The Secret to Achieving More Than 40,000 Operating Hours on Gas Seals

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Introduction

As today's oil and gas industry continues to respond to the changing dynamics of a world economy, there is little argument that compressor reliability and uninterrupted operation are paramount and crucial to plant operation. Compressor sizes continue to increase, as do their cost, and spare compressors simply aren't an option. Further, the operating requirements such as pressure rating and speed continue to expand beyond original intent, resulting in compressors being taxed beyond their design capabilities. One means to improve reliability though, is the integration of dry gas seal technology. Proven as a solution for almost two decades on thousands of installed units, the dry gas seal has been shown to improve compressor and plant reliability, as well as product quality. However, the key to success in achieving optimum reliability is selection of the right dry gas seal and control system as well as a commitment to training and commissioning/operational procedures.

From the Beginning

A recent analysis of refurbished gas seals used on compressors conducted the world's largest supplier of engineered sealing systems and associated products, validates that a majority of all seal failures result from lack of clean and dry sealing/buffer gas supplied to the compressor. This high frequency is significant because far too many companies invest their money and efforts in monitoring or recording gas seal leakage flow, yet devote little emphasis to reliability and prevention of problems in the first place. More often than not, seals fail due to lack of a continuous supply of clean, dry sealing/buffer gas that is critical to successful operation and seal longevity. Unfortunately, this extremely critical requirement is often ignored throughout the planning, commissioning and operating process. Flooding the compressors and seals with trapped water and/or liquid during hydro-test, as well as piping errors, are among the common and costly mistakes that result in seal failure at start-up. This shortcoming, particularly during the commissioning period, results in multiple seal failures, which cause operational loss and delay in start-up.

The review of the Corrective Action Request (CAR) on several returned seals strongly suggests that optimal reliability is often sabotaged during initial construction and seal selection. Optimum seal life and compressor reliability begins in the early planning stage with a thorough review of plant flow and operations,specification compliance, safety codes and the local environmental regulations and factors. With this information in-hand, review the intended process fluid including gas composition, operating pressure and temperature, liquid and contaminate level in the process, nitrogen availability, and the auxiliary buffer gas requirement. Finally, review the project parameters in terms of schedule and budget constraints.

Seal Selection

Armed with this information, the next step involves selecting the optimal dry gas seal that meets the specified parameters. The dry-running, non-contacting spiral groove sealing concept was introduced to the compressor industry in the early 1980s in response to the growing demand for increased operating design, as well as for compliance with regulations focused on Volatile Organic Compounds (VOC). The seal's technology is based on face separation resulting from hydrodynamic lift that occurs because of a spiral groove design. This face separation results in slight leakage – the flow rate of which is a function of sealing pressure and speed -- across the faces. The fact that the seal faces are not in contact during operation also is significant, as no face wear or frictional heat is created. Therefore, a non-contacting seal requires no circulating cooling fluid at normal compressor speed, and no process contaminant particles are transferred into the product. Users of the gas-lubricated non-contacting seals also report that installation and maintenance are less expensive than with wet sealing systems.

Non-contacting, dry-running seals are available in tandem and double seal arrangements. The tandem arrangement gas seals are commonly used on ethylene and propylene applications. The first seal operates as a primary seal, while the second functions as a back-up device. Process gas from the discharge line of the unit is piped to the control system supply line, and this control system then regulates and filters the buffer flow before it is injected to the primary seal. Leakage across the primary seal is piped to the flare. The pressure and/or leakage flow rate are monitored and recorded to ensure that the seals function properly. To comply with emission requirements, an intermediate labyrinth is installed between the primary and secondary seals. A controlled nitrogen flow rate of 1 acfm at 2 to 3 psi above flare pressure is injected between the two seals. As a result, leakage flow across the secondary seals remains as inert nitrogen gas. This sealing arrangement meets and often exceeds the fugitive emission regulation issued by the EPA, as well as the 1991 California South Coast Air Quality Regulation Management District directive limiting fugitive VOC emission to 1,000 ppm.

In contrast, the double seal arrangement consists of two seals facing each other. Nitrogen or inert buffer gas at 20 to 30 psi above sealing gas is injected between the two seals. Although the double seal arrangement provides zero emissions, slight amounts of buffer gas are expected to leak into the process fluid. A tandem seal arrangement is normally specified for refrigerant applications, such as propylene and ethylene, to avoid the process being contaminated from buffer nitrogen leakage.

Another thing to consider is the selection and design of a control system since key to optimum seal performance is to ensure that clean and dry buffer gas is available at all times. The modern control system equipped with Gas Conditioning Unit (GCU) has proven to advance the performance of dry gas seals by solving critical gas supply issues. Unlike conventional gas panels that only incorporate coalescing filters, the GCU features a knock-out filter/coalescing vessel that removes solid particulates as well as free liquids and aerosols. A heater controller also monitors and maintains gas temperature. Maintaining gas temperature above its dew point prevents condensation of aerosols in the process gas stream. Therefore, the collective features of the GCU effectively manage liquids to ensure the cleanest possible gas supply is available at all times. With minimal customer interface connections and self-controlled, self-regulated functions, the GCU meets the difficult sealing challenges faced by many in the industry.

Training is Key

Another common source of problems is lack of planning and training. For example, many maintenance technicians in plants with dry running gas seals have never received training in seal operation and maintenance. Technicians familiar with wet seals are used to flooding the seal cavity with no consequences, however, in contrast, dry running seals require no lubrication, which means the faces have to be isolated from bearing oil all the time.

Training has to be an integral part of the maintenance and operations process prior to the commissioning period and any short-cuts will likely result in a costly plant start-up. Contrary to common practice by many in the industry, mechanical failure or delivery of a new pump or seal is the wrong time to begin a training program, let alone acquaint oneself with the compressor, pump or seal operating manual. Rather, training programs should be arranged as part of supplier selection. The compressor, pump and mechanical seal manufacturers, as well as the engineering firm, should offer training as part of their service. Also, it is essential that your seal manufacturer provide on-site technicians to help you improve equipment reliability – Mean Time Between Repair (MTBR) – and overall plant productivity. Be wary of any supplier that promises the best technology, yet simply ships you a box containing a product without delivering the proper support.

Finally, communication among all players is vital. Too often, finger-pointing between the engineering firm, compressor technician and the seal manufacturer occurs. Without a clear understanding and effort to bring all parties to the table at design onset, there is sure to be problems.

Successfully Commissioning the Compressor System

After performing the necessary planning and training, the all-important commissioning process occurs. However, once again, without a thorough review of the environment and all factors, even the best laid plans can result in seal failure. In fact, 99 percent of all dry gas seal failures that occur during commissioning are not caused by seal failure. Rather, failure results from a variety of factors including: a flooded compressor with oil/liquid, foreign contaminates in the seal's cavity, problems with the alignment, piping and/or instrumentation.

With so many factors necessary for a successful compressor start-up, it is important to develop a team of critical component experts for the commissioning. This team should include, yet not be limited to, the engineering company that selects the critical components, compressor manufacturer, seal manufacturer, and the plant owner/operator of the compressor. Clearly defined areas of responsibility for each party are essential, especially for the many steps that must occur in conjunction with another function or team member. More often than not, unproductive and lengthy start-up periods are a result of parties not fully understanding the responsibilities and roles of each of the critical partners.

Ironically, the time when everything must come together -- the start-up -- is often the only time the team physically comes together. As such, it is crucial to change this model by opening the lines of communication at the beginning of the project -- not at its culmination when it is too late to effect change. The following guidelines have proven to aid sustainability and increase productivity.

- Focus on creating a shared document – **a strategic agenda --** that leads participants to action, creates a forum for comments, and outlines ideas, concerns and possible bottlenecks. Goals and objectives must be commonly understood and agreed upon by all parties involved with the commissioning.

- Create a clear, agreed upon **process for reaching these goals**. This process must include reviewing the compressor start-up checklist and assigning definitive deadlines and responsibilities. To be effective, requests should be recorded, tracked, and reviewed at each compressor start-up.
- Recognize that other critical partners have data that is crucial to successful implementation, so **share information**. This step includes asking questions and communicating before the compressor start-up, as well as gathering any necessary materials. Make sure someone captures the agenda, discussion points and action items.
- Encourage each critical partner in the commissioning process to develop a **sense of involvement and empowerment**. Such an environment creates ownership, as well as fosters honesty and teamwork.
- ***Review the Compressor Start-Up.*** There is always chance for improvement, so schedule time near the completion of the start-up to review what happened and acknowledge the effort. Such an effort will give you the unique opportunity to troubleshoot future issues that may occur based on the history, documentation?

Final Thoughts for Success

Although it once seemed unthinkable, many members of the industry are now benefiting from 10-plus years of continuous operation of their compressor and seal arrangements. By selecting the proper dry gas seal and control system as well as engaging in adequate training and a thorough commissioning process, reaching the beyond 40,000 operating hours milestone is realistic – as is the resulting reliability and improved uptime.

About the Author

Joe Delrahim is Director, Type 28 Gas Seal Sales of Latin America of John Crane Inc.
Joe has a 35 years backround in turbomachinery market, he joined John Crane 30 years ago into the Engineering Department to design Dry Gas Seals, since then he has been supporting worldwide the product and market development.

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Appendix:

About John Crane

John Crane is the acknowledged technology leader and the world's largest manufacturer of mechanical seals and associated products. With a workforce of over 6,000 people in 50 countries, John Crane provides an unrivalled global presence combined with personalized local service and support. John Crane offers a comprehensive range of engineered mechanical seals and sealing support systems, mechanical packing, power transmission couplings and centralized lubrication systems under the brand names John Crane, Sealol, Safematic, Flexibox, Metastream, Powerstream, and Lemco. These products are sold widely into rotating equipment applications in Petroleum, Chemical, Pharmaceutical, Pulp & Paper, Power Generation, Food & Beverage, Mining & Minerals, Transportation, Industrial, Water & Waste, Refrigeration, Automotive, and Appliance markets. For more information, visit www.johncrane.com

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