Stress Analysis of Seal Gland for the Development of Special Purpose Machine.

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Abstract— To analyze the effectiveness of new seal designs, it is important to compare their performance with existing designs. To do this, mechanical seals are tested in accordance with API Standard 682. The specification requires every seal type to be tested in every seal arrangement, single seal, pressure-less and pressurized dual seal. So as not to have to test every seal size, API 682 specifies tests The idea underlying the liquid leak test is that a test specimen holding pressurized liquid will show a leak by the emergence of the liquid. It is customary to conduct this test simultaneously with the water pressure test stipulated in the code of regulations for pressure vessels. All openings in the test specimen must be rendered liquid-tight beforehand. When filling the specimen, it must be carefully vented of all air, as any leaks in the area of air or gas cushions will be unable to make themselves felt

Keywords— mechanical seal, pressure 400bar, leak test.

I. Introduction

Mechanical seal is defined as one of the machine parts which has two flat face with buffer action against the shaft performing seal ability by rotating portions. It is a piece of engineering equipment which seals a rotating portion of the equipment with contact pressure between the two surfaces vertically setting against the shaft.

Mechanical seal is applied to the sealing portion at the rotating equipment (pump, compressor, etc.) and for the purpose of sealing the liquid is from between the rotating portion and the stationary portion of the Mechanical seal. The mechanical seal is an end face seal which consists of the rotating component and stationary component and seals with the contact pressure between the precisely finished surfaces vertically setting against the shaft. The mechanical seal seals with the contact pressure properly given by the fluid to the sliding faces. It consists of precise machining parts and seals mechanically. And that is why it is called “Mechanical Seal”.

Seal faces use the product being sealed as the face lubricant. This can be a thick film, thin film or in some cases only the lubricant properties of carbon graphite face itself. In order for fluid to lubricate the face and not leak out, extreme face flatness is required.

The bottom drawing shows a view of how mechanical seals are placed in a pump. The total amount of curvature allowed is usually less than one helium light band. This is equal to 11.5 millionths of an inch. When the faces are out of flat by 4 to 5 light bands the seal will usually leak profusely. When the seal is mounted inside the product there are several advantages. The rotary action of the seal helps it to clean itself by throwing dirt particles away from the seal parts. Abrasives that try to come in between the faces are naturally excluded by the centrifugal.

Fig. 1- Mechanical seal

A. *Need for special purpose machine*

The main purpose of the test is to check the leakage rate of the gland, the test meant as an integrity check of the gland assembly, making sure no O-rings were cut during assembly, faces cracked, etc. It is not meant to provide an indication of the performance of the seal in service under the application process condition. The API 682 (American Petroleum Institute) ,allows a maximum pressure drop of 0.14 bar over 5 minutes .

A pressure of 0 to 400 bar depending on the requirement of the customer. All the outlets are sealed with a packing and the water inlet is given through a single inlet until the air is not removed. A pressure gauge is connected to the test chamber to measure the testing pressure, which varies according to the specimen's design data. At all events it should be at least as high as the ultimate operating pressure. The precautions stipulated in the pressure vessel regulation must be observed for the test. After applying the testing pressure and waiting for an appropriate length of time, the specimen must be examined carefully for damp areas. A guide value for the detection sensitivity achieved by this method is 0.5 mbar-1/s. This method used as a static leak test on large mechanical seals is usually unable to detect a leak, as it is generally impossible to view the inside of the mechanical seal, e.g. its sliding faces, in the assembled state. A leak is indicated by the pressure drop per unit of time, which is thus a means of assessment. And then the pressure is applied using the hydraulic that even supports the upper portion of the gland. The pressure applied is for half an hour and is tested above the required pressure so as to prevent the future consequences, the decrease in pressure or any pressure drop observed will determine the quality of the

gland. If any cracks observed the remaking is done other than this if found then it is disposed as the gland is made up of casting procedure, voids present also affect the gland and simultaneously the mechanical seal.
For a seal design to be successful the seal material should have the following properties.

A. They must be wear resistant.
B. They should have a low coefficient of thermal expansion.
C. They should have high overall strength.
D. They should have good thermal properties, such as high thermal conductivity, to remove heat generated from the rubbing surfaces.
E. They should have good resistance to corrosion from both inside and outside environment.
F. They should be easy to manufacture and have low cost The material used for the primary and mating ring in seal assembly is usually different so that the resulting friction and wear is minimized. Therefore the selection of material pairs should be made with the following consideration

Fig.3- seal gland.

B. Legend forMechanical Seal Test Rig

1	Reservoir with heat exchanger	10	Motor
2	Pressure relief valve	11	Variable speed drive
3	Circulating pump	12	Shaft
4	Flow meters	13	Thermocouples
5	Filter	14	Air intake valves
6	Simulated pump housing	15	Actuator coolant intake
7	Gland with mechanical seal	16	Actuator coolant discharge
8	Valves	17	Pressure gauges
9	Webdaq and computer		

- This test rig has a safety feature that would shut it down automatically in case there is leakage of the coolant to the surroundings beyond a certain limit.
- The Webdaq data gathering system of the test rig is adequate as it can collect uninterrupted data for up to three million data points.
- The design of the test rig is simple; the reservoir (seal pot) provides the water supply for the simulated pumping housing and the coolant for the mechanical seal.
- A small pump is affixed to the system to provide head that fluid flow at a certain pressure can be maintained throughout the system. The function of the variable speed drive is to change the speed at which a seal is being tested.
- The reservoir was designed so that it can be pressurized from an external source.
- This was important as it allows one to increase the pressure delivered to the simulated pump housing.
- The valves, flow meters and pressure gages are used to adjust or change the operational point to what is desired.
- The level switch is a major safety aspect of this test rig. In the event that a leak is sprung during operation, the level switch is calibrated so that whenever the water level in the reservoir falls below the centerline of this device.
- It causes the entire rig to shut down by shutting off the power supply.
- The assembly of the stuffing box and the gland is done in the common way, where the primary ring position is marked in relation to he gland and the static ring.

C. ANSYS

Meshing

The mesh generation for the three dimensional models for both rings were done using ANSYS pre-processor. Mesh refinement is critical to the accuracy of the results gained from simulation, and with this in mind different mesh sizes were simulated. A mesh sensitivity analysis was done by refining the mesh size until the answers for the simulations remain the same. The results were compared for deviations as this was necessary to evaluate if the simulations were converging..

Static Structural analysis

Total deformation

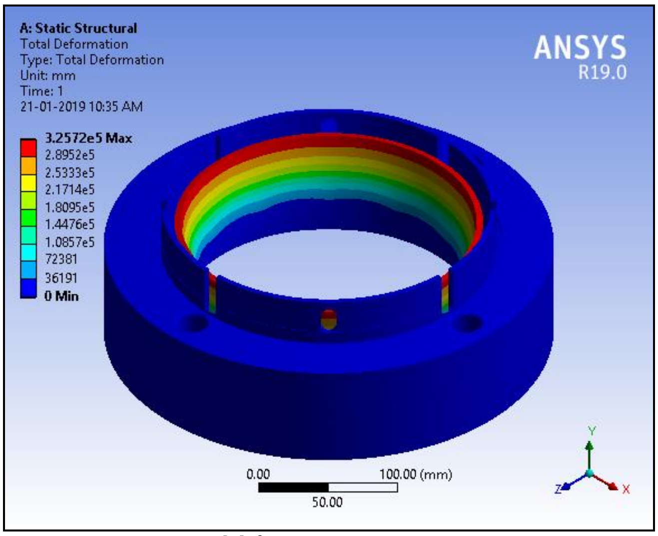
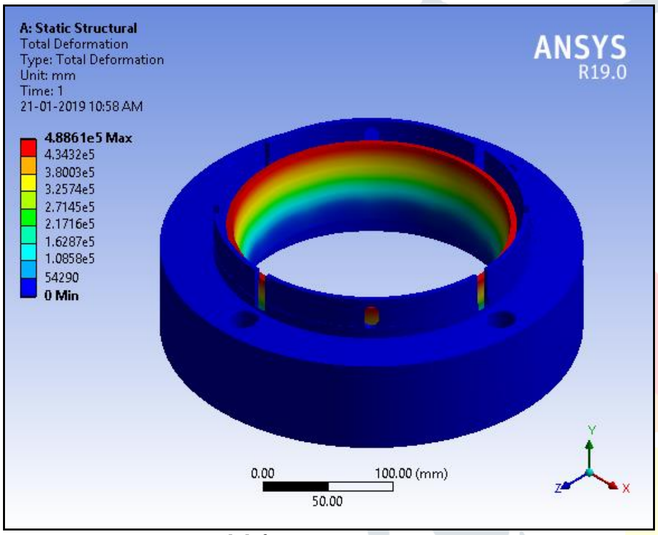


Fig. 4-Total deformation at pressure 26.772 MPa.



. Fig. 5-Total deformation at pressure 40.158 MPa.

Considering figure 4 and 5 total deformation in seal gland is observed in both the case. In figure 4 the pressure applied is 273 kg/cm^2 that is around 26.772 MPa. It is observed that the maximum deformation in the seal gland is around 3.2572*10^5 mm which is negligble and can be ignored. While in figure 5 the pressure applied is 1.5 times then the desired pressure that is 409.5 kg/cm^2 that is around 40.158 MPa. In this case the maximum deformation observed is 4.8861*10^5 mm and eventually even this deformation can be neglected. This proves that mechnical seal can sustain a pressure upto 1.5 times then the desired pressure if there is any sudden increase in the pressure without the commands of the operator or any accidental increase the pressure.

Equivalent Stress

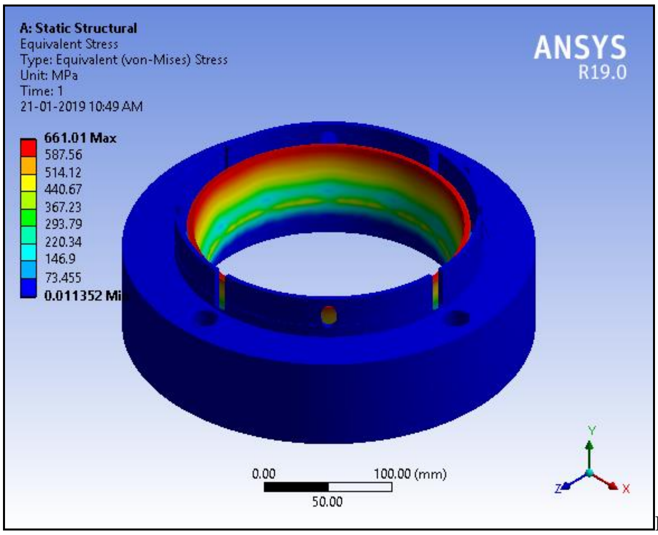


Fig. 6-Equivalent stress at pressure 26.772 MPa.

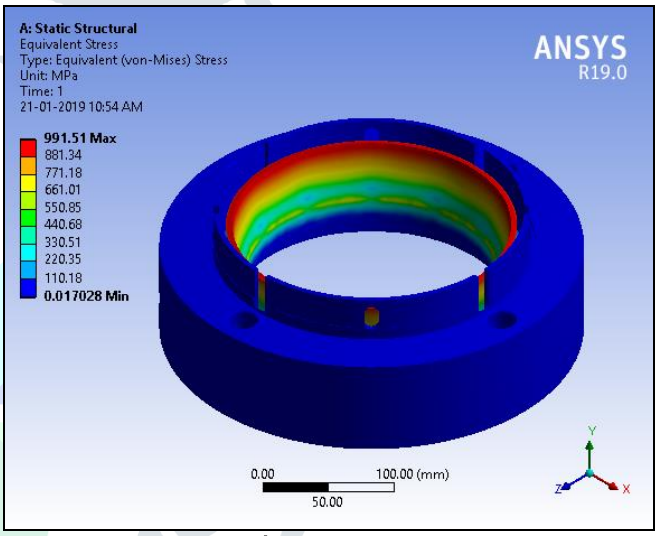


Fig. 7-Equivalent stress at pressure 40.158 MPa.

D. Results and Discussion

To test the seal gland of pressure 267.722 bar to 1.5 times that is 401.92 bar so that if in case on site the pressure applied is more then the 267.722 bar and sustain the internal pressure, it is necessary to take into consideration of the safety the stresses developed are high as 991.51 MPa which can contain toxic gases which may damage the living surrounding so as to would help us to simulate the exact conditions and provide the necessary details such as total deformation with the results.As if now the seal gland details are imported into ANSYS and has provided us the approximate results.

References

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