Maximum safety and maximum simplicity

Fluiten is an entirely Italian company that has worked in the rotating shaft seal sector for over forty years. Fluiten mechanical seals are designed and built in strict compliance with DIN or API standards, and are mainly used in the petrochemical and energy industries. In refineries and petrochemical and chemical processing plants, the dispersion of dangerous toxic substances into the environment implies serious health, safety and environmental problems.

Metrology Lab

Although mechanical seals are simply accessory components of more important machines, they play a fundamental role in preventing and controlling risk situations. Fluiten has always stood out for its commitment in pursuing utmost quality and technological innovation by continuously investing in research and development. For a long time now, Fluiten has built highly reliable mechanical seals and has continued to invest in research into products and technology in order to optimize reliability and performance.

It is precisely these concrete facts that have convinced one of the most important (perhaps the most important) international companies in the oil sector, with sites and plants in Italy too, to turn to Fluiten for the supply of safety equipment for installation at its plant in Sicily. This company is also the most active in safety research for its plants. The request the company technicians sent Fluiten was simple in its wording, but highly demanding to meet: they wanted to be able to count on a reliable system where a safety seal steps in immediately if the primary seal leaks. In this way, the plant technicians are able to act in time to prevent process fluids from leaking out into the atmosphere and thus avoid irreparable damage.

FLUITEN Seal type BM6L

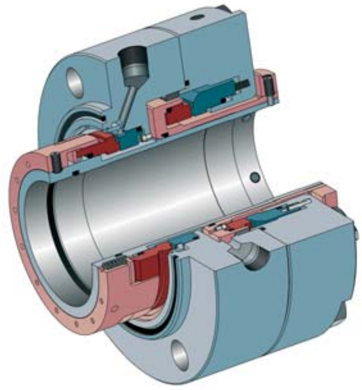
Among the most used set-ups to ensure high safety levels, the easiest to apply, particularly when adapting existing plants to the standards now in force, is precisely that of placing a back-up dry seal downstream from the primary one. This allows single seals to be replaced easily with only minimal space requirements. A lot more space is instead needed for seals fitted with buffer or barrier fluid tanks. The alarm system is also simplified to a line connected from the seal to the blowdown with a pressure switch which alarm any gas leaks from the primary seal before the gas can reach the surrounding atmosphere. In the case of liquid leakage, the system instead includes a leak detector with ultrasonic alarm or float. In this arrangement, it is essential to keep the back-up seal always efficient. It is therefore fundamental to establish its expected life and reliability even after years of operation, and when it has to contain a primary seal leak, whether it be of liquid at maximum working pressure (catastrophic effect) or gas after a long period of operation and/or during transient mechanical or hydrodynamic faults.

What makes the seal developed by Fluiten more reliable over time thus ensuring sealing assembly safety even after long periods of operation is the exclusive Fluigrid surface treatment on the extra-hard dry contacting mechanical seal faces. The treatment involves inducing controlled uniform porosity a few tens of micrometers thick over the whole sliding surface and incorporating carbon particles into the micro-recesses in the silicon carbide face. This creates a highly efficient self-lubricating contact surface resulting in insignificant wear and minimal heat generation.

During pump operation, the primary seal is lubricated by the pumped fluid itself in optimal flushing and temperature conditions, whereas the secondary seal - downstream from the primary one - runs dry.
The main problem the secondary seal has to face is the risk of overheating, since - unlike the primary seal - it has no lubrication. If the primary seal suddenly gives, the secondary seal finds itself in a highly critical situation: it suddenly receives the fluid from the pump, and is therefore instantly subject to high pressure and temperature without flushing. Consequently overheating problems may arise. Refinery technicians need to know what safety margin they have if a catastrophic event should occur, i.e. how long this back-up seal can hold before the fluid leaks into the atmosphere.

Fluigrid ring

The customer asked Fluiten to carry out specific lab tests on the seal in question precisely in order to assess this margin.
Fluiten's consequent efforts were therefore directed towards measuring the performance of their mechanical seals for light hydrocarbons, in this case LPG, by carrying out specific test cycles laid down by the customer in order to have more reliability information than that provided by the current test procedure laid down in the API 682 standard. For this purpose, Fluiten optimized both the electronic and mechanical parts of their existing test rig to create an automatic system able to monitor the behaviour of dry seals in the various operating conditions which may occur during the estimated life of a mechanical seal. The main parameters, such as pressure, temperature and rpm, may be changed automatically, and the respective resulting effects in terms of power consumption and heat generated are recorded both during dry operation and in lubricated conditions. With this data, it is possible to assess whether the mechanical seal temperature exceeds the critical vaporization or autoignition values of the fluid carried by the pump. It is therefore useful when selecting mechanical seals for use in critical areas.

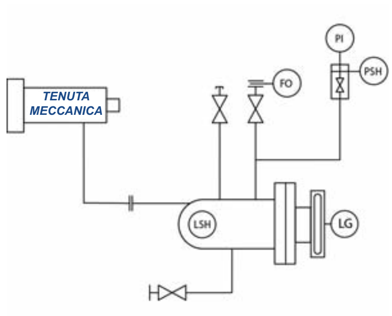


2CW-CS Contacting wet inner seal with dry-running containment

There are other safe alternatives involving mechanical seals, but they need much more complex monitoring systems than the solution proposed by Fluiten, and are very much more difficult to manage on the plant since they require a whole set of routine checks, refilling and connection to the control room. Even though these alternative solutions are considered the utmost in safety, they need a lot of space and are therefore difficult to install on old plants, which need adapting (the majority of plants which are decades old cannot be suitably adapted). They also have the drawback of being very costly even in newly designed plants. Unlike the solution Fluiten is developing together with its customer, the alternative systems require continuous manning to refill with barrier fluid and keep the pressure at the correct level (i.e.Plan API 52-53-53b). Consequently construction, installation and running costs are high.

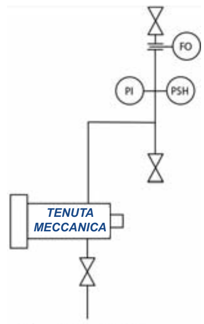
Test rig

The solution proposed by Fluiten was one of the first safety seals to be placed on the market about twenty years ago. Subsequently its use in the hydrocarbons field was restricted owing to poor knowledge of the limits of dry seals. There were occurrences where the primary seal gave and the secondary seal was not able to play the role of emergency seal because it had become too worn over time. It therefore turned out to be totally ineffective for the task it had been designed for. For this reason, this solution has always taken second place to others which were considered more credible in the past. We are therefore talking about a technology that was used with a few technical reservations by plant design companies, and which has not been taken into proper consideration till now.



API PLAN 75

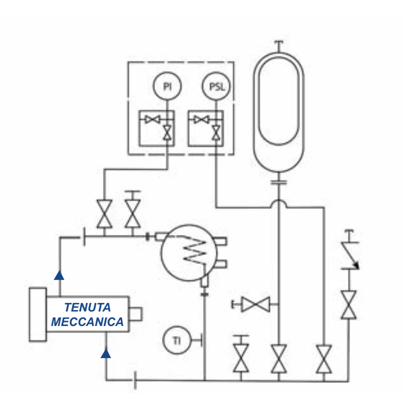
Today this solution is the most competitive on the market now that it has reached a high standard of reliability that offers the customer suitable product quality guarantees. Fluiten's customer is the most active and most experienced oil company in the refinery field and is on the cutting edge of research into new better and more reliable solutions. It never abandoned the use of this seal, and has - on the contrary - re-launched it and reintroduced it into its latest applications. The project Fluiten is implementing with its customer is a latest generation application, based on reliable but simple components, since overcomplexity is the first step towards outage and malfunction.



API PLAN 76

The secondary seal solution is not exclusive to Fluiten: the basic design criteria for these seals are laid down in a sector standard that gives clear indications regarding the construction of mechanical gas seals. The API 682 standard lays down how the stationary and rotating rings should be, how the springs should be and the other basic characteristics. Subsequently each sector company determines its own special configurations for certain parameters, such as the spring load, the balancing ratio, and the machining of the faces.

The Fluiten test bed was quite simple as it was originally conceived. After being re-engineered to meet the customer's special requirements, it is now possible to change the temperature and pressure in order to simulate immediate start-up owing to sudden leaks, and, for example, to see what happens to the secondary mechanical seal when the pressure suddenly goes from zero to twenty atmospheres.



API PLAN 53B

Thanks to a test bed fitted with a sufficient number of redundant safety devices, Fluiten can "reconstruct" a catastrophic event after simulating uninterrupted dry seal operation for at least two-hundred hours in heavy duty conditions. This is the basic parameter required by the customer. After two-hundred working hours, the seal was dismantled to examine the faces for wear and to see the results of instantaneous leakage of the secondary seal. Seal assembly temperature measurements, together with the face wear inspection at the end of the test, provide utmost guarantees regarding long operating periods and the certainty that when the main mechanical seal shows symptoms of leakage of any degree, the back-up seal will be able to prevent undesired fluid propagation into the atmosphere.

The distinctive feature of the Fluiten test bed, which was also the greatest difficulty that had to be overcome when building it, was to make sure it could operate unmanned and totally automatically for two hundred hours (or more). In compliance with the customer's requests, the fluid used in the test bed was Freon, which is able to simulate the critical operating conditions found with light gases such as butane and propane. The seal worked for two-hundred hours in dry contact conditions without any type of cooling.

TEST CONDITIONS

Detail of Test rig

Fluid used for test: Freon R134A

This fluid was suggested and chosen since it behaves in a similar way to high-vapour-pressure light hydrocarbons and therefore it is valid in all respects for the proposed test aims.

- *Temperature: 25 °C*
- *Viscosity: 0.198 mPa.S*
- *Specific gravity: 1206 kg/m3*
- *Vapour pressure at 20 °C: 0.57 MPa G*
- *Pressure on the internal seal: 1.55 MPa G*
- *Flushing flow rate on the internal seal: 6 l/min*
- *Speed: 1450 rpm*

Pressure test on the stand-by seal:

a) Dry running at atmospheric pressure (h 220)
b) Lubricated and at maximum stuffing box pressure (h 12)

TEST PROCEDURES:

- *Dimensional check and marking of the faces*
- *Pressurization, start-up and measurement of the power absorbtion by the seal upon sudden start-up*
- *Keep running for a minute*
- *Stop and re-measure the power absorbtion*
- *Start up again and keep running for two hundred hours*
- *Seal leaks are recorded at eight hour intervals*
- *Stop and measure the power absorbtion with the internal seal under pressure*
- *Start up, keep running for a minute and repeat*
- *Start up again and bring up to stable operation*
- *Slowly increase the pressure between the primary mechanical seal and the back-up seal*
- *Make sure the back-up seal is intact and gradually reduce the pressure*

- *Subsequently raise the full pressure on the mechanical back-up seal using a solenoid valve*
- *Stop and proceed with the final inspection*

INSPECTION AND DATA REQUIRED AFTER THE TEST:

- *The faces must be inspected to see if they are within the limits of tolerance laid down by the constructor for dimension, planarity and surface porosity*

- *Face wear must not exceed 1.27 E -4 mm per hour during the 200-hour test*

- *The average leak during the 200-hour test must not exceed 2.5 ml/h*

TEST CONCLUSIONS:

The seal tests were successfully passed both from the point of view of the API 682 standard and the customer's specifications having following results.

When the solenoid valves were opened, it was suddenly subjected to the same temperature and pressure conditions as the pumped fluid. A series of events was then simulated completely automatically so that the reaction of the seal could be tested in highly varied conditions. The fourteen temperature measuring instruments found along the whole process and fifteen safety sensors on the test bed provided precious information for monitoring the process at the seal input and output and inside the exchanger, and to keep pressure drops and temperature under control. These tests are of enormous value since they are not prescribed by the present API 682 standard. If they are passed successfully, they will give this safety solution new life and enhance its value for the whole sector. Since the company assessing their use is the number one in the sector, we can expect that many others will follow their example.

The bed is a significant investment for Fluiten, and a logical consequence of the company philosophy. Fluiten considers research and development as essential in the constant pursuit of quality and reliability, which are fundamental in order to ensure technical excellence and competitiveness. Since it is an important investment, the test bed was made to be flexible so that it may be adapted to new requirements and simulate the reactions of mechanical seals to different conditions of use and the worst situations imaginable. Fluiten is looking into cooperation with the Politecnico di Milano (Milan Polytechnic University) to make its test rig available for any experimental calculations the Department of Mechanics may wish to carry out on mechanical seals.

Fluiten is an Italian company that competes with large multinationals. It has made this demanding investment not just to meet the specific requirements of one customer, but so that it may use the test bed in the future in order to develop and test other innovative products. Fluiten may also perform tests on mechanical seals made by other companies to assess their efficiency if customers so request. In other words, it can act as an analysis laboratory for technical cross-checking.

Fluiten has presented the test rig at Achema, one of the most important fair devoted to the chemical industry which take place in Frankfurt.

Fluiten Italia S.p.A
ACHEMA 2009 | Hall 8 - Stand F8/F10

Critical situations during mechanical seal operation

The efficiency of a mechanical seal is mainly due to the faces of a rotating part and a stationary part which are kept closed by mechanical and hydraulic pressures which push towards each other. The amount of heat generated between the faces depends on this closing force, the peripheral speed, the self-lubricating characteristics of the contact face material, and the lubricating characteristics of the pumped fluid. When these factors are combined, heat stability must be ensured in the area where the faces slide together to prevent the pumped liquid from vaporizing and avoid rapid face wear.

If mechanical seals work in liquids with good lubricating qualities that can ensure a stable liquid film between their faces, the amount of heat generated remains relatively low. Furthermore liquids have relatively high thermal conductivity which makes sure any heat is dissipated effectively. In the case of fluids with low vapour pressures, lubrication is poor and thermal conductivity is bad. Consequently, all other mechanical seal operating conditions and design parameters being equal, their life expectancy is considerably shorter. The most critical refinery applications owing to problems which regard - among other things - major safety criteria are those that involve light hydrocarbons since they may gasify if the pumping pressure falls to atmospheric pressure due to a mechanical seal leak. For this reason, health safety sealing systems have been developed that limit the risk of an unexpected build up of gas, which may reach explosive concentrations, and/or flammable liquids, which may lead to fire.

The flexible face of the mechanical seal is fitted in the gland (therefore stationary) in such a way as to minimize the effects of any residual misalignment that could induce seal face instability. This stationary face is coupled to a rotating face fixed to the shaft sleeve at perfect right-angles to the axis of rotation. The combination of materials used has been seen to have high wear resistance and a high degree of thermal conductivity. Therefore it is able to dissipate the heat produced at the sliding faces extremely well. Both faces have been designed geometrically using finite element analysis so that the seal faces are not subject to heat distortion. The O-rings fitted have a sufficient cross-sectional area and fine hardness to put up minimal resistance to face closure and therefore minimize the spring thrust required. These factors (low spring load, large contact surface, and suitable balancing ratio) combined with the Fluigrid surface treatment lead to low heat production and wear, and therefore long seal life.

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