How Grundfos talk lifecycle costs for wastewater pumps

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Lifecycle cost calculations in wastewater installations can realize huge savings over time for the wastewater company. The lifecycle costs summarize the total cost of a wastewater installation – and in this regard the pump system plays a major role.

The pump system may not be the largest single investment in the wastewater installation, but over the time from cradle to grave; it is the component in the system that is the key element to ensure long-term cost-effectiveness of the wastewater installation.

Total lifetime costs normally include costs such as planning, design, purchasing, installation, commissioning, energy, maintenance and operation, downtime costs and of course any environmental costs and costs for disposal at the end of the lifetime. Most of these costs are however rather insignificant parts of the lifecycle costs of a wastewater installation and only three of these factors have significance. This article therefore focuses only on the pump system, since this will normally have the highest impact on the total cradle-to-grave, lifetime cost of the wastewater installation.

In the pump system, the three main issues that need to be considered are, depending on the pump brand selected and in no particular order:

- Investment
- Energy costs
- Maintenance costs

Investment

The initial procurement cost is often seen by municipalities and contractors as the parameter to ensure low cost. Meeting investment budgets means keeping in mind that the cost of operation, maintenance and disposal could be 5 to 20 times higher than the initial investment and this is why municipalities and contractors increasingly consider the requirements for performance, reliability and energy consumption when purchasing a pump system.

Choosing the right pump is therefore a key issue which needs to be handled carefully – not by looking only at the initial procurement costs but by looking at the total lifecycle cost. This means other people besides the purchaser, for example a service maintenance engineer and designer, should be involved in the decision of the pump purchase, to ensure pump system reliability.

> Tip: Involve different people to ensure all aspects of the pump purchase are taking into consideration.

Energy costs

Decision makers might think that the energy cost of the pump is easy thing to work out. You simply take a pump catalogue, find the correct pump for the wastewater installation, look at the curve and determine the energy consumption in the specified duty point. Then you multiply with the estimated running hours, price per kW and the expected lifetime of the pump – and you have the total energy cost of the pump over the lifetime.

Well, think again – many things must be considered when determining the energy cost of a pump. For example:

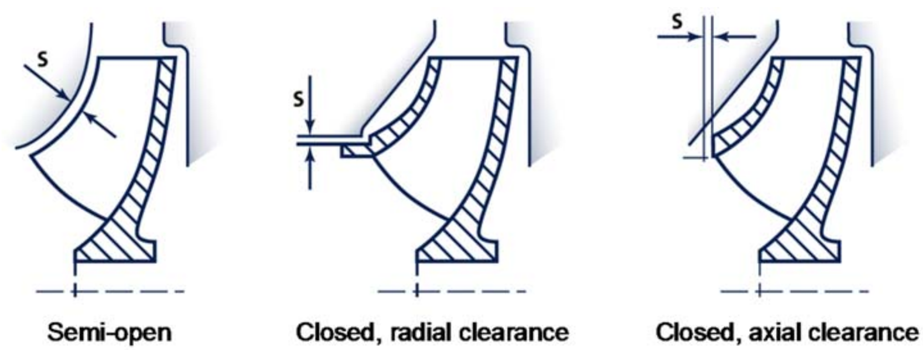
a. Wear
b. Variable load
c. Installation
d. Clogging

a. Wear

A wastewater pump has probably one of the toughest pump jobs in the world. These pumps are pumping media containing sand, stones, rags, robes, beer cans, diapers, and much more. The media content leads to wear and costly breakdown of the pump – if chosen wrongly. The wear of the pump leads to lower efficiency. It has been demonstrated that wear can easily lower the efficiency with 3-5% every year if nothing is done to maintain the pump.

Most pump brands make it possible to restore some of the efficiency loss by different means. Some have a replaceable wear ring, whereas others have built in trimming, where restoration of the efficiency is done by adjustment of the impeller clearance using outside bolts. Even though you might be able to restore some of the efficiency, full restoration of the efficiency is not possible, since the wear affects also non-replaceable parts of the pump.

Considering this, the design of the pump impeller is a key issue, since a simple design with large free passage, no inserts and moving parts will wear less than the opposite, thus ensuring a high efficiency over the pump lifetime.



Wear of impeller clearances with different impeller designs.

Tip: Ask for pumps with large free passage, no inserts and no moving parts to reduce wear keeping high efficiency over the pump lifetime.

b. Variable load

The second issue regarding energy consumption is the duty point at which the pump is operating. It is seldom constant and varies depending on the time of the day, over the year and during the pump lifetime. Choosing a pump with a high efficiency in one point might make good business sense at the time of selection, but might be totally wrong later on. Always ask for flat efficiency curves – this ensures high efficiency over a wide duty range and also if the pump is running with variable speed drive.

If the pump is running with variable speed, a pump with a duty point relatively to the right of the curve should be selected so that when adjusting the speed downwards, the pump's duty point moves to a part of the curve with higher efficiency.

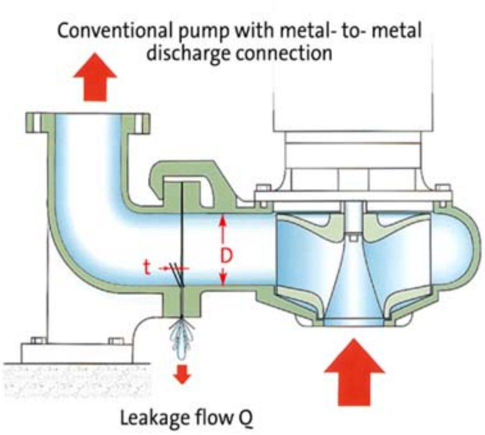
Tip: Ask for pumps with large free passage, no inserts and no moving parts to reduce wear keeping high efficiency over the pump lifetime.

The energy saved when operating with a variable speed drive is also very dependant on the system curve. If the static head is small compared to the friction losses, the energy-saving potential is relatively small; whereas in a system with large friction losses compared to the static head, the savings potential is quite large.

A variable speed drive can also heavily influence the clogging frequency of the pump, as the water velocity might fall below the self-cleaning velocities in the system, as discussed below.

c. Installation

The third issue of energy cost is the installation. It is of course important to avoid leakages in the system and it is recommended to have seals or gaskets at all joints. If the connection between the pump and the installation equipment is metal to metal, leakages can occur, especially when the system gets older. The more leakages there are, the greater the loss of energy.



Tip: Ask for a seal between pump and installation equipment and with sufficient rising main dimensions taking into account the flow velocity in the pipe.

A too small diameter in the rising main leads to increased head requirements and increased energy consumption, since the pipe friction losses of the installation is amplified in small pipes. A small rising main also increases the leakage flow.

To avoid high losses, the water velocity through the pipes should be kept low. The exact maximum velocity depends on the length and roughness of the pipes, but as a rule of thumb the velocity should not exceed 9.8 ft/sec [3 m/sec.] It is however also crucial to avoid velocities that are too low, as this will result in sedimentation and deposits in the pipes, increasing friction losses and energy consumption. A low velocity will also contribute to the maintenance costs, as manual pipe cleaning might become necessary.

For horizontal rising mains, a minimum of 2.2 ft/sec [0.7 m/s] is recommended, whereas a vertical rising main should be dimensioned for a velocity of no less than 3.2 ft/sec [1 m/s]. This is especially important in pump systems with variable operation. The water velocity is of course also heavily influenced by the use of variable speed drives and care should be taken that the pump is not at all times running at a low speed, as the self-cleaning velocity in the pipes might otherwise not be achieved.

d. Clogging

Clogging in the installation is not connected directly to the energy cost. However the impeller design is and the improved non-clogging capability of an impeller has normally been achieved by using semi-open impeller designs. By using a semi-open impeller, you might gain better nonclogging capabilities, but at the expense of efficiency loss.

New developments with impellers now combine the best of both worlds by having non-clogging, high efficiency impellers with large free passage, no inserts and no moving parts. So you get non-clogging and high efficiency without compromising either of them, especially when taking into account the ever-changing dry matter content of modern wastewater.

> Tip: Ask for a, non-clogging, high efficiency impeller with large free passage, and no inserts and moving parts.

Maintenance costs

Maintenance costs are often difficult to estimate. Historical data for existing pumps might help determine this. Normally, the maintenance cost will be divided in two:

a. Planned maintenance costs
b. Unplanned maintenance costs, for example with the sump and grates at the intake

a. Planned maintenance costs

Obviously, the planned maintenance costs will vary depending on many different factors. For example:

- value of pump
- cost of maintenance on pump
- operational experience
- consequence of pump failure
- probability of pump failure
- system design.

> Tip: Ask for recommended spares to be stocked to ensure that service can be done easily, with worn parts changed without special tools or specially-trained operators. Ask for pumps with built-in analogue sensors, thus allowing monitoring of the condition of the pump, for planning of maintenance in due time.

If you have small inexpensive pumps or pumps which are difficult to maintain due to their placement, planned maintenance activities might be kept to a minimum, whereas large expensive, critical pumps might get the full range of planned and predictive maintenance.

b. Unplanned maintenance

An experienced operator will normally know or be able to estimate the unplanned maintenance cost as well. He will know what typically breaks down on the particularly pump brand and knowing the service friendliness of the pump he will be able to determine the cost of the repair, taking into account:

- maintenance to be performed on the pump
- time taken to do the activity
- number of staff involved
- spare parts cost for the activity.

> Tip: Ask for fast spare part availability to ensure that unplanned maintenance can be done fast and reliably. Asking for pumps with built-in analogue sensors will allow the operator to minimize the unplanned, expensive service visits with planned, just-in-time maintenance operations.

Conclusion

As can be seen, LCC can be an excellent tool for selecting the optimum pump, ensuring minimum cost of pump operation over the pump's lifetime. But many things need to be taken into account to make the selection a success, for example the following:

- Ensure that all aspects of the pump evaluation are done before the pump purchase and that pumps with high efficiency, non-clogging capabilities and large free passage impeller are preferred.
- The selected pump should have flat efficiency curves, a seal between the pump and installation equipment and be extremely service friendly with built-in sensors to minimize unplanned expensive service visits.
- The pump system should be chosen with the full system perspective in mind.

You might think that all these requirements cannot be met at the same time from one pump manufacturer. If so, then you are in for a pleasant surprise – this is indeed possible by choosing the correct pump supplier for the job.

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