Chapter 1

Pump System Life Cycle Cost Reduction

The primary objective of life cycle costing is to evaluate and/or optimize product life cost while satisfying specified performance, safety, reliability, accessibility maintainability, and other requirements.

Pumping systems account for an estimated 25%-50% of the energy usage in many industrial plants, and perhaps 20% of the world's electric energy demand (Ref. 1-1). Centrifugal pumps rank first in failure incidents and maintenance costs. That is why centrifugal pumps in critical applications are installed in identical pairs, one serving as the operating, the other one serving as the standby or spare pump.

Despite these statistics, many pump purchase decisions are still made solely on the basis of lowest initial purchase and installation cost. The notion exists that, if a cheap pump doesn't perform well, it can always be upgraded. While this may be true in those pumps that suffer from installation errors or component defects, it is not true for pumps that suffer from fundamental design compromises. Moreover, these decisions seem to disregard that initial purchase price is generally only a small part of pump life cycle cost in high usage applications. Market conditions, short-term financial considerations, and organizational barriers are to blame for this short-sighted approach.

Conventional Wisdom: *You can always upgrade an inferior pump*

Fact: *Certain bad choices defy cost-effective upgrading. A plant may have to buy a better pump or suffer through and endure its bad decision.*

Progressive, reliability-focused pump users who seek to improve the profitability of their operations will have to consider using Life Cycle Costing, or LCC. The conscientious application of LCC concepts will help reliability-focused plants minimize waste. LCC will also dramatically reduce energy, operating and maintenance costs.

Life cycle pump cost is the total lifetime cost to purchase, install, operate, maintain (including associated downtime), plus the cost due to contamination from pumped liquid, and the cost of ultimately disposing of a piece of equipment.

A simplified mathematical expression could be

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

where:

- LCC = Life Cycle Cost
- C_{ic} = Initial Cost, purchase price (pump, system, pipe, auxiliary services)
- C_{in} = Installation and commissioning cost
- C_e = Energy costs (pump, driver & auxiliary services)
- C_o = Operation costs
- C_m = Maintenance and repair costs
- C_{dt} = Down time costs
- C_{env} = Environmental costs
- C_d = Decommissioning and/or disposal costs

Energy, maintenance and downtime costs depend on the selection and design of the pump, the system design and integration with the pump, the design of the installation, and the way the system is operated. Carefully matching the pump with the system can ensure the lowest energy and maintenance costs, and yield maximum equipment life.

When used as a comparison tool between possible design or overhaul alternatives, the Life Cycle Cost process will show the most cost effective solution, within the limits of the available data. Figure 1-1 shows a typical breakdown of pump life cycle costs. In this case, the initial pump purchase cost represents only nine percent of the total life cycle cost. Ref. 1-2 offers more details on Life Cycle Cost analysis.

Conventional Wisdom: *There's not enough data to calculate life-cycle cost*

Fact: *There's always enough data for a reasonably close estimate of pump life-cycle cost.*

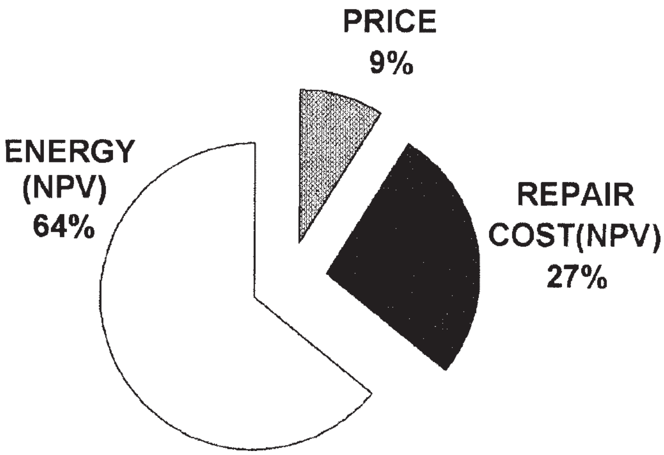

Figure 1-1: Typical life cycle cost breakdown

INITIAL COSTS

The initial investment costs include the initial pump and pumping system costs. Initial costs also include engineering, bid process ("bid conditioning"), purchase order administration, testing, inspection, spare parts inventory, training and auxiliary equipment. The purchase price of the pumping equipment is typically less than 15% of the total ownership cost. Initial cost is also influenced by such critical factors as the size and design of the pump piping, pump speed, the quality and/or duty rating of the equipment being selected, materials of construction and control system. All of these choices can substantially affect the life cycle cost and working life of the pump.

INSTALLATION COSTS

Pump installation and commissioning costs include the foundations, grouting, connecting of process piping, connecting electrical wiring, connecting auxiliary systems, equipment alignment, flushing of piping and performance evaluation at startup. The care and effectiveness in executing these installation activities will have a great impact on subsequent reliability, maintenance and down time costs, during the life cycle of the pump. Unless shown to be outdated, the equipment manufacturer's installation, start-up and operation instructions should be adhered to. A checklist should be used to ensure that equipment and the system are operating within specified parameters.

ENERGY/OPERATING COSTS

Pump/system energy consumption is often one of the larger cost elements and may dominate the total life cycle costs, especially if pumps run more than 2,000 hours per year. Energy and maintenance costs during the life of a pump system are usually more than 10 times its purchase price (Ref. 1-1). Energy costs are dependent not only on the best efficiency of the pump(s), but also on the energy consumed by the pump system (pipe size, etc.), and by how much time and how far the pump spends operating away from the best efficiency flow rate. Additional influencing factors include minimum flow bypasses, control valve pressure breakdown, auxiliary service energy consumption, and driver selection and application.

Operating costs are labor costs related to the operation of a pumping system. These vary widely depending on the complexity and duty of the system. Regular observation of how a pumping system is functioning can alert operators to potential losses in system performance. Performance indicators include changes in vibration, shock pulse signature, temperature, noise, power consumption, flow rates and pressure.

Conventional Wisdom: *Pump initial cost is the most important selection factor.*

Fact: *With rare exceptions, pump initial cost should be the least important selection factor.*

MAINTENANCE AND REPAIR COSTS

Obtaining optimum working life from a pump requires special care in the design of the system (pump piping, etc.), design and selection of the pump, installation, and regular and efficient servicing. The cost depends on the time and frequency of service and cost of materials. Pump design can greatly influence these costs through the hydraulic selection, materials of construction, components chosen, and the ease of access to the parts to be serviced.

Downtime can be minimized by optimized preventive maintenance programs, and programming major maintenance during annual shutdown or process changeover. Although unexpected failures cannot be predicted precisely, they can be estimated statistically by calculating mean time between failures, or possibly avoided through continuous monitoring fault tolerant smart pump control systems.

LOSS OF PRODUCTION

The cost of unexpected downtime and lost production is a very significant item in total life cycle cost, and can rival the energy costs and replacement parts costs. All of the above factors affecting the working life of a pump can impact downtime and loss of production. Despite the design or target life of a pump and its components, there will be occasions when an unexpected failure occurs. In those cases where the cost of lost production is unacceptable, a spare pump may be installed in parallel to reduce risk. If a spare pump is used, the initial cost will be greater, but the cost of lost production will be avoided, or at least minimized.

PUMP RELIABILITY FACTORS

Figure 1-2 summarizes the many factors that influence pump reliability. These, obviously, include selection (type chosen), installation, usage (application), operation, and maintenance-related parameters. While each of these will be covered in much more detail throughout this text, it should also be noted that correct operating instructions are often lacking. It is certainly obvious that pump start-up, operating surveillance, shut-down and related procedures can and will influence pump reliability. Detailed guidance on the correct procedures to be employed can be found in Appendix 1.

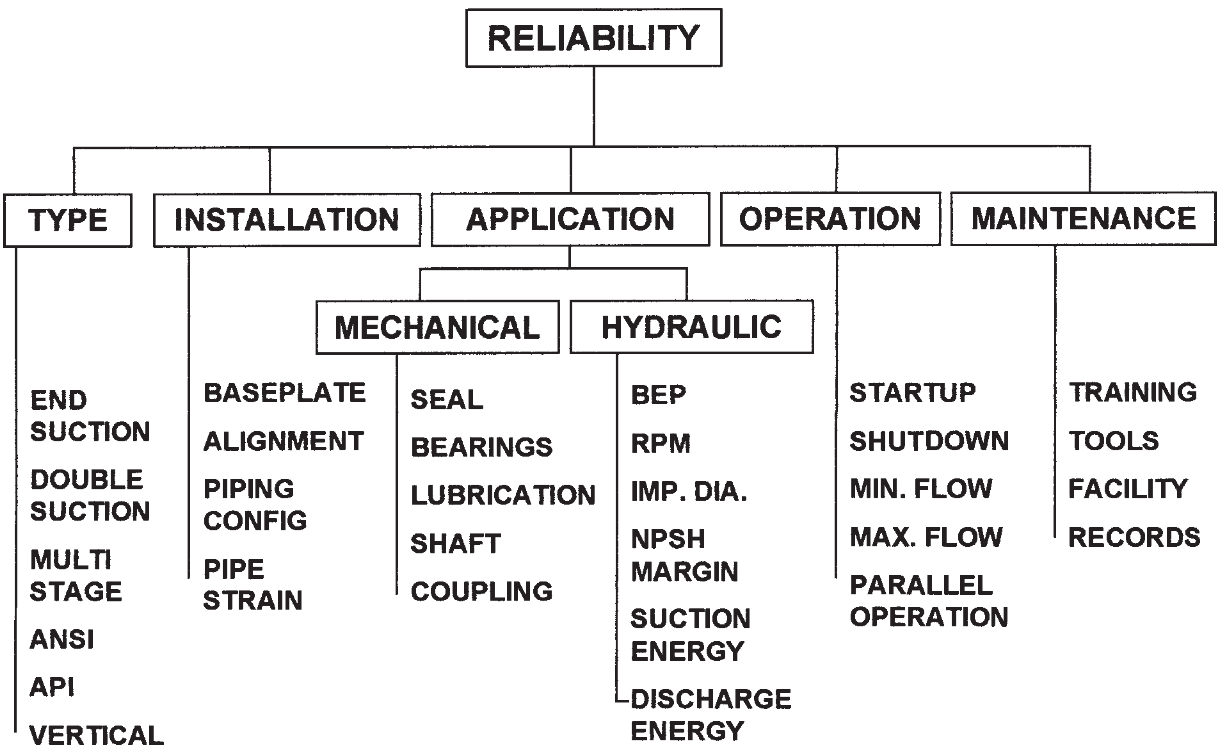

Figure 1-2: Pump reliability factors