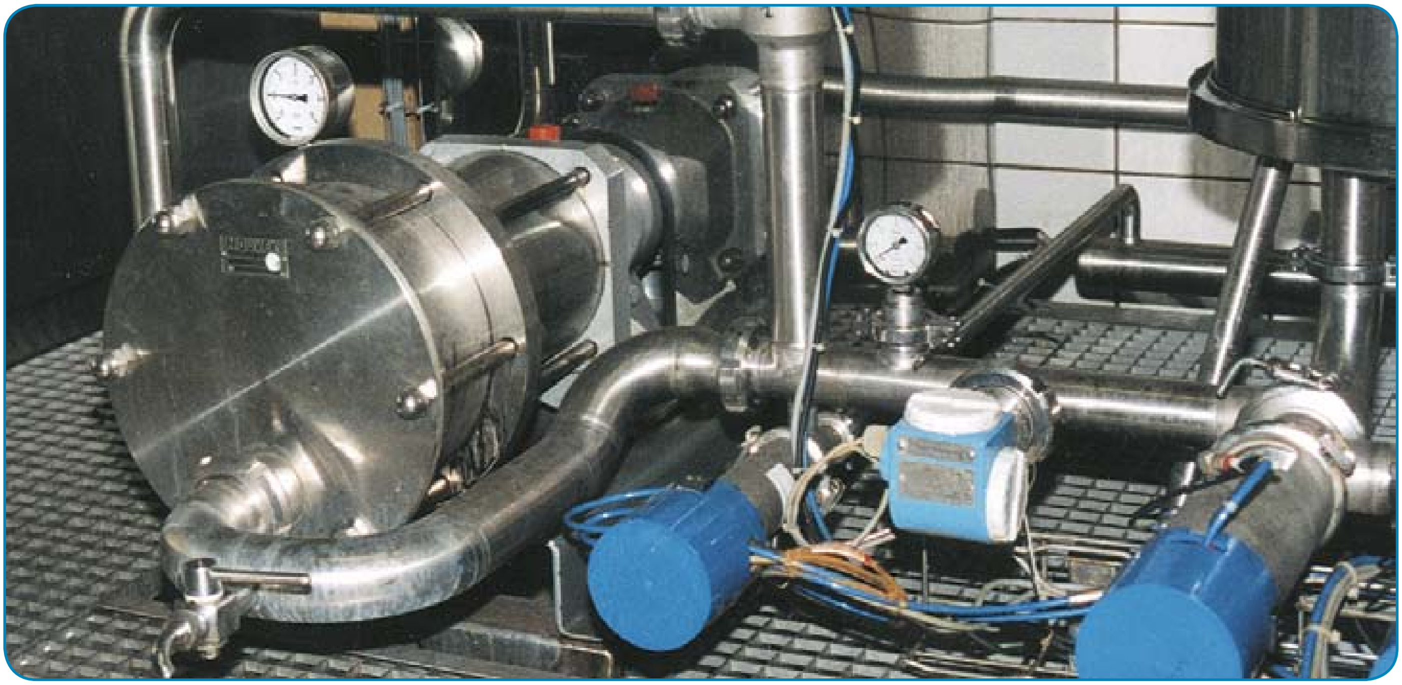
Efficiency Through Indirect Measures

If Not Considered and Monitored, Indirect Factors Can Directly Impact the True Efficiency of the Product-Transfer Process

By Wallace Wittkoff



Introduction

Typically, the amount of product pumped per unit of energy used would be considered a very direct measure of efficiency. However, operators tasked with optimizing energy savings and reducing costs must also consider broader and possibly indirect energy consumption. This white paper explores how pump design can affect three indirect efficiency areas:

- Use of seal coolant (water) with the associated energy consumed to supply and then treat.
- Pump design that affects efficiency of product recovery.
- Pump design that reduces product loss and consequential energy use to treat this waste.

These indirect factors often result in what can be termed "energy creep." Energy creep occurs when indirect efficiency issues are not monitored and unintended waste occurs.

To begin, the fluids for mechanical seal flush fluid are not free.

While seal cooling or flush only applies to a subset of pump applications, it serves as a good example of an indirect efficiency issue for those analyzing the total energy footprint of pump selection. Frequent applications can be found in the food, beverage and pharmaceutical industries where transferring sweeteners that tend to crystallize on seal faces can cause premature seal failure. (See Figure 1 showing transfer line from sweetener storage.) Traditionally, the common solution to this has been to use advanced seals (most of which are not permitted or adaptable for hygienic applications) or using mechanical seals with water or other fluid flush.

However, seal water usage on pumps is a classic case in which energy creep can occur. It is typical over time that the volume of seal water is increased to be safe. In fact, some experts in the industry noted that they typically see up to 10 times the necessary amount of water actually needed for seal flush. Ultimately, the ideal would be to avoid needing seal flushing at all.

Figure 1: Mouvex eccentric disc pump in a transfer line from sweetener storage.

Benefits of Eccentric Disc Design

Negating the use of seal water altogether can help to avoid this cost (and possible creep). The solution is to use pumps that have totally sealed pumping chambers and do not require seal flush. Diaphragm and magnetic-drive pumps may be familiar options. However, new to the field are eccentric movement pumps that better fit some applications that are not suitable for the former pump styles.

Most processors realize that water is becoming a valuable (and increasingly expensive) natural resource. Water is a visible expense as the county, city or other sources that provide it are passing onto the processor the costs to supply and then treat the water. If the processor treats the water, he can determine the energy usage and costs for this. For an example, a processor who handles sweeteners in the confectionary industry has calculated that his plant's total cost for water used in flushing seals was more than $10,000 per year/per pump.

In another case, a processor that makes sauces in the Southeast United States was faced with a permit cost of more than $400,000 if additional water was to be used in the plant. The reason is if water is used over and above the limit, the county must expand its water-treatment capacity. The project was canceled because of this reason. Whether it is a per-pump water use cost or permit cost, new options to negate the use of water means less energy used to supply and treat the water, as well as other costs that may be incurred.

The eccentric movement or eccentric disc design for sealing pumps is an alternative to the magnetic drive or diaphragm, no-flush options. The eccentric movement sealed pumps do not use mechanical seals and, therefore, seal flushing is not needed. Compared to magnetic drives, the eccentric movement designs can also be configured in a hygienic/sanitary design, employed in semi-abrasive applications, and at the same time avoid heat build.

The eccentric movement pump is one of the few non-pulsing positives displacement pumps that negates the use of dynamic seals. In most cases, this pump is driven by standard rotating drives. This drives the shaft within the pump with a coupling. However, unlike most pumps, the shaft is machined on different planes so that the drive end of the shaft is on a different plane than the tip that is driving the pumping mechanism (See Figure 2 — Mouvex C-Series pump cutaway).

Attached to the shaft are bearings and both are enclosed by a hermetically sealed metal bellow or rubber boot. As the shaft rotates, the metal bellows or rubber boot (See Figure 3 — Mouvex S Series pump boot and exploded view) does not rotate thanks to the bearings. Instead, it flexes in an eccentric motion. This flexing is very minor and within the elastic range of the stainless steel so that preventive maintenance (PM) inspection is recommended at 150 million duty cycles, meaning for some applications a PM of every 5 years is more than adequate.

The actual pumping mechanism is similar to the peristaltic effect of hose pumps, but this pump does not use hoses, so it does not fall victim to any of the possible issues associated with them. The disc of the pump is driven by the eccentric movement of the shaft, which produces a peristaltic effect on a channeled cylinder. Product flows in an inner and outer pumping chamber, producing fully complementary flows. The pump, therefore, does not produce pulsation. Since this pump does not depend on clearances for operation and, in fact, takes up clearance that could be generated by wear, the pump has no measurable slip. With no mechanical seal, there are no surfaces on which products, such as corn syrup, liquid sugar, glucose or any number of difficult-to-seal fluids can crystallize, adhere, and subsequently damage the seal. Therefore, with no dynamic seal the need for flush water to remove these products is eliminated.

Why Discard What You Already Pumped?

The eccentric movement pump concept goes beyond resolving broader efficiency issues from just a water or seal-flush use perspective. During the production cycle of a traditional pumping system, startup and shutdown are highly inefficient because:

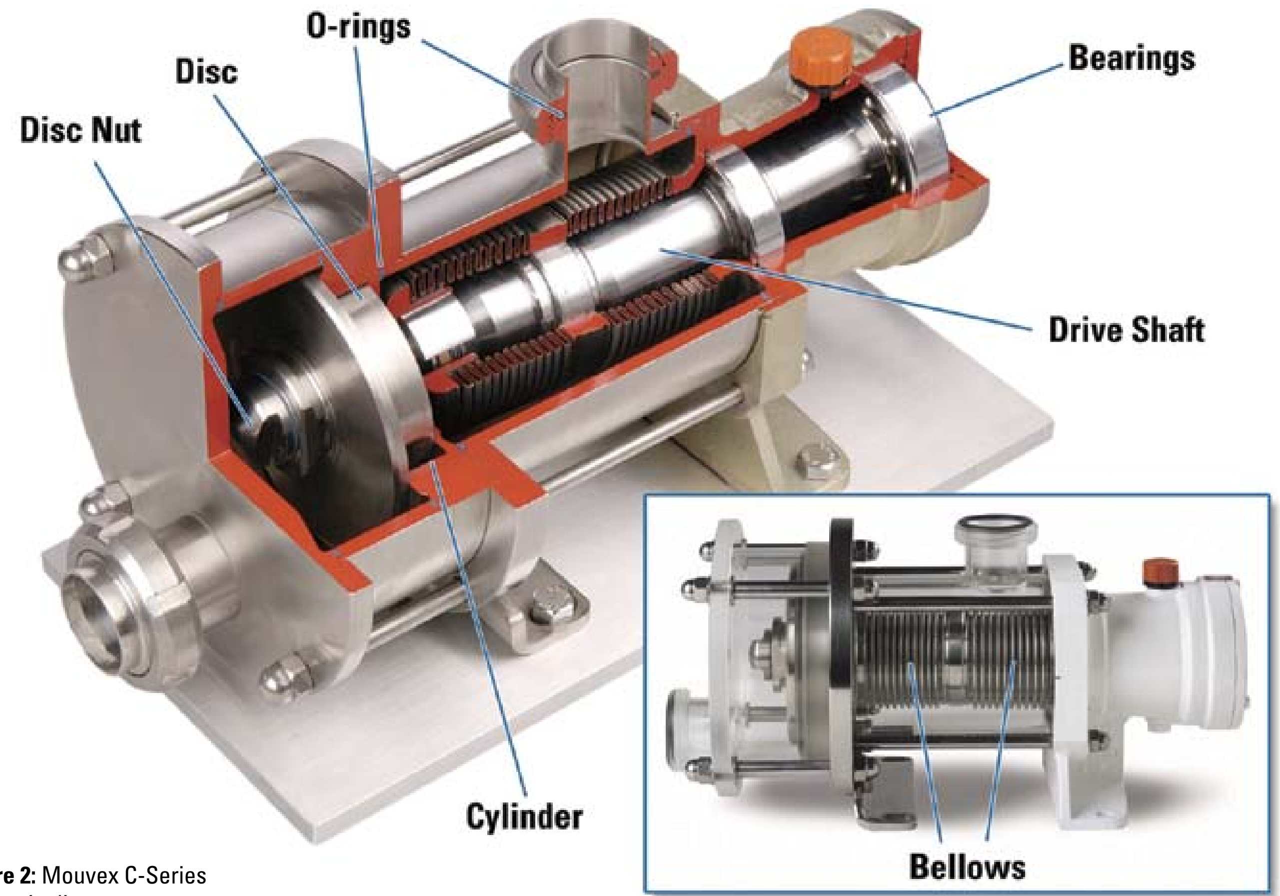


Figure 2: Mouvex C-Series eccentric disc pump

- The pumping system is not stabilized, so the product being pumped is not to specification and must be re-worked or treated for waste.
- For most pumps, once the inlet tank is empty and the pump loses prime, the discharge line remains full of product and also becomes a loss.

It is clear that pumping a product and then not using it is a very inefficient use of resources. Disposing or treating this unsuitable fluid further adds to this inefficiency.

Efficiencies When Starting A Process

Since it has essentially no slip, the eccentric movement technology is able to produce a stabilized and usable product flow much earlier in the startup process. This compares with pump styles that have slip and require a control system to adjust and compensate. As a field application example, companies that use spray-drying processes find this to be the case in their operations.

Typically, processes of this nature begin on water for calibration and stabilization. The water is then replaced with actual product. However, a process upset occurs when this change occurs. The degree to which a pump has no slip and can maintain constant flow during the transition is related to how the process retains stability and product losses are minimized during transition. In the case of spray driers, much like shower heads, if flow changes the spray pattern changes, rendering differences in the product and possible rejection.

Figure 3: Mouvex S Series exploded view

Mouvex SLC Series seal-less eccentric disc pump

Efficiencies When Ending A Pumping Process

On completion of a process, the residual product left in the pump discharge line also represents an opportunity for cost savings by improving product recovery and reducing treatment needs for lost product.

In another field application example, a company that produces coffee extract was able to recover an additional 400 pounds of product at the end of each run because even after the feed tank was empty, the pump continued to effectively pump air, thus helping purge the line. Pumps that are able to run dry and continue to generate air pressure on the discharge to purge the product out of the discharge line are considered to produce a compressor effect. The pumps that employ the eccentric movement principle such as the Mouvex® pump, produce this compressor effect. When considering the effect of efficiency, recovering 400 pounds per run meant:

- Resources did not need to be used in treating it as waste.
- All the resources to produce it were not lost.
- Resources would not be used to reproduce the lost coffee extract.

The additional indirect efficiency issue was that coffee extract was very aggressive on mechanical seals and required advanced seals or water flush. Mouvex eccentric movement technology, with its seal-less design, also helped in this application because resources were not expended for seal water.

Putting It All Together

While it is important to consider the direct efficiency parameters of a pump, such as the amount of product pumped per unit energy consumed, considerations should include the indirect efficiency consequences of pump technology selection. The issues of periphery services to the pump—such as seal water, or consequences of the pump design, such as the amount of product loss and waste treatment costs—all combine to create the true efficiency of the product-transfer process.

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