SEALING SYSTEMS MATTER

Choosing Mechanical Seals to
Optimize Life Cycle Cost, Safety, and
Environmental Compliance.

Abstract

The Fluid Sealing Association, an international trade association of sealing device manufacturers, has established an educational initiative called *Sealing Systems Matter*. A primary objective of the initiative is to influence the decision-making process applied to the purchase, specification, and upgrade of sealing systems used in the process industries and municipalities. In today's highly competitive market, an increasing number of users and specifiers are buying sealing systems on the basis of initial cost, at the expense of higher lifetime costs to their operations in terms of energy consumption, water usage, effluent treatment, chronic maintenance cost, and perhaps reduced ability to keep abreast of their safety and environmental responsibilities.

Sealing Systems Matter will promote educated decision-making based on total life cycle cost (LCC), thereby accounting for the costs associated with energy consumption, water usage, seal maintenance, equipment maintenance, productivity losses, and environmental monitoring. *Sealing Systems Matter* will utilize newly developed educational materials, on-site training programs, technical presentations, and software tools to take the LCC message to facilities owners, plant managers, operators, contractors, engineers, consultants, and other stakeholders.

Background

Optimization of sealing systems represents a significant opportunity for North American industry to save energy, improve equipment reliability and availability, keep abreast of changing environmental and safety regulations, and increase process plant productivity. Case studies have shown that better system design and more effective application of mechanical seals and seal support systems can save substantial amounts of energy through decreased process dilution. This represents a large, frequently overlooked savings opportunity. In addition, this same attention to the selection of seal technology and operation of the entire system can improve plant safety and environmental compliance, reduce water consumption, improve equipment reliability and reduce overall maintenance costs.

The *Sealing Systems Matter* initiative is the result of the collaborative efforts of members of the Fluid Sealing Association. Its purpose is to educate users and specifiers of mechanical seals and seal support systems in the cost reduction opportunities available to them, and to provide education and tools designed to assist in the decision-making process. This includes a software tool to assist in the calculation of comparative life cycle costs for the inevitable array of alternatives facing them when selecting and buying seals for use in their rotating equipment.

Opportunities for Sealing Systems Optimization

In today's business environment companies are expected to constantly improve their financial performance while dealing with tighter environmental regulations, increased occupational health and safety requirements, escalating raw material and energy costs, and competition from lower cost regions of the world. This has focused a great deal of attention on the need to reduce cost and optimize ROI in the short term.

As one might expect, this emphasis on short term cost reduction can encourage the uninformed buyer to focus primarily on "initial cost" when evaluating investments and operating decisions, potentially ignoring collateral effects that can have significant impact on operating costs throughout the life of the equipment. Buyers considering a longer term, more holistic perspective should make the effort to look beyond initial cost to identify these collateral effects, estimate their financial implications, and consider the total life cycle cost (LCC) of the investment and operating decisions they make.

In the case of mechanical seals and seal support systems used on rotating equipment such as pumps, compressors, mixers, and agitators, maintenance and reliability engineers have always had an intuitive understanding of the LCC trade-offs between "lowest initial cost" and "best available technology". They understand that dilutive fluids injected into the process stream through seal support systems can create a large energy burden downstream where these same fluids must be removed to restore process integrity. They know when equipment experiences repetitive failures, the consequences on maintenance expenditures and resources, equipment downtime, safety, and environmental compliance can far exceed the initial cost of even the most sophisticated sealing systems.

Faced with pressure from plant management and purchasing to reduce maintenance expenditures, many of these engineers have tried to present LCC arguments for buying the best available technology and optimizing the long term costs for their facilities. This has been difficult, however, because there has never been an agreed industry approach to the analysis of LCC for mechanical seals and seal support systems, even though there broad consensus that LCC can and should be an effective management tool in any cost reduction effort.

What is Life Cycle Cost?

The LCC (or Total Cost of Ownership) of any piece of equipment is the total "lifetime" cost to purchase, install, operate, maintain, and dispose of that equipment. Determining LCC involves following a methodology to identify and quantify all of the variables within the LCC equation. When used to compare possible seal arrangements and support system alternatives, the LCC process will identify the most cost effective solution within the limits of the available data.

The variables considered in an LCC analysis for seals typically include:

- initial purchase cost of the seal, support system, and auxiliary services
- installation and commissioning
- operating costs
- seal maintenance costs

- equipment maintenance costs
- energy costs
- down time and loss of production costs
- environmental costs
- decommissioning and disposal costs

Why should organizations care about life cycle cost?

In today's business environment there can be great temptation to consider only the initial purchase cost of a mechanical seal system. This approach can best be characterized as "penny wise and pound foolish". It is in the fundamental interest of users and specifiers of seals to evaluate the LCC of different solutions before specifying new equipment or making changes to existing installations.

To illustrate, consider a pump handling a process fluid with entrained solids. As always, the user has several seal options available to choose from:

1) Relatively inexpensive seal ($500 each) with no external support system.
2) Relatively inexpensive seal ($500 each) with an external flush support system.
3) Relatively expensive seal ($2000 each) designed to operate in the process fluid without a seal support system.

In selecting option 1, the user will soon discover that he/she is replacing seals on a frequent basis, because the design and materials of construction are not suitable for abrasives and the seals are wearing out or clogging up. The user could rationalize that "the seals are not all that expensive" and he/she is happy changing them whenever they fail. If, however, he/she were to objectively consider the total costs associated with the loss of production, the additional parts and labor required to rebuild the pump, the additional effluent treatment costs to mitigate the leakage, the potential safety and environmental consequences, the housekeeping effects, and the damage that frequent leakage and rebuilding is inflicting on the pump, he/she might not be so content with his/her decision.

In option 2, the conventional (and simplest) approach to extending seal MTBF is to pipe a constant supply of water to a connection into the seal chamber. Introduced at a higher pressure, the water "flush" displaces the process fluid and allows the seal to operate in a "clean" environment. However, in order for this system to be effective the flow into the seal chamber must be significant, usually measured in GPM. All of this water flows through the back of the seal chamber directly into the process stream. In some applications this may have little consequence. In most, this water will need to be removed from the process downstream to restore product integrity, at significant cost in terms of energy consumption and effluent treatment.

Option 3 requires that a "best available technology at lowest life cycle cost" approach be chosen. The user will research and select a seal designed specifically for handling solids, fitted with superior materials of construction suitable for long term use in abrasives. Such a selection might initially cost several times the other choices, but an LCC analysis will show that over the life of the equipment Option 3 will save tens (sometimes hundreds) of thousands of dollars in water and energy consumption, maintenance, and effluent treatment. Multiplied by hundreds of pumps in the plant, the total impact is significant.

Following are the results of an LCC analysis using typical values in the FSA Life Cycle Cost Estimator for the three options described above.

Inputs*	**Option 1**	**Option 2**	**Option 3**
Seal type	Conventional Seal for general water / chemical duty applications	Conventional Seal for general water / chemical duty applications	Slurry Seal with design features and materials for abrasive applications
Seal Support System	None	Clean water flush into seal chamber –1GPM	None
Initial Seal Cost	**$500**	**$500**	**$2000**
Seal replacement cost / failure	$250	$250	$1000
Equipment repair cost / failure	$1500	$1500	$1500
Lost production / failure	$1000	$1000	$1000
Estimated seal life (MTBF)	6 months	24 months	24 months
Cost of clean water flush	$0.50 / 1000 gallons	$0.50 / 1000 gallons	$0.50 / 1000 gallons
Cost to remove flush water dilution downstream	$70.00 / 1000 gallons	$70.00 / 1000 gallons	$70.00 / 1000 gallons
Estimated life of equipment	20 years	20 years	20 years

Outputs* **(see definitions below)**	**Option 1**	**Option 2**	**Option 3**
Annual equipment repair cost	$3,200	$800	$800
Annual seal repair cost	$500	$125	$500
Annual lost production cost	$2,000	$500	$500
Annual Energy consumption	$139	$36,931	$139
Life Cycle Cost (PV)	**$44,165**	**$289,012**	**$16,534**

*In the interest of brevity not all Inputs and Outputs are listed above.

As this example shows, an LCC analysis will identify (sometimes in fairly dramatic fashion) the most financially attractive alternative considering all cost elements, not just those relating to the initial project spend, maintenance budget, or purchasing spend. In the final analysis it is the overall profitability of the operation that will define its ability to compete in global markets and therefore the viability of the plant to continue operations. A manager that practices "lowest initial cost" over LCC will likely see some short term savings, but over the long term the cost penalties will almost certainly put his/her plant at a competitive disadvantage versus others who take a longer term, more holistic view.

In addition to the economic reasons for using LCC, many organizations are becoming increasingly aware of the environmental impact of their businesses on the nation's capacity to produce energy, and are initiating energy conservation programs with a view to reducing power generation emissions and preserving natural resources. One initiative in support of energy conservation in the process industries is *Pump Systems Matter* sponsored by the Hydraulic Institute, a trade association of Pump manufacturers. Additional information can be found at www.pumpsystemsmatter.org .

An industry standard tool to estimate LCC

As part of *Sealing Systems Matter* the member companies of the Fluid Sealing Association have come together to develop and distribute a comprehensive, web-based, Life Cycle Cost Estimator for sealing systems, based on the following goals:

- Provide a greater understanding of the components of sealing system LCC.
- Identify opportunities for industry to significantly reduce energy, operating, and maintenance costs.
- Contribute to environmental responsibility through reduction in energy consumption, emissions, and waste.
- Make industry more competitive in the world markets through increased productivity.
- Encourage buyers and specifiers to take a “best available technology” approach versus “lowest initial cost”.
- Establish a sealing industry LCC standard to ensure acceptance of the concepts and outputs.

The Life Cycle Cost Estimator is logically and clearly organized to prompt the user for his/her own application and utility cost assumptions for up to three (3) different Mechanical Seal and support system scenarios, including Compression Packing and Sealless Pump options. The tool calculates the "lifetime costs” associated with each scenario, and presents the conclusions in Present Value (PV) for the following cost variables:

C_{ic} Initial Purchase Cost
This is the initial cost to purchase the sealing solution, and may include engineering, bid process expenses, P.O. administration, testing, source inspection, and initial spares as appropriate, provided all scenarios are treated in a similar fashion.

C_{in} Installation Cost
These costs may include special area preparations, installation and connection of utilities piping systems, electrical wiring and instrumentation, installation of auxilliary systems, and special services required at start-up.

C_o Operating Cost
These are the costs associated with the consumption of utilities needed to support the sealing scenario such as cooling water, flush and quench fluids, buffer and barrier fluids, barrier gas, and/or effluent treatment.

C_{sm} Seal Maintenance and Repair Cost
These are the costs associated with the reconditioning of the mechanical seal or the replacement of the packing, lantern ring and sleeve.

C_{em} Equipment Maintenance and Repair Cost
These are the collateral costs associated with the need to perform repairs and replace parts on the equipment due to the failure of the sealing solution.

C_e Energy Cost
This is the frictional power consumed by the seal or packing, or the incremental power consumed by the sealless pump due to its comparatively lower efficiency (i.e. total power consumed minus power consumed by a conventional pump). It is also the energy consumed in additional downstream processing to remove flush-to-process dilution and/or restore process temperature.

C_{lp} Downtime and Loss of Production Cost
This is the cost of lost production resulting from the unexpected failure of the sealing solution affecting the operation of an entire production unit. It is seldom a precisely calculated value, but rather a rule-of-thumb estimate of the "opportunity cost" of downtime.

C_{env} Environmental Cost
This is the cost of complying with environmental regulations for the particular scenario selected (e.g. monthly OVA sniffing of single seals). It could also include penalties and fines for fugitive emissions if these are regularly occurring in an existing application.

C_d Decommissioning and Disposal Cost
Although not usually considered, the disposal costs for a sealless pump, several mechanical seal assemblies, or many packing sets consumed over the lifetime of the equipment may be significant if the product handled is extremely hazardous.

A report can be easily printed to support specification, proposal, or Management of Change documentation. The detailed output from the Life Cycle Cost Estimator shows the potential for reductions in energy, water usage, maintenance, and total LCC. It is intended to be used by reliability, maintenance, and project engineers, consultants, plant operators, and seal manufacturers and their representatives as well as government agencies and municipalities and others responsible for buying, applying, and operating mechanical seals and seal support systems.

The Life Cycle Cost Estimator is not intended to offer an accurate method of calculating the absolute total cost of seal or sealing system ownership. It is expected that each company, plant, or user will make different assumptions and assign different values to input variables when conducting an LCC analysis, and actual results will therefore be different. However, the Life Cycle Cost Estimator will provide an effective tool for comparing LCC for two or more possible sealing systems within an organization utilizing comparative cost values.

Nor is it suggested that the lowest LCC be automatically selected as the best solution. A user comparing three different sealing options could find that their analysis produces LCCs of $30,000, $40,000 and $150,000 respectively. He/she might have good reasons for preferring the $40,000 seal over the lower cost option (standardization, supplier preference, equipment familiarity, etc.) — but at least he/she will know that it is probably a good idea to reject the $150,000 arrangement.

The Life Cycle Cost Estimator for sealing systems can be found on the FSA web site at www.fluidsealing.org .

Summary

In today's business environment there can be great temptation to consider only the initial purchase cost of mechanical seals and seal support systems. Such an approach, without due regard for the collateral costs generated by such decisions, can add significantly and unnecessarily to the overall cost burden of a process plant, making it increasingly less competitive in the global marketplace.

The members of the Fluid Sealing Association feel a strong responsibility to develop, manufacture, recommend, and support products which will provide our customers with the highest levels of reliability, safety, and environmental compliance. In recent years the total life cycle cost of sealing products has been dramatically reduced through improved materials and designs, and these products are in wide use across the process industries. However, North American industry has a long way to go before we can say we are utilizing best available technologies and optimizing LCC throughout.

A significant lack of understanding currently exists regarding the optimum application and operation of sealing systems. This contributes to excessive operating costs, which can only be adequately analyzed through a calculation of total life cycle cost. While the concepts of LCC are fairly well understood, to date it has been extremely difficult for users and specifiers of Mechanical Seals and Seal Support Systems to actually develop an LCC analysis due to the complexities involved.

The Fluid Sealing Association has recognized this difficulty and has introduced its *Sealing Systems Matter* educational initiative to bring better understanding and practical tools to the marketplace. Through the anticipated success of this initiative, we hope that more customers will adopt an LCC approach to their decision-making resulting in expanded use of best available technologies, improved plant operations, and a lower cost base leading to enhanced competitive position for our North American process industries.

About the Fluid Sealing Association

The Fluid Sealing Association (FSA) is an international trade association. Founded in 1933, membership today represents over 85% of the manufacturing capacity for fluid sealing devices in North America. Our membership is most heavily concentrated in North America, but also includes a number of companies in Europe, Asia and South America.

Contact:
The Fluid Sealing Association
994 Old Eagle School Road #1019
Wayne, PA 19087
Unites States of America
+1.610.971.4850
www.fluidsealing.com