economics of long-term leasing of membrane-based water make-up systems

Author: John C. Kiernan, Ionics

This paper was originally presented at the 58th Annual International Water Conference, November 3-5, 1997, Pittsburgh, Pennsylvania. Reprinted with the permission of the Engineers’ Society of Western Pennsylvania. Copyright © 1997, Engineers’ Society of Western Pennsylvania

Note: Ionics was purchased by SUEZ in 2005.

summary

Upgrading conventional boiler feed systems with membrane-based water treatment processes continues to be a growing trend. This paper reviews the factors affecting fixed cost contracts, and gives suggested guidelines for bid preparation.

introduction

Historically, water treatment for boiler make-up and process requirements has been relegated to an experienced employee of the end-user. These water “gurus” were to maintain an aging ion-exchange demineralizer and provide a consistent quality product to the plant’s boiler house and/or storage tank. System economics were given only a cursory look as there were few alternative water treatment options to consider.

With the general acceptance of reverse osmosis (RO) in the mid-1980s, and the introduction of alternative membrane-based processes such as electrodeionization (EDI) in the mid-1990s, the industrial water treatment user now has expanded options for consideration. Therefore, the evaluation of the plant’s specific needs and the related economic evaluation around alternative options has become more complex.

Today, numerous process options should be considered when evaluating the decision to upgrade a company’s make-up demineralization system. These options include filtration, softening, coagulation, reverse osmosis (RO), double-pass RO, EDI, off-site regenerated ion exchange, on-site regenerated ion exchange, ultrafiltration (UF), microfiltration, and ultraviolet light treatment. Today’s best treatment options often consist of a combination of processes, and the end-user may need to get proposals from a variety of suppliers before determining the overall economics of the treatment process.

Life-cycle cost comparisons require a look at relative operating costs, amortization costs, estimated membrane replacement costs, degree of operator involvement, maintenance costs, etc. However, these evaluations may be quite complex and a plant may enter into a purchasing process which does not fully consider all the life-cycle cost criteria. A supplier, in turn, may submit a proposal to meet specifications which does not offer alternative treatment options such as those that may have a higher capital cost but a lower overall operating cost.

It is not surprising that many end-users are now embracing long-term leasing of membrane-based water make-up systems as an attractive alternative to capital purchase. Power utilities, both fossil-based and nuclear, were the first to use the long-term leasing option and, more recently, municipalities, refineries, and chemical manufacturers have turned to the full-service contract as a way to ensure long-term high-quality water at an optimized cost. It is not just a matter of low-cost financing. A whole array of value-added incentives contributes to the economics of leasing a membrane-based water system.
This paper focuses on the various advantages of a long-term leasing contract in comparison to either short-term leases or capital purchases. It also gives several recommended guidelines that a company should follow to ensure it receives proposals for the most reliable and economically attractive systems to meet their facility’s requirements.

It should be emphasized that every situation is slightly different and that companies must determine which procurement approach is best suited to their specific requirements.

capital purchasing vs. leasing

Capital Purchasing

Getting Started. The most common way to upgrade a demineralization system is still capital equipment or systems purchase. Generally speaking, a company assigns an internal project engineer or hires a consultant to begin properly sizing a system and evaluating treatment options. He presents a budget to management and enters the capital requisition into the budget process for the purchase in the upcoming fiscal year. The capital requisition process can vary significantly, depending on the specific corporate culture and purchasing philosophies. Attention must be paid to make sure alternatives are appropriately evaluated to compare capital and operating costs and the overall economic impact.

The Formal Bid Process. The formal bid process begins with water treatment suppliers bidding a system that meets the bid document specification. Often, rigid specifications require suppliers to change existing in-house designs. In certain cases, alternative bids are not allowed so as to simplify the evaluation process. The engineering costs associated with modifying the supplier’s existing design are included in the bid proposal and a formal quotation is sent to the customer. The evaluation of the supplier’s proposal requires in-house expertise to ensure compliance with the specification, or in the instance of an alternative bid, compatibility of the proposed system with the plant’s needs.

Installation and Training. Once the supplier is selected and the system is purchased, installation begins. Omissions or ambiguities in the bid specifications can open the door to change orders. This may result in adversarial relations between the purchasing party and the supplier’s on-site manager. The net result of the requisition is that the plant is now responsible for the expertise required to operate the new system. Training of the plant operators is generally overlooked beyond the obligatory week-long initiation offered by the supplier. Plants must train several operators, and anticipating turnover, will need to maintain an ongoing training program. Membrane treatment processes have particular operational needs, and with inadequate training, the possibility exists to irreversibly damage the system. Various courses are taught in troubleshooting membrane-based systems. The fact that they continue to be well attended indicates that a real need for advanced operator training exists.

Warranty Issues. A frequently overlooked hidden cost of capital purchases is found in the form of non-enforceable guaranties and warranties. When a supplier must bid a system to rigid specifications, the customer is responsible for the design’s performance. A supplier will agree to accept responsibility for the system performance only if the feed water conditions are within the specified range, and if the operating and maintenance records clearly demonstrate the proper operation of the system.

Leasing

General. A direct contrast to capital purchasing is long-term leasing. Leasing a membrane-based system is a rapidly growing trend in the water treatment industry. Leases can take many forms from straight equipment leases called Build-Own-Operate (BOO) contracts to Build-Own-Operate-Maintain (BOOM) contracts to Build-Own-Operate-Transfer (BOOT) contracts. For BOOT contracts, the water treatment plant is turned over to the lesser for a residual fee at the end of a set period of time.

Each lease is as individual as the feed water it is treating. Under the terms of a full-service lease or BOO contract, the customer is paying to have the equipment supplier maintain a minimum level of acceptable water quality in the treated water storage tank. If quality or quantity are not maintained, the customer does not pay, and in most cases, the supplier must also provide emergency service if they cannot fulfill the contract.

Simplified Procurement Process. The procurement process is immediately simplified in a lease purchase. By issuing performance specifications and site restrictions, a project engineer can prepare bid specifications quickly. The supplier must then optimize the process to ensure the lowest life-cycle costs. Procurement time is dramatically shortened.
and the need for a long-term budget planning cycle is eliminated. In most cases, the cost of water to the facility in a long-term lease contract is lower than what the existing equipment produces. This lets the facility realize an immediate benefit to the bottom line and justifies the negotiated contract in the first month of operation.

**Simplified Bid Process for Suppliers.** From the supplier’s viewpoint, the bidding process is also shortened with a long-term lease. By owning the system, suppliers can use standard designs and materials, significantly reducing design, and fabrication costs. Most experienced suppliers of membrane-based water treatment systems have multiple designs ready for fabrication. Drawings, bills of material, and photographs of the equipment are, typically, immediately available to the customer.

**Simplified Bid Evaluation Process.** Assuming that the contract is written to ensure reliability, a fast delivery and the cost of water are the customer’s two main concerns. In cases where reliability is in question, the water treatment supplier should be asked to provide current references with on-line percentages. It is also recommended to verify that the equipment to be provided is similar to that used at other sites.

**What are the costs of supplying water?**

The costs of supplying water include the following elements:

- Capital costs of process equipment
- Site-specific costs
- Process risk
- Operating and maintenance costs
- Length of contract

These factors are interrelated in nearly every combination. A supplier must determine the optimum balance of design and function to offer the customer the most competitive price while obtaining a reasonable return. Generally, the longer the lease period, the more options available to the supplier in optimizing the system’s design.

Following is a review of each factor.

**Capital Cost of Process Equipment.** The costs of the equipment provided can be defined as the capital costs associated with the design and fabrication of the treatment process, less the residual or recoverable costs of the unit after the term of the lease.

If a company is allowed to supply a standard system, the recoverable costs of the unit, or the ability to use it elsewhere, is high. The supplier can amortize the equipment over a standard length of time, generally ten to fifteen years, regardless of the length of contract.

Obviously the more complicated the process, the higher the cost of the equipment. But with a lease system, the vendor can over-design the system in order to reduce operational expenses and risks.

Figure 1 shows the monthly amortization cost per $100,000 of investment for varying lengths of contracts at various rates of return. For instance, at a 10% Return on Investment (ROI), a systems’ supplier would consider investing an additional $100,000 in capital on a 10-year contract, if the additional equipment realized a $1,321 savings per month of operating expense.

---

**Figure 1: monthly fee per US$100,000 of investment**

An example of such a situation is the use of ultrafiltration as a pretreatment to RO. UF has demonstrated its ability to reduce RO membrane replacement costs by lowering the Silt Density Index (SDI) of the feedwater.

**Site-Specific Costs.** Site-specific costs include installation, project-specific engineering, and any special process requirements that have a net zero residual value at the end of the contract. Decommissioning and return of the equipment is also included. Site-specific costs must be recouped over the life of a contract or as a balloon payment at the end of the lease period.

The effect of site-specific costs on the monthly price of the leased equipment can vary significantly, depending on the contract duration.
Recently a company asked for bids on a high purity water system to produce steam. Contract periods of 1, 3, and 5 years were requested. Capital costs were US$300,000 and site-specific costs US$24,000. Assuming a 10% ROI is targeted, Figure 2 shows the breakdown of the three contract prices.

![figure 2: Effect of contract length on site specific charges](image)

Reducing site-specific costs has a direct and dramatic effect on short-term leases. Thus, most suppliers prefer trailer-mounted units for ease of installation and decommissioning.

For longer-term leases, site-specific costs have less of an impact on the monthly charge. It is not uncommon for the vendor’s site preparation requirements to actually expand in an effort to relieve the customer of any up-front capital costs.

While short-term leases favor the trailer-mounted systems, the reverse is not always true. Trailer-mounted systems have been found to be economical on several long-term leases including a 25-year lease to a West Coast utility.

**Process Risk.** Process risk can be defined as the contingency costs associated with the process operation of the leased system. Process risk is directly tied to the feed water characteristics and product water requirements. Surface water feed sources generally have a higher process risk than well water, due to their variability in quality. Fluctuations in turbidities, salinity, and temperatures require increased pretreatment and operator expertise.

When determining a fixed monthly cost, a supplier must estimate the effect of feed water fluctuations on operating costs. Severity, as well as duration of difficult feed water conditions, must be approximated and incorporated into the supplier cost make-up.

Customers can reduce process risk by properly defining the quality characteristics of the feed water. A range of values must be obtained to guide the supplier in what should be considered a proper design basis.

When ranges of values are too wide, or when upset conditions are expected, it is helpful to let the supplier attach a surcharge to the base cost of the system. This lets the lesser offer a realistic base lease cost and still be covered in the event of an anticipated feed water upset.

Process risk can also be reduced by extending the lease period. As previously discussed, long-term leases allow for the conservative design of pretreatment and process control. Long-term leases also give the opportunity for the equipment supplier to staff the site with high-quality long-term employees.

**Operating Costs.** Operating costs consist of utilities (power, water, etc.), chemicals, membrane replacements, instrument calibrations, spare parts inventories, maintenance, and operational labor. If a system is properly defined, a supplier can guarantee power requirements. Power costs can then be excluded from the terms of the negotiated contract. The same is true for the cost of the raw water and discharge of waste water from the system. This type of contract greatly reduces the complexity of monitoring the utility costs.

Other operating costs, such as membrane replacement, treatment chemicals, and spare part inventories are lower for a system supplier because of the purchasing power of an OEM. If a supplier uses a standard design, spare part inventories can be further reduced by maintaining a central supply for multiple sites.

In addition, a long-term leased system has a series of operational benefits over a capital purchase or short-term lease system.

The quality and training of the operator of a long-term based system is greater than the normal plant operator. The supplier-furnished operator is part of the company’s core business. The operator is normally cross-trained on a series of water treatment processes, and in the event of a problem has the resources of the entire corporation to draw upon.

In the event of a system problem, the revenues from that site are affected. This arrangement guarantees a quick response from the supplier. In addition, a support staff that is continually increasing their database of water treatment knowledge is only a phone call away.
Operational monitoring can be conducted by computer phone links, allowing troubleshooting and, in some instances, rectification of programming problems from remote sites. While such equipment is available on a capital purchase, it is generally not installed due to capital constraints.

In the event of employee turnover, an experienced full-service supplier will draw on several “floater” operators until a suitable replacement is found and trained on the system. Training costs for these floating operators can be spread out over a number of lease installations.

Generally, labor is not included on short-term rentals due to the prohibitive costs of temporary living expenses for the supplier’s employee.

Length of Contract. Most system costs are tied directly to the length of the contract period. The longer the contract period, the more process design options are open to the system supplier.

Site-specific and capital costs are spread out over a longer period, greatly reducing their impact to the monthly fee. Process choices that focus on operating costs and long-term reliability are promoted.

Operating costs are reduced by implementing a preventive maintenance program based on dozens of similar designs. Training and expertise of the operating personnel is enhanced.

The warranties and guaranties of the system rest solely on the system supplier. Operating and maintenance records are the burden of the supplier, and any inability of the system to meet the lease criteria is outside the responsibility of the customer.

recommended guidelines

The evaluation of a lease system over a capital purchase is a site-specific decision. Depending on the uniqueness of the required treatment process, knowledge base of in-house personnel, and company purchasing philosophies, and culture, the option of leasing a membrane-based water treatment system can prove beneficial to the customer.

By incorporating the following guidelines into the Request for Quotation, a customer can receive the full benefits of the supplier’s expertise, and ultimately realize the lowest production costs for the water make-up requirements.

reduce process risk

On bid specifications, specify the feed water qualities and indicate a knowledge of the fluctuations of the feed source.

avoid a unique system

Use existing, standardized designs to lower engineering, and design costs.

minimize site-specific costs

Minimize the effect of site-specific costs by preparing the site before installation of the leased equipment, or examine the option of trailer-mounted systems.

commit to a long-term lease

Extend the length of the contract to allow for the installation of a capital-intensive system and to minimize the effect of site-specific costs.

allow for process improvements

As the length of a contract is extended, the likelihood for additional process options available to the supplier increases. Dramatic improvements in membrane performance, reduction in power requirements, or innovative pretreatment methods will continually occur in the water industry. Suppliers of leased systems should be encouraged to modify the installed system to improve the overall economics of the treatment process.

summary

The leasing of advanced water treatment equipment and services is a continuing trend in the marketplace. The economics of using an outside supplier for the production of make-up water is based on the shifting of risk from the customer to the supplier. In most cases a supplier has a lower risk involved in operating a membrane system than the potential customer, and therefore can offer the service for a lower cost.

The economics of leasing a system are not restricted to the least expensive source of money, but based on a collection of interrelated factors affecting overall system costs. In all instances, the length of contract directly affects these costs.

Realizing the relationship between costs and contract length lets the customer structure the Request for Quotation to get the best response from the supplier.
references


