LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

EVALUATING

LIFE CYCLE COST

By

D. Paul Russell
Senior Staff Engineer

Background

Pump life cycle cost (LCC) pertains to the total cost associated with installation, operation, maintenance, and decommissioning activities during the course of a pump's installed life, often 15 to 20 years and sometimes more. Intuitively, most of us who deal with pumps and pumping systems recognize that the initial capital outlay for a pumping system is small in comparison to the LCC associated with the installed equipment. The problem is that many of us do not have LCC quantified in such a way that we can use it effectively to make cost saving decisions. The purpose of this paper is to show a methodology by which LCC can be estimated for a pump system and to demonstrate how investing in improved reliability and decreased utility consumption can have dramatic payback.

Reliability and Life Cycle Cost

Reliability is a significant factor in pump LCC. Plant Maintenance Philosophies tend to fall primarily into one of two categories. One is "best practice"(BP), the other being "room for improvement"(RFI). RFI plants are repair focused plants. These plants spend money on maintenance but not a great deal on reducing maintenance. By comparison the BP system determines upgrade feasibility and views each maintenance event as an opportunity to make an improvement. The reward for the BP system is to continuously optimize the LCC and experience increased profitability as a result. It is unfortunate that in search of more favorable short term quarterly earnings results, many companies have given up on greater long term profitability by adopting a "RFI" policy.

The price of the pump is minute by comparison to the total LCC for high usage pumps that are in operation over 2000 hours per year. Quite often the value of lost production will dwarf all the other elements. How often have we heard, "If the system goes down we will loose $50,000 an hour", or some such number. Just a few hours of down time adds up fast.

Elements of Life Cycle Cost

C_{ic} Initial capital cost

This is the purchase price for the pump. Usually the complete system is reviewed when making a Life Cycle Cost analysis. To simplify pump comparison we have left system considerations out of the examples assuming that each pumps would generally use similar piping arrangements.

C_{in} Installation and commissioning costs

This usually ranges from between 1 and 2 times the cost of the pump. Note that this multiplier is meant to cover electrical, foundations, utilities, etc., and is based around the cost of standard API and ANSI pumps. Special consideration should be made when dealing with engineered pumps. While engineered pump costs are higher due to their specialty design, their installation related costs generally remain equal to a standard pump of the same size and horsepower.

C_e Energy costs, includes electricity steam and water

For the example here we used $0.08/Kwh and $0.03/gal of water. We would increase the $0.03/gal to $0.05/gal if the water had to be treated at the plant.

C_o Operator cost (normal system supervision)

In our first example we use $2,000 annually based on 3 shifts of 2 operators and 1 supervisor at an average salary of $45,000 that oversee 200 pieces of equipment.

$$\$2000 = 3_{shifts} \times 3_{personnel} \times \$45{,}000_{avg.\ salary} / 200_{pieces}$$

371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

C_m Maintenance cost

This is very equipment dependent and actual maintenance records should be consulted. This annualized cost should consist of the following.

- Cost for spare parts used
- Cost for any third party work
- Plant labor
- Inter-department charges

C_s Downtime and loss production costs

The total pump related downtime multiplied by a hourly cost for lost production.

C_{env} Environmental cost

Environmental costs consist of costs related to leakage, emissions, or decontamination to make the equipment safe for maintenance inclusive of any legal costs and fines.

C_d Final decontamination and disposal costs

For industrial in chemical applications it is quite often more expensive to throw things away than to buy them. A number of 2x the initial capital cost is a conservative estimate when taking environmental restoration, and disposal of auxiliary systems and equipment into account.

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

Below are two examples of how application of LCC to a problem application can provide a compelling financial case for investing to resolve a problem application.

EXAMPLE 1 – Refinery coke pit sump pump.

Cokers are used in some refineries to process bottom of the barrel product. Residual oil is injected into drums at a very high temperature whereupon it flashes. The resultant gas is taken off and used to make additional petroleum products such as gasoline and diesel oil. The remaining material in the drum forms a solid block of coke. The drum is opened and water jets are used to cut the coke. This water is recycled through a settling basin called a maze, where entrained coke particles settle and are periodically dredged out. Pumps in the coke maze or pit have to handle a mixture of hot water, petroleum solvents and abrasive coke fines. Most refineries are operating at rates far above their original design capacity. Increased throughput within the maze decreases the settling efficiency putting additional burden on the pumps resulting in higher costs. The following LCC analysis was conducted to determine whether there was financial based for replacement for existing problematic vertical line shaft pumps with LPI 5100 submersible coke pit pumps.

An example of Life Cycle Cost - 15 Year Life Continuous Operation

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

- Coke pit sump pump
- Flow 1100 GPM
- Head 150 TDH
- 100 HP motor power draw 51 KW @ $0.08/kw hr
- Vertical line shaft design 55 feet long
- Water with coke fines
- 2 pumps one operating on standby
- Sleeve bearing flush 3 GPM @ $0.02 / gal, pump flushed if it is running, standby pump not flushed
- MTBR for existing pumps is 6 months

LCC = Cic + Cin + Ce + Co + Cm + Cs + Cenv + Cd

Table 1 shows the life cycle cost breakdown for these pumps.

C_{ic}	Initial capital – 2 pumps @ $75k each.	$150,000
C_{in}	Installation 0.75 x Cic	$112,500
C_e	Electrical 51kw x $0.08/kwh x 8,760 hrs *15 yrs	$536,000
C_e	Water Flush 3 GPM x $0.02/Gal * 60 min/hr * 8760 hrs/year x 15 years	$473,000

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

C_o	Operating cost (2000 x 15)	$30,000
C_m	Maintenance 2 pumps @ $75k/year x 15 years	$2,250,000
C_s	10000 bpd/@$3/bbl margin + 750tbd coke @ $50/ton = $67k/day margin. Estimated .5 day per year lost production due to pump related slowdown or outages x 15 years	$500,000
C_{env}	Environmental cost – estimated @ 5% of pump cost /year = $3,750 x 15 years	$112,000
C_d	2x $150,000 capital cost	$300,000
	Total LCC	**$4,463,500**

Table 1

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

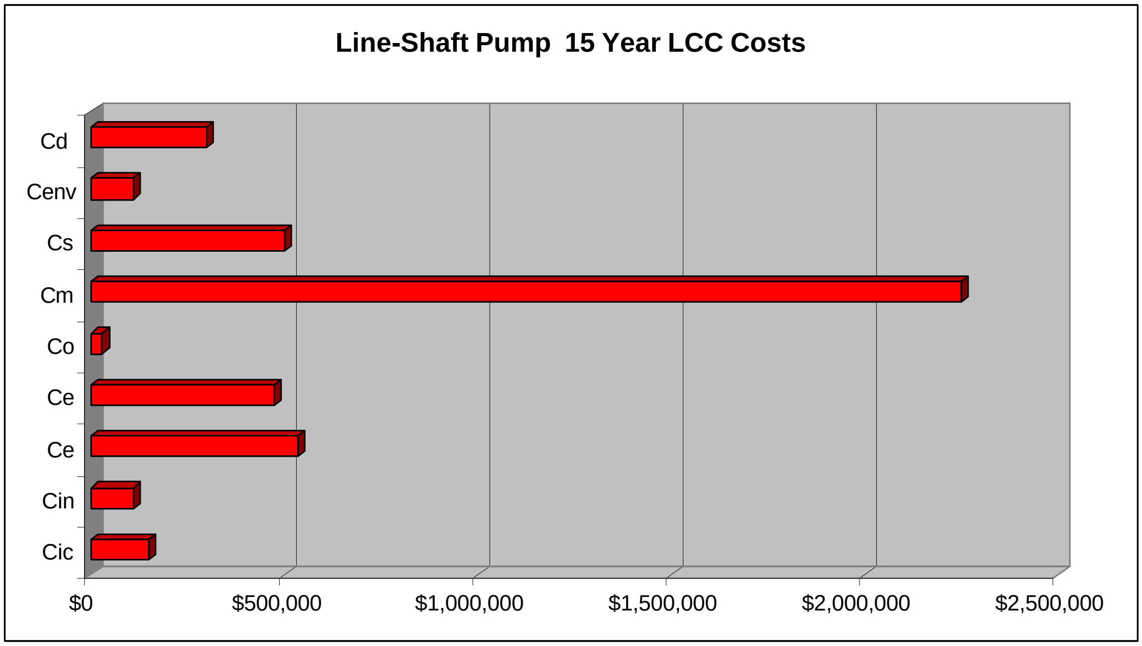

Chart 1

This particular plant is a Best Practice Plant. They viewed the repairs as an opportunity to do something different. They replaced the vertical line shaft pump with a series 5100 Submersible. Below is a breakdown of the anticipated LCC for the submersible.

Submersible Operating Conditions

- Flow 1100 GPM
- Head 150 TDH
- 100 HP motor power draw 51 KW @ $0.08/kw hr
- Submersible design
- Water with coke fines

- 2 pumps one operating on standby
- A cooling Jacket on the motor is flushed at 3 gal/minute and water cost is $0.02/gal.
- Design service cycle is two 2 years. The estimated repair cost, assuming that the seals bearings and hydraulic components are serviced at this time as well is $30,000.

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

Submersible

C_{ic}	75,000 per pump	$150,000
C_{in}	Installation was only 10% of the capital cost as necessary electrical and support structure was already in place. No new foundations were needed.	$15,000
C_e	Electrical (Same) 51kw x $0.08/kwh x 8,760 hrs *15 yrs	$536,000
C_e	Water Flush 3 GPM x $0.02/Gal * 60 min/hr * 8760 hrs/year x 15 years	$473,000
C_o	Operating cost unchanged (2000 x 15)	$30,000
C_m	2 pumps @ $15k /year x 15 years	$450,000

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

C_s	10000 bpd/@$3/bbl margin + 750tbd coke @ $50/ton = $67k/day margin. Estimated .2 day per year lost production due to pump related slowdown or outages x 15 years	$200,000
C_{env}	Environmental cost - estimated @ 5% of pump cost /year = $3,750 x 15 years	$112,000
C_d	2x $150,000 capital cost	$300,000
	Total LCC	**$2,266,000**

Table 2

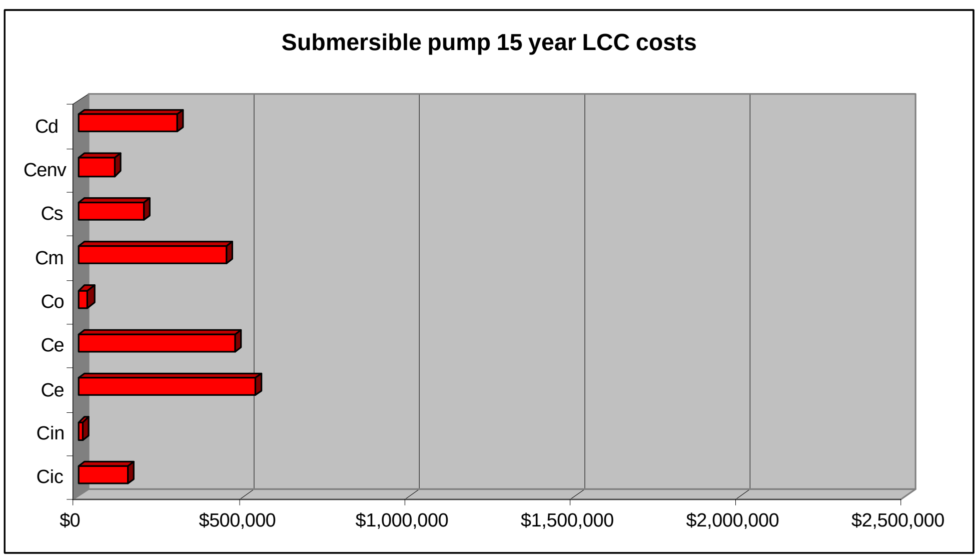

Chart 2

The LCC savings is $4,463,500 – $2,266,000 = $2,197,500 over the life of the unit for each pair of pumps they replace. Recall, the

LAWRENCE PUMPS INC.
371 Market St. Lawrence, MA 01843
PH:(978)-682-5248 Fax:(978)-975-4291
www.lawrencepumps.com

pumps cost $75,000. This savings has not taken into account any cost increases during the life of the coke pit, all has been estimated with the present value alone.

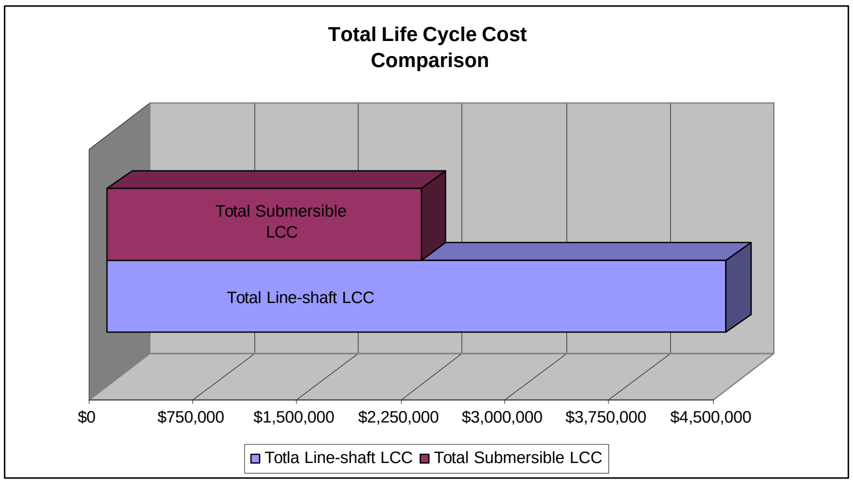

Chart 3

Summary

It most industrial pump applications the initial purchase price of the equipment is a small percentage of the total costs associated with operation, maintenance, and downtime. Consideration of life-cycle costs will allow the plant management to make decisions regarding capital purchases and system upgrades that will save time and increase profitability.