12th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

PERFORMANCE CHARACTERISTICS OF POLYURETHANE FOAM GASKETS

A. Egemen Erbil
Ford Otosan Company
İzmit Gölcük Yolu 14. Km 41680
Turkey

Zeynep Parlar
Vedat Temiz
Istanbul Technical University
İnönü Cad. No:85 Gümüşsuyu, 34437 Istanbul
Turkey

ABSTRACT
In this study, the performance characteristics of polyurethane foam gaskets have been investigated experimentally in a flanged joint system. Accordingly, it is possible to be compared the test results of polyurethane foam gaskets which have different properties by using this designed testing apparatus. Samples are prepared as foam in place method by using polyurethane material. Whilst samples have been prepared, mixing ratio of 2 different materials, weight in grams value of foamed gasket in 1 second (g/s) and temperature of foamed surface are taken variable parameters; ambient temperature, same type material and polyurethane foam gasket machine foaming velocity are taken constant parameters. The results obtained from the experiment are targeted to use by selecting the optimum gasket according the operating conditions.
Keywords: Gasket, polyurethane, foam, sealing

1. INTRODUCTION
The fundamental benefits of liquid injection gaskets are their easy processes and good conformity with counter face. These gaskets can expand after injection remarkably, thus making a good contact with flanges. Since the application of these gaskets are relatively new, the technical literature about these sealing elements are considerably limited. Following some of the studies concerning about the gasket are mentioned.
Sixt, T. presented a general overview about the usage, properties and advantages of the liquid injection seals [1]. In another study by Widder, E., the creep, stress relaxation, fatigue and leakage characteristics of static seals were investigated. A set of systematical experiments was carried out by the author and the results of these experiments were presented [2]. The effect of surface roughness of counter face to the sealing performance of gaskets was studied by a Otsuka, M., Okamura, T., Suetsugu, N., Ohta, T. and Ono, S. [3]. In this work, it was found that a leakage taken place on the micro gaps between the gasket and counter face. A similar study with the current one was carried out by Sawa, T., Yoneno, M., Kawamura H., and Schimizu, A. [4]. They used a rectangular flange in their experiments. They concluded that as the distance between the axis of bolts and test casing increases, the sealing performance of the gasket improves.
In this experimental study, the sealing characteristics of polyurethane foam gaskets have been investigated. The 10 different test samples have been prepared for this purpose. An internally pressurized test casing was used in the experiments. The pressure drop for 10 minutes and failure pressures of gaskets were obtained.

2. EXPERIMENTAL WORK

2.1. Test System

Since the applications of static and dynamic seals differ greatly from each other, the test systems of these seals also must be different. In this work, a test system for polyurethane (PU) foam gaskets has been designed and set up. In this system, actual operating conditions of these gaskets were simulated. The general view of the test system and system components are shown in the Fig. 1. A flanged cylinder having 200 mm inside diameter was used in the experiments. The gasketed plate was placed between the cover and the cylinder. The cover screws were tightened with the same torque using a precision torque meter having an accuracy of ±%1. A pressure sensor and a pressure indicator were used in order to observe and record pressure changes during the experiments. The pressure sensor has a measuring range of 0…50 bar and has an accuracy of ±%0.5. The oil pressure inside the cylinder was achieved by means of a positive displacement hand pump as shown in the Fig. 1.

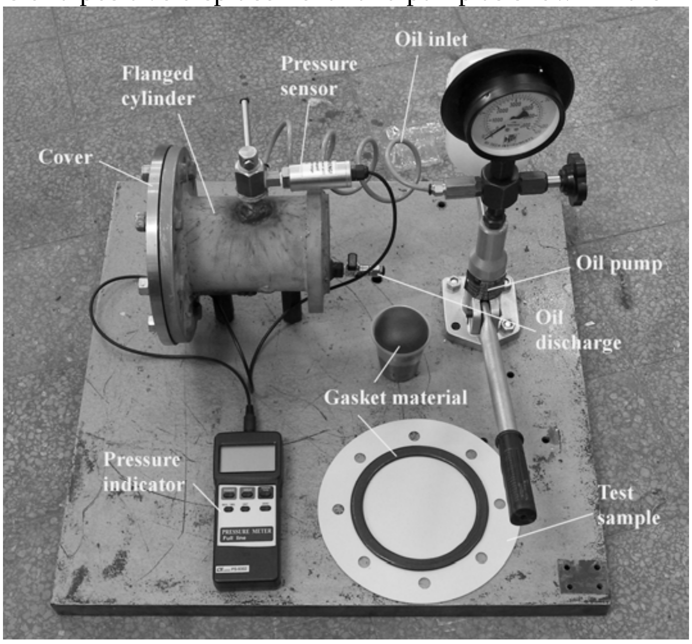

Figure 1. General view of the test system

2.2. Test Materials

In this experimental study, polyurethane foam gaskets prepared with different mixing ratios under different conditions were used. Two components were mixed together in order to form the gasket. The first one (will be mentioned as component A) is polyurethane and the other one is the material that achieves the gasket to adhere the surfaces (will be mentioned component B). The prepared 10 different test samples and their mixing condition are given in the Table 1.

Table 1. Material properties of test samples

	Reference Sample	Based on mixing ratio				Based on mass flow rate			Based on plate temperature	
Sample Number	1	2	3	4	5	6	7	8	9	10
Component A:B	4:1	5:1	4:1,5	6:1	3:1,5	4:1	4:1	4:1	4:1	4:1
Mass flow rate (g/s)	3,8	3,8	3,8	3,8	3,8	5	1,9	2,7	3,8	3,8
Plate temperature	Room	Room	Room	Room	Room	Room	Room	Room	Heated	Cooled
Injection speed (mm/s)	9300	9300	9300	9300	9300	9300	9300	9300	9300	9300
Quantity	4	4	4	4	4	4	4	4	4	4
Hardness (IRHD)	25	20	32	5	40	24	20	22	5	10

2.3. Experimental Procedure

The gaskets which were prepared at the conditions mentioned above were injected to the circular plates as shown in the Fig. 2. These plates were placed between the flanged cylinder and cover. The cover screws than tightened with a constant torque which is adequate for obtaining appropriate squeeze ratio.

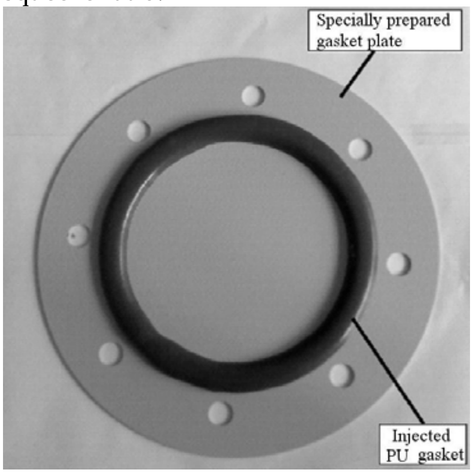

Figure 2. The test sample gasket

Experiments were carried out in two step. In the firs step, the oil pressure drop in the cylinder with time was recorded for all test specimens. Test pressure in these experiments was taken as 6 bar and time for the pressure drop was 10 minutes. After 10 minutes, pressure drop speed considerably decreased.

In the second set of experiments, the oil pressure that causes the failure of the gasket has been determined. For that purpose first, the indicator of pressure sensor was set to "hold max" setting and the oil pressure inside the cylinder was increased gradually with relatively slow speed in order to avoid any impact effect until a failure on the gasket takes place. The failure pressures for all test specimens were also recorded.

3. TEST RESULTS

In Fig. 3. the pressure drop (Δp) at 6 bar pressure for 10 minutes is shown for all test specimens. As seen in the Fig. 3, the maximum pressure drop has been reached in the sample 5. This sample has the highest ratio of adhesive component when compared to other samples. The other sample which shows relatively great pressure drop is sample 6 which was prepared with the maximum mass flow rate. The minimum pressure drop has been reached in sample 2 and 7 excluding reference sample (sample 1). Sample 2 has the maximum ratio of polyurethane which is the base material for sealing. Other sample which shows relatively low pressure drop is sample 7 which was prepared with the minimum mass flow rate.

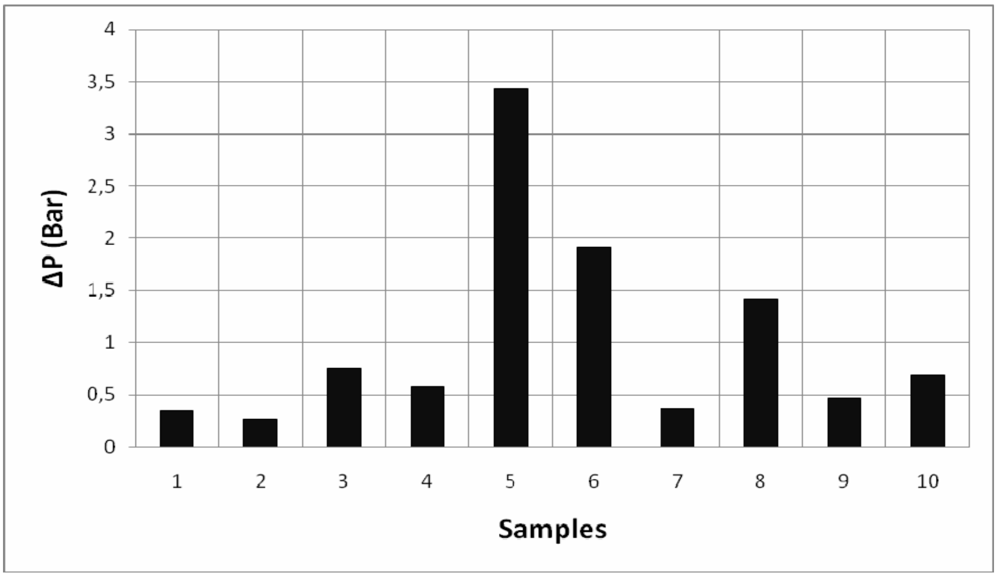

Figure 3. The pressure drop at 6 bar oil pressure for 10 minutes.

In Fig. 4, the failure pressures (p_{max}) for the above mentioned test samples are shown. As seen from the Figure that failure pressures of the majority of the samples do not differ remarkably. The maximum failure pressure was obtained in the reference sample (Sample 1). Sample 5 shows the lowest failure pressure value around 10 bar.

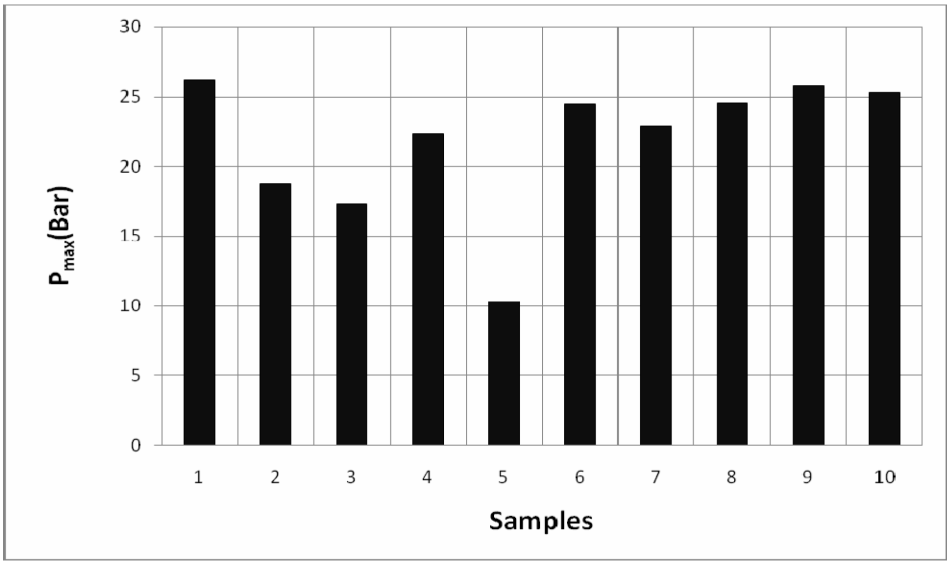

Figure 4. Failure pressures for the test samples

4. CONCLUSIONS

Regarding all these explanations, the following conclusions can be drawn from the present study:

- ✓ Increasing adhesive component ratio on the seal material has negative effect on the sealing performance of the foam gasket.
- ✓ Increasing polyurethane component ratio on the seal material has positive effect on the sealing performance of the foam gasket.
- ✓ Increasing the mass flow rate while preparing the sample considerably worsens the sealing characteristics.
- ✓ The surface temperature of the plate does not affect both the sealing performance and failure pressure of gasket remarkably.
- ✓ The mass flow rate also gives similar effects that of surface temperature of plate.

5. REFERENCES

[1] Sixt, Torsten : Liquid Injection Sealing: A New Sealing Approach, Society of Automotive Engineers, Inc., Warrendale, Pennsylvania, USA, 2004

[2] Widder, Edward : Advances toward life estimation in static sealing, Society of Automotive Engineers, Inc., Warrendale, Pennsylvania, USA, 2003

[3] Otsuka, M., Okamura, T., Suetsugu, N., Ohta, T. ve Ohta, T. :A new concept of static rubber gasket for sealing rough surface, Society of Automotive Engineers, Inc., Warrendale, Pennsylvania, USA, 2003

[4] Sawa, T., Yoneno, M., Kawamura, H. ve Shimizu, A., : An improvement of the sealing performance in stamped steel bolted flanged joints by using liquid sealant under internal pressure Society of Automotive Engineers, Inc., Warrendale, Pennsylvania, USA, 1989.

6. ACKNOWLEDGMENTS

Some components of the test system for the experiments was kindly provided by Turkish National Research Council (TUBITAK). The authors record their thanks for this support.