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# Sanitary Pumps: **The Role of Design in Reducing TCO**

Sanitation is essential to food safety. Equipment should be designed for easy cleaning to minimize maintenance costs.

**Learn which pump features have the most leverage on the total cost of ownership equation.**

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The sanitary pumps used in food and beverage and pharmaceutical processing have special requirements that impact their overall cost. This is because of their critical role in safety and their need to be thoroughly cleaned. When selecting a pump for a processing line, total cost of ownership (TCO) should not be left until the end of the discussion. Rather, it should be moved to the front of any pump selection decision, even ahead of specs and price.

The term TCO refers to an estimate of all the direct and indirect costs involved in acquiring and operating a product or system over its lifetime. The TCO equation may involve different parameters depending on the application and the market.

Process industries such as food and beverage and pharmaceutical utilize TCO when sourcing sanitary pumps. In this case, a simplified TCO equation may be expressed as follows:

The initial cost is the price of the pump itself. Not surprisingly, this is a number that receives — and deserves — a lot of attention. However, companies that concern themselves with only the initial cost may be in for a rude awakening because this forms only a fraction of the TCO. As Benjamin Franklin famously said: "The bitterness of poor quality remains long after the sweetness of low price is forgotten."

Operational costs start with installing and testing the pump. They also include the costs of training employees to operate the pump and the energy required to run the pump.

Maintenance costs include inspecting, cleaning and adjusting the pump to ensure it is running optimally (also, reactive maintenance whenever the pump fails unexpectedly).

Downtime costs include paying employees who cannot work, lost production and potentially lost customers. In addition to a mechanical pump failure, downtime may also be caused by foreign material entering the process stream, causing the production line to be shut down.

$$TCO = I + O + M + D - R$$

I: Initial Cost; O: Operational Costs; M: Maintenance Costs; D: Downtime Costs; R: Remaining Value

Finally, the remaining value refers to how much the pump will be worth when it is eventually decommissioned (or scrapped) and replaced with a newer model.

The actual and relative values of the variables in the TCO equation depend on the material pumped and clean-in-place (CIP) or clean-out-of place (COP) options when the pump needs to be opened, dismantled, cleaned and reassembled. There are a variety of other maintenance and downtime factors that affect TCO. The focus for operators is to consider early on, during the pump selection decision stage, how these various factors will either increase or reduce long-term TCO.

## Ensure Ease of Disassembly and Cleaning

A typical scenario in a meat and poultry processing plant is to have three shifts. The pumps are run for two of these shifts, while the third shift is the cleaning shift when the pumps are "torn apart" (i.e., disassembled, cleaned and reassembled).

One problem is that, in many cases, this involves workers who do not know or are not focused on what the equipment is worth. They have only one goal concerning sanitizing a pump, which is to take it apart quickly, clean it quickly and put it back together quickly.

As a result, the sanitation process is where most wear-and-tear happens to pumps and other processing equipment. In fact, wear-and-tear can account for 95% of any damage to a pump, requiring many replacement parts and a lot of maintenance.

The solution is to select a pump with fewer parts to be cleaned, a pump that can be disassembled without the need for tools, and a pump with one way reassembly (i.e., the parts can be assembled in only one way). In addition to speeding the sanitation process, this reduces the need for spare parts and maintenance, reducing the TCO.

## Removable vs. Swing Arm Front Covers

Traditional pumps used for meat and poultry processing have a front cover bolted to the rotor housing using regular hexagonal nuts. In this case, the cleaning crew must remove the nuts and physically lift the heavy front cover away from the pump's body, which can damage the threads on the rotor housing bolts.

During processing, fats and fluids can cover everything. It is not uncommon to drop front covers, resulting in injury to the workers and damage to the cover that affects the quality of its seal to the rotor housing. Furthermore, since all of the parts removed from the pump may end up being placed (or dropped, or thrown) into a bucket or cart, the heavy cover may damage other components like the rotor or the sealing rings.

Sanitation crews typically do not go out of their way to be gentle with the equipment. If roughly handled, a heavy front cover can damage other components, such as putting a ding in the side of a rotor. Dings, scrapes and abrasions will cause downstream problems when the rotor is returned to the pump, potentially causing wear and introducing foreign material into the process stream.

An alternative arrangement is to secure the front cover with wingnuts and mount a swing arm, swinging the cover away from the rotor housing while keeping it attached to the housing. The use of such a swing arm avoids damage to the threads on the main housing bolts, prevents the cover from falling on the floor — which may damage the cover and injure the workers — and precludes the pump cover from damaging other components in "the bucket," thereby reducing the TCO.

Another very important advantage provided by the use of a swing arm-mounted front cover is the fact that — in the case of more viscous slurries such as those arising from meat and poultry products — it remains "un-dinged" makes it possible to run the pump without the use of an O-ring.

An example of a COP pump design from Unibloc Pump. Without tools, cleaning crews can quicky open the pump cover, swing it aside and remove the pump rotors.

This mechanical gasket is used to provide a tight seal between the cover and the rotor housing, but — assuming there are no dings in either the cover or the housing — the cover's pristine precision-machined surface will mount flush to the rotor housing providing a perfect seal. Every meat and poultry plant has experienced an incorrectly mounted O-ring ending up in the product, resulting in throwing away tens of thousands of dollars of meat for the sake of a $5 gasket. Eliminating the need for the O-ring can dramatically reduce TCO.

### Shaft Lengths and Diameters

Many pumps employed for meat and poultry processing feature relatively long and thin shafts to support the rotor. These shafts may deflect and bend under higher speeds and pressures, resulting in metal-on-metal contact between the rotor and the rotor housing, and between the rotor and the front cover. In turn, this will cause wear on the rotor, the housing and the front cover, which will result in loss of performance and increase the risk of introducing foreign material into the process flow.

After some period of time, the pump will need to be returned to the manufacturer to be re-machined. This re-machining will involve removing a few thousandths of an inch from the rotor housing and the front cover, equipping the pump with a slightly larger rotor and returning it to the plant.

In a plant with a number of these pumps, with all the machines being stripped and rebuilt each night, it is only a matter of time before the wrong rotors end up in the wrong pumps. In the case of a larger pump housing with a smaller rotor, the result will be loss of processing efficiency. In the case of a smaller pump housing with a larger rotor, the result will be more aggressive wearing on the new rotor and the rotor housing.

In some cases, re-machining may be required relatively infrequently, say every one or two years. However, depending on operating conditions like speed, pressure and the materials being processed, it may be as little as every three to four months.

On average, re-machining costs around 70% to 80% of the cost of a new pump. After a pump has been re-machined three or four times, it will need to be scrapped and replaced with a new device. All of this dramatically increases the TCO.

An alternative type of pump employs shafts that are shorter and thicker, making them sturdier and more robust. These shafts do not bend and deflect as much as their longer, thinner counterparts, thereby minimizing wear and tear on the rotors, curtailing the need for re-machining and reducing the TCO.

### Rotor Bolts vs. COP Spacer Rings

There are various ways by which the rotor can be connected to the shaft. One technique is to use a stainless-steel rotor bolt with an O-ring (some pumps use two bolts). In this case, the shaft is only held and supported at one end by the motor and its bearings.

This bolt must be undone as part of the cleaning process. When the pump is reassembled, it is not uncommon for the bolt to be under-tightened or over-tightened. If the bolt is under-tightened and backs out, or if it fails for any reason, the pump may be destroyed, and any foreign materials introduced into the process flow will cause the entire line to be shut down. Alternatively, if the bolt is over-tightened or if it locks, the workers may be obliged to introduce tools (wrenches, hammers, etc.) into the rotor housing. In this case, dings may be introduced into the rotor housing, potentially reducing efficiency and causing wear.

An alternative approach is to replace the rotor bolt and associated O-ring with two "COP spacer rings" created out of a super-hard alloy. One of these COP spacer rings is mounted in a recess in the front panel, while the other is mounted in the end of the rotor. The spacer ring in the rotor protrudes a few thousandths of an inch from the rotor and presses against the spacer ring in the front cover.

One result of this is that the COP spacer rings function as a support bushing, which means the shaft is now held in position at both ends, further limiting its ability to deflect and bend. Any wear is confined to the spacer rings themselves, but — due to the hardness of their material — any wear is almost infinitesimal and far below the detection threshold of modern technologies. Furthermore, when the COP spacer rings do eventually need to be replaced, their cost is only a fraction of that of a new rotor. All of this goes to reduce TCO.

### Minimize Components

There are multiple advantages that derive from minimizing the number of components in the working end of the pump. In addition to reducing replacement costs, having fewer components eases and speeds the task of dismantling, cleaning and reassembling the pump. This can become extremely significant in the case of a facility with large numbers of pumps that need to be sanitized every day.

As previously noted, one advantage of a swing arm-mounted front cover is that it makes it possible to run the pump without the use of a gasket in the form of an O-ring. It is generally accepted that the leading source of foreign material being introduced into the flow by a pump is due to its front cover gasket not being installed properly. If the gasket gets pinched when the cleaning crew puts the machine back together, it can get cut when the pump is turned back on, and it may not be until the next cleaning cycle after the pump has been run for one or two shifts that the cleaning crew opens the pump and realizes that half of the gasket is gone.

The result of using a pump that does not need a gasket between the front cover and the rotor housing, and that does not use a rotor bolt and associated O-ring, is to significantly reduce TCO.

### Size the Pump Correctly

It is crucial to select the size and capacity of a pump such that it is operating in the best range of its capabilities. If an undersized pump is used, it will run too fast, which will increase wear-and-tear and degrade the life of the system. If an oversized pump is employed, it will boost the initial cost.

Generally speaking, it is a good idea to determine the theoretical size and capacity required and then oversize the pump by a small amount (say 10%). In addition to providing "headroom" to accommodate unexpected increases in production, the pump can run slightly slower. This strategy may reduce stress on all its components, leading to reduced maintenance and longer life, thereby decreasing TCO.

### Conclusion

In the quest for maximum production at the lowest cost, plant managers try to look at the whole picture before investing in process equipment. TCO is an especially important consideration for sanitary pumps because of their relatively high maintenance needs and their relationship with downtime. By understanding the many ways that pump design can impact TCO, maintenance managers and plant operators can better control costs.

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