When sealing aggressive and abrasive crude oil in pipelines, reliability and extended service intervals are required. Challenging conditions place high demands on the design limits of sealing and supply systems, which can handle frequent stops/starts and occasional pressure reversals or reverse pump rotation.

The Revised API 682 Mechanical Seal Standard

By Thomas Böhm and Markus Fries, EagleBurgmann

The 4th Edition includes details on the revised product coding system, the seal system selection process and seal supply systems.

After nearly six years of intensive work, the American Petroleum Institute (API) 682 mechanical seal standard is soon to be adopted. Since its introduction in 1994, API 682 has become "the" standard that sets the global tone for the procurement and operation of seal and supply systems for centrifugal pumps in the oil and gas sector as well as in the petrochemical industry. API 682 is a "living" standard that directly incorporates diverse practical experience in its regular updates.

Founded in 1919 and located in Washington, D.C., the API includes close to 500 companies from the oil and gas sector and the petrochemical industry. Since 1924, it has focused on technical standards. To this day, API has adopted roughly 500 standards that address diverse processes and components in detail—which ultimately ensure a maximum of operating and process reliability. API standards, which are clearly defined and in part attached to approval tests, do not only take effect in the U.S. In many cases, they have developed into worldwide industrial standards. API is often considered a synonym for safety and reliability.

Individual standards—including API 682 regulations for mechanical seals and seal supply systems—have become so popular that they have even been referenced in outside industry applications. The authors of the new edition point out that this was never the intention and clarify the actual purpose of the API 682 standards. The standards are for seal systems in pumps—not in agitators or compressors—and for oil and gas and petro chemistry—not for water supply or the food sector.

API 682 History

Initial information about mechanical seals was originally provided in the API 610 pump standard. During the 1990s, API 682 developed into a separate, more comprehensive standard for mechanical seals and supply systems. The API 682 standard is continually maintained and updated by end users and manufacturers. Another quality of API 682 is that it does not typically permit only a single technical solution. In addition to proven and tested standard solutions (defaults), the regulations also deliberately list alternatives (options) and even allow customized solutions (engineered solutions). This diversity is demonstrated more clearly in this edition than in previous ones.

The composition of the 25-member task force is representative of the practical way in which API approaches the topic of seals. Since 2006, the task force has been updating the 3rd Edition of API 682 that took effect in 2004 and is still valid. In addition to leading seal system manufacturers, the American-European expert panel—which intentionally counted on non-API member collaboration—also included renowned planning companies and representatives from some of the largest mineral oil groups, who are users of the seal solutions.

Checked and Tested Safety

While the currently valid API 682 edition included about 200 pages, the 4th Edition is 260 pages. The revised edition is organized into a body of text with 11 chapters and detailed annexes with a significantly expanded scope. For example, Annex I provides detailed information on more than 20 pages for API-conform seal qualification tests.

Default seals and options must be tested using five different media and clearly defined operating conditions representative of typical API applications. Together with the described seal designs, this yields a high number of possible test variations. In the process, the expended time per test and seal type can take up to 200 hours. The result for typical industry seal designs is documented in a test certificate and a detailed report. Customer-specific qualification tests can be agreed upon for engineered seals.

Essentially, checked and tested product safety is the core of the standard. The objective of API 682 is continuous operation of at least three years (25,000 operating hours subject to the legally stipulated emission values, or for maximum "screening value" of 1,000 parts per million by volume, EPA Method 21), increased operational reliability and simplified maintenance. The standards defined by API apply exclusively to cartridge systems with a shaft diameter of 20 to 110 millimeters and a defined range of operating conditions.

Coding System

The 4th Edition also includes the revised product coding system (Annex D). The proven classification parameters "Category," "Arrangement" and "Type" will be continued. They are listed first in the revised code and provide information about the setup and field of use of the respective API seal. The seal arrangement includes:

- Arrangement 1—single seals are differentiated
- Arrangements 2 and 3—double seals with and without pressurization

Details regarding the supply system—specified as "Plan"—are in the old and new code. The addition of precise information regarding material selection and shaft diameter is new. This gives more meaning to the code and guarantees a clear specification of the mechanical seal and its operation—from selection to

The Principle Innovations of API 682 4th Edition at a Glance

Mechanical Seals

- Adaptation of pressure limits: 20 bar (gauge) for Category 1, 40 bar (gauge) for Categories 2 and 3
- Detailed notes to engineered seals
- Combination of seal types in Arrangements 2 and 3
- Definition of vapor pressure margin
- Overview table of internal gap dimensions
- Selection of SiC face material independent of category
- Optional bellows material Alloy 718 for metal bellows seals, Type B
- Additional requirement for set screws for torque transmission
- New details regarding the selection and operation of pressurized double seal systems
- Reduced minimum gap at the internal pumping device

Seal Supply Systems

- Transmitters instead of switches
- Alternative arrangement selection method on the basis of Risk & Hazard codes
- New API Plans (03, 55, 65A, 65B, 66A, 66B, 99)
- Hydrostatic level detection for Plans 52, 53A
- Temperature measurement of gas bubble for Plan 53B
- 28-day refilling interval for barrier pressure systems
- Minimum pipe wall thicknesses of 2.5 millimeters for welded joints
- Temperature limits for instrumentation

documentation. Industry experts agreed that the expanded coding system will prove itself in practice and endure permanently.

More Precision During Selection

The selection process of an API seal system is complicated. Several flow charts and tables on more than 10 pages are dedicated to this topic in the new edition. To provide more precision in the technical selection process when determining the arrangement, an alternative selection tool (Annex A.4) has been included in the 4th Edition for the first time. This method is based on the established "Risk & Hazard Code" and has been tested in practice.

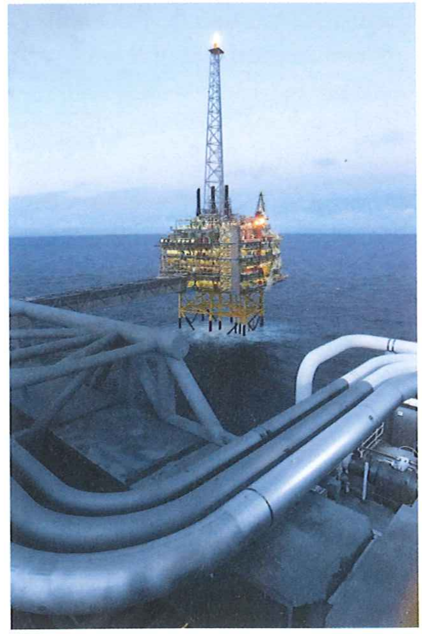
The starting point is the pumped medium. Its real hazard potential is accurately recorded and described by the "Hazard & Risk Code" in the "Material Safety Data Sheets." Decisions can be made quickly and securely, for example, about whether a single seal (Arrangement 1) will suffice, or if a double seal with barrier pressure system is required.

Practical Experience

The experience-based, "lived" standard of the API 682 edition is demonstrated by the two silicon carbide (SiC) variants, reaction-bonded silicon carbide and self-sintered silicon carbide, which are treated equally as default materials for sliding surfaces in chemical (Category 1) as well as in refinery/oil and gas applications (Category 2 or 3). Until now, sintered SiC was set for chemical applications because of its superior chemical stability, whereas the reaction-bonded variant established itself in the refinery sector. This restrictive allocation was canceled because of practical application examples (best practices) that were brought to the attention of the task force, which called for a course correction.

Chapters 8 and 9, dealing with the hardware for the supply systems and instrumentation, were subjected to intense revision. They were completely reorganized so that the topic is now handled in three stages, which makes it more systematic. The first block introduces the supply systems in total. The piping and the components are addressed next.

Numerous operators use robust seals in their gas injection compressors. Pre-configured seal management systems are also used to safeguard optimal operation of the gas-lubricated sealing system.



Statoil offshore oil platform

Seal Supply Systems

Plan 53 with a pressurized barrier fluid belongs to the more complicated supply systems. In detail, three types are possible:

- Plan 53A is the solution with the constructively least amount of effort. The pressure on the barrier medium is generated directly via gas pressurization—normally with nitrogen—in the tank. However, the application has limits, since higher barrier pressures could cause a dissolution of the nitrogen in the barrier medium. The consequence would be the risk of inadequate lubrication in the sealing gap of the mechanical seal. That is why Plans 53B and 53C are used for higher barrier pressure.
- Plan 53B uses a clever solution, which makes it popular. Pressurization occurs via an elastomer bladder in the reservoir that separates the nitrogen from the barrier fluid. Pressure monitoring with consideration of the temperature in the bladder accumulator records the values and transfers them

to the control room. The fill level with consideration of any temperature impacts is calculated there, and the correct time for refilling the barrier fluid is determined.

- Plan 53C works with a piston accumulator, which makes it among the more sophisticated seal supply systems.

A new prescribed refilling interval of at least 28 days has also been included in the 4th Edition of API 682. The fluid reservoir must be large enough to supply the seal with barrier fluid for this entire period—without refilling. To obtain the most compact reservoirs, the seal manufacturers are required to find optimized system solutions with minimal leakage values for the barrier medium.

Also, Plans 03, 55, 65A, 65B, 66A, 66B and 99 have been newly included in the regulations and, along with the already existing plans, are described in detail in Annex G.

Transmitters Replace Switches

Regardless of pressures, temperature, flow rates or fill levels, the 4th Edition heralds a change to modern transmitters for the supply systems. Switches had previously been the default, but transmitters have now taken the position. Although they can be more expensive, they transmit continuously measured values. The control room is now aware of the actual system status at any time and can immediately sound the alarm if problems arise.

The transition to transmitters as default is illustrative: the API specifications primarily concern operating and process reliability and only then consider economic viability. This universal application is also verified by the decision of the task force to only permit seamless pipes in the future for "Piping" for the supply systems. The use of welded pipes, which would be less expensive, was considered unacceptable.

The task force also addressed the topic of heat resistance of instrumentation used in supply systems pragmatically. In the past, frequent debates occurred regarding whether supply systems for high temperature applications—for example, a 400 C approved pump—have to be equipped with special instrumentation for high temperatures. Now the temperature specification for the instrumentation has been limited to 100 C. If instruments with higher temperature limits are required in the future, the customer has to inform the seal vendor accordingly.

A Clearer Structure

The essential improvements, in addition to the technical supplements and updates, are the clear structures of the latest API regulation. The body of the text was tightened and structured appropriately, whereas technical details and background information were placed in the annexes. Some of the wording in individual chapters was revised to improve understanding.

The improved user friendliness is shown in Annex E, which addresses structured communication and data exchange between suppliers and customers. Descriptions that previously encompassed many pages in API 682 are now bundled into two compact checklists in the 4th Edition. The first list systematically describes what must be considered for inquiries and quotations. It specifies the data that needs to be provided and the additional information and documents with which it must be combined. For example, seal systems that deviate from standardized API solutions must be shown separately. Annex E is completed by a second checklist that shows in which order the documentation is necessary.

Apart from the numerous technical updates and improved user friendliness, one detail is visually the most striking innovation of this edition: all mechanical seals are equipped with red plugs in the supply connections of the seal gland upon delivery. Until the unit is installed, these plastic closures prevent the ingress of dirt in the seal. During operation, the connections are either assigned to pipelines, or the plastic plugs are replaced with enclosed metal plugs. An additional benefit is that the 4th Edition API seals are quickly identified by the red plugs.

Thomas Böhm is head of standardization – Division Mechanical Seals – for EagleBurgmann and an API Task Force member. He can be reached at thomas.boehm@de.eagleburgmann.com or +49 8171 231048.

Markus Fries is product manager at EagleBurgmann GmbH & Co. KG, Wolfratshausen. He can be reached at markus.fries@ de.eagleburgmann.com or +49 8171 231161.

EagleBurgmann is a provider of industrial seal technology that is used in industries including oil and gas, refinery, power, chemical, energy, food, paper, water and mining. For more than 20 years, the company has provided its knowledge in further developing API specifications for the design of seal systems for the oil and gas and petrochemical sectors and is active in the API 682 Task Force. For more information, visit www.eagleburgmann.com.