LIFECYCLE COSTS The true cost of a new pump

When purchasing a pump — or any piece of capital equipment — is the cheapest upfront pump really the cheapest pump? The initial purchase price of a pump makes up only a very small percentage of the pump's life cycle cost.

By Matthew Thompson, Technical Engineering Manager, Renroc Group Australia

The Hydraulic Institute has a paper called *"Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems"*, which lists all costs associated with a pump's life, these are:

- Initial Investment Costs (C_{ic})
- Installation and Commissioning (Start-up) Costs (C_{in})
- Energy Costs (C_e)
- Operation Costs (C_o)
- Maintenance and Repair Costs (C_m)
- Downtime and Loss of Production Costs (C_s)
- Environmental Costs, Including Disposal of Parts and Contamination from Pumped Liquid (C_{env})
- Decommissioning/Disposal Costs, Including Restoration of the Local Environment (C_d)

$$LCC = C_{ic} + C_{in} + C_e + C_o + C_m + C_s + C_{env} + C_d$$

Many of these categories have multiple items that fall under them and for full details the complete article should be consulted. But, how can this knowledge be used to provide the most efficient and most economic pumping systems? This article aims to look at how using life cycle costs may alter the best pump choice and the best pump technology.

Change of pump type

Often, the largest cost associated with the life of a pump is the energy used by the pump. To achieve the lowest energy cost you want to have the highest pump efficiency, meaning the lowest power consumed. Pump efficiency includes the hydraulic efficiency, motor efficiency, coupling efficiency, and any other associated devices with the pumps that consume energy. The biggest savings will often be seen by optimizing the hydraulics. The larger the pump, the more savings can be achieved by efficiency gains.

To optimize hydraulic efficiency, one should look at the hydraulic type to be used, as this can result in significant efficiency gains. For example, pumping water at 3,800lpm and a differential pressure of 78 bar. Using a centrifugal pump in accordance with API 610, you will get a hydraulic efficiency of approximately 72% and by using

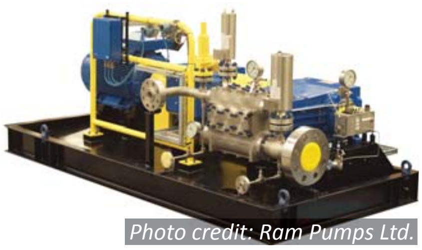
Photo credit: Ram Pumps Ltd.

Figure 1: *Example of a plunger pump.*

a plunger pump in accordance with API674, you will have a hydraulic efficiency of 95%. This would result in the energy savings seen in Table 1.

Change of sealing technology

Sealless pumps can often have mixed reviews, depending on people's experience with the technology. Based on large samples of data by major chemical companies, it has been shown that sealless pumps can have a failure rate a third lower than mechanical seal pumps. Add to this that the average mean time between repairs (MTBR) for a canned motor pump is between 6-8 years compared to a standard mechanical seal pump which has MTBR of 2-3 years. This is due to the standard mechanical seal pump having several wear

Pump Types	API 674 (PD Recip.)	API 610 Centrifugal	Difference
Volumetric Efficiency	95%	72%	23.0%
Flow Required (l/min)	3800	3800	0
Differential Pressure Bar (g)	78	78	0
Absorbed Power (kW)	519	686	167
Price per kW (current estimate / h)	0.16	0.16	0
Assumed Operation (hours)	8	8	0
Electricity Cost Per Day (Operating)	$ 664.32	$ 878.04	$ 213.72
Electricity Cost Per Month (Operating)	$ 19,929.60	$ 26,341.14	$ 6,411.54
Electricity Cost Per Year (Operating)	$ 242,476.80	$ 320,483.92	$ 78,007.12

Table 1: *Power savings (in AUD) of an API674 plunger pump compared with an API610 pump.*

parts compared to the canned motor pump, which has none, dependent on manufacturer.

With such an increase in pump availability, great savings in the life cycle cost areas of Maintenance and Downtime can be achieved. The maintenance cost can be reviewed in Table 2, even with individual overhaul costing 25% more than a mechanical seal pump, the canned motor pump has half the maintenance cost of the mechanical seal pump.

Aside from the maintenance costs, the downtime costs can also be reduced due to the higher pump availability.

Other costs that can be reduced by the use of sealless pumps in life cycle costs are;

- Installation costs – For a canned motor pump there is no alignment required or other commissioning requirements. Pumps can be attached to pipework and commissioned.
- Operational costs – Sealless pumps are leak free without a sealing system, so no operational measures to check for leakage are required which can save significant amounts of money throughout the pumps life cycle.

A comparison of a pump with dual seal and a canned motor pump is shown in Figures 2 and 3. The complexity of the seal system can lead to increased costs in procurement, in addition to those areas already discussed.

Change of material

Material selection is integral for pump lifecycle costs; it can affect most aspects of the life cycle equation, including initial cost, maintenance cost, downtime, and environmental costs. Pumps can be constructed in many materials from metals, plastics, polymers, and ceramics.

Certain applications such as produced water, seawater, slurries, acids, and other exotic fluids will

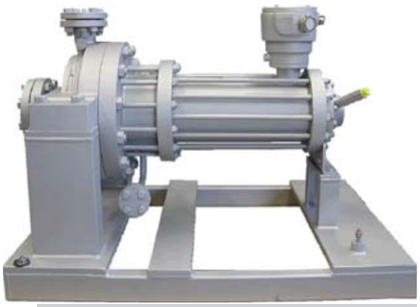

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Figure 2: *Canned motor pump.*

Figure 3: *Dual mechanical seal pump.*

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Option	Dual Seal	Canned Motor
Years of Service	25 years	25 years
Repair Cost per Repair	$ 7,500.00	$ 10,000.00
Repair Interval Avg (MTBR; years)	3 years	8 years
Repairs During Service	8 repairs	3 repairs
Repair Costs per Annum	$ 2,500.00	$ 1,250.00
Lifetime Repair Cost (C_m)	$119,317.75	$59,658.87
Inflation Rate	5%	

Table 2: *Repair costs (in AUD) of canned motor v mechanical seal pump.*

Pump Types	Stainless Steel Pump	SiCcast Pump
Initial Cost (C_{ic})	$ 25,000.00	$ 32,500.00
Energy Costs per Annum (C_e)	$ 21,024.00	$ 21,024.00
Pump Lifetime (weeks)	6 weeks	40 weeks
Pump Change Outs per Year	9 change outs	1 change out
Cost Pumps per Year (C_m)	$ 225,000.00	$ 32,500.00
Installation and Removal of Pump	$ 5,000.00	$ 5,000.00
Annual Costs of Removing and Installing Pumps (C_{in} & C_d)	$ 45,000.00	$ 5,000.00
Total	$ 316,024.00	$ 91,024.00

Table 3: *SiCcast pump savings (in AUD).*

Figure 4: *Impeller subject to corrosion and erosion.*

Figure 5: *Pumps made of advanced materials like SiCcast can give significant life cycle cost savings.*

cause erosion and corrosion issues for materials. This can, in severe cases, leave parts in the condition shown in Figure 4.

In a certain application, stainless steel pumps were lasting approximately six weeks before requiring complete replacement. Investigation of the site led them to use pumps made of SiCcast, which is a material made of Silicon Carbide and epoxy resin. It has a lifetime corrosion warranty for seawater applications and has been specifically designed for corrosion and erosion applications. The SiCcast pumps were approximately 30% more expensive to purchase than the equivalent unit in stainless steel. However, the SiCcast unit currently lasts approximately 10 months compared to six weeks. Taking into account other factors in the life cycle cost equation this gives costs as shown in Table 3.

As this application shows, it is prudent to investigate all possible material options. This may be coatings, complete pumps, advanced metallurgies, or other developments, but significant savings can be made even if not shown in the initial investment costs.

Conclusions

This article is by no way exhaustive and all aspects of life cycle need to be considered for accurate values. This article has also not discussed in detail how, in many ways, the biggest way to decrease life cycle cost is through intelligent plant design. Plant design plays the biggest role in efficiency and wise operation can produce huge savings. However, it is trusted that this article does provide curiosity for anyone involved with pumps to more carefully review lifecycle cost as opposed to purchase cost. Hopefully, the article also shows the benefits of considering multiple pump technologies and the potential value in engaging with a multi-disciplinary pump expert.

ABOUT THE AUTHOR: *Matthew Thompson*

Matthew Thompson completed his Bachelor of Engineering (Honours) at Monash University with a final year thesis project "Pumping Environmentally Sensitive Liquids" a study of sealless pumps. Since completion of his studies he has worked with BP and been the Engineering Manager at Renroc Group since 2010.

Renroc Group is a speciality pump supplier servicing the Australasian region including API610, API674, API685, sealless, plunger, and others. Pumps have also been installed in the harshest conditions, including offshore. Renroc Group through supply of multiple technologies aims to provide the best pump for the application giving a reliable and low life cycle cost.

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