

Case Study—Onion Damage

A food processor was experiencing significant product damage with the 8-inch pump handling whole onions. Not only was the system plugging, but much of the final product was also too damaged to sell. This waste and inefficiency cost the processor thousands in lost revenue.

In examining both the pump and the design of the system, three issues were identified:

- **Incorrect pump type**—The pump in service was considered a non-clog style pump, with an enclosed, multiple vane impeller and a volute cutwater. While this style of pump can work well in some food waste applications, it is not recommended for delicate, whole-food products.
- **Low water-to-product ratio**—The water-to-product ratio was low, causing inadequate pipe velocities and clogging. The system only pumped approximately 20 percent of the recommended 1 to 3 gallons per pound of product. The onions fell out of suspension and were damaged.
- **Discharge pipe would be too small for potential solutions**—Altering the water flow to achieve correct water-to-product ratio would make the existing discharge pipe diameter too small, causing higher than recommended

pipe velocity. The high velocity would keep the onions suspended in the pipe, but could lead to damage when the product reached the dewatering screen.

Possible Pump Solutions

Three possible solutions were examined to mitigate the product damage and plugging. The first option was to replace the whole system with a more expensive mechanical conveyer. This would have taken the plant offline for a significant amount of time compared to other options and cost the most money to implement. The second option was to keep the existing pump and replace the discharge pipe to accommodate the recommended flow based on the water-to-product ratio. The concern was that the existing pump would still produce a high product damage rate. It did, however, have the advantages of being the fastest fix with the least initial expense.

The third option was replacing the existing pump with a new pump designed to handle whole foods. This pump design allows food to pass through the pump and exit through the center of the discharge nozzle, minimizing contact with any pump surface. Along with the new pump, replacing the discharge pipe to the correct diameter would be required.

Solution—Hydro-Transport Food Pump

The third option was deemed the most advantageous, in terms of time, design and overall cost.

The food processor recalculated the correct gallons per minute needed to transport the desired pounds per hour of onions and recalculated the total dynamic head of the system with the correct discharge pipe diameter. After this assessment, a 10–inch, hydro-transport food pump with a single port impeller and expanded offset volute was chosen for the job. This size pump was needed to handle the system's flow and pressure requirements and to ensure that the largest onions would not plug the pump.

With the new pump in place and following the guidelines for handling food products—including water-to-product ratio and pipe velocity—the food processor reduced damage to onions by more than 90 percent. The up-time of the pump and energy efficiencies have been working well since 2010—saving tens of thousands for nearly two years.

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Dave Young is the northwest regional manager for Cornell Pump Company—a Clackamas, Ore., manufacturer of centrifugal pumps for industrial, agricultural, mining, oil, gas and municipal applications. Young has more than 17 years of experience in food and agricultural pump solutions. He can be reached at dyoung@cornellpump.com or 503-653-0330.