SEALING CHARACTERISTICS OF ALL ALUMINUM VACUUM SYSTEM USING ELASTIC METAL GASKET

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Sealing characteristics of combination of aluminum alloy franges and elastic metal gasket[1] "Helicoflex" for ultra high vacuum is described.

Helicoflex is a flexible metal O-ring composed of an elastic helical core and a metal sheet which wraps the elastic core. Fig. 1 shows the structure of Helicoflex. The elastic helical core supplies sealing force to the metal sheet. The material of the metal sheet can be selected among Al, copper, SUS etc. All of which have an enough ductile characteristics. As the metal sheet material, we selected pure Al. because Al is strong against corrosion and soft enough. It is not necessary to be baked to a high temperature. Practically, the sealing performance depends largely on the condition of work surfaces of the flange and the gasket. For the reliable sealing with a leak rate less than 10^{-11} atm. cm^3 s^{-1}, one of the following conditions must be satisfied. (1) The surface of the flange is finished in a lathe using sharp single point tool as illustrated in Fig. 2. The roughness of this surface is about 5 μm ∿ 50 μm. (2) The surface of the flange is superfinished with the roughness less than 0.5 μm using oil impregnated emery paper or diamond tool. Especially using diamond tool, the smooth mirror finish is easily obtained in spite of the hardness of the aluminum alloy 2219-T87.

The flange surface finished by a lathe, as illustrated in Fig. 3 the peaks of the flange surface cut into the aluminum sheet of the gasket, as the flanges are tightened. The picture of the surface of the gasket before use is shown in Fig. 4. The picture of the pressed surface of the gasket is shown in Fig. 5. The surface of the dales do not contact with gasket and it seems to continue from the inside to the outside. But the conductance is negligible small for leakage. This sealing mechanism is based on the same principle as ordinary cutinto-type metal gasket in detail, but the existence of elastic core improves reliability and easy using. The features of this sealing are relatively insensitive to the scratch of a flange and gasket, but the same gasket cannot be used repeatedly.

The superfinished surface of the flange, as illustrated in Fig. 6 the aluminum sheet contacted with flange surface is flowed in the gap between elastic core and flange surface, as the flanges are tightened. The surface of the gasket in contanct with flange surface is superfinished too with this flowing. The picture of the pressed surface of the gasket is shown in Fig. 7. This sealing is performed by superfinished metal surfaces which are placed in closely contact each other. This is a new type metal seal. The features of this sealing is relatively sensitive to the scratch of flange and gasket, but especially in the case of smooth mirror finish by diamond tool, repeated use of the same gasket is possible.

The elastic sealing characteristic of the Helicoflex O-ring in room temperature is shown in Fig. 8. Yo is the initial sealable tightening force along the O-ring. Y_1 is the minimum sealable tightening at decreasing the tightning force. Y_2 is the maximum sealable tightening force. For the flange surface finished in a lathe, initial tightening force increases infinitely as repeated use of the same gasket. And it is nearly stable for smooth mirror finished surface of the flange.

About two conditions of the flange surface, the sealing mechanisms are essentially different. So the causion for using is different, but each case have a special feature respectively. So the proper use is needed for each purpose.

Reference

H. Ishimaru and G. Horikoshi, IEEE Transactions on Nuclear Science Vol., NS-26, No.3, p.4000.

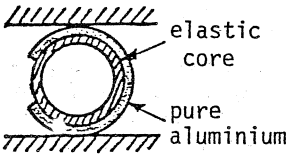

Fig. 1

Fig. 2

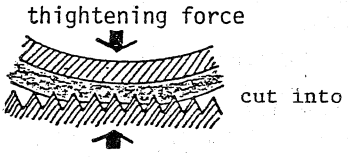

Fig. 3

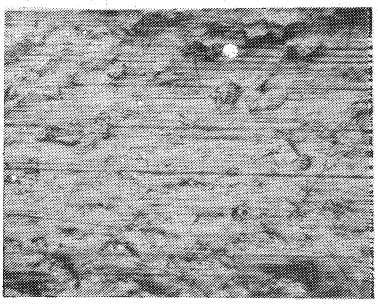

Fig. 4 Surface of the gasket before use x100

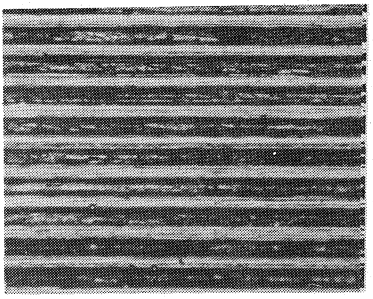

Fig.5 Surface of the gasket pressed by the flanges finished in a lathe x100

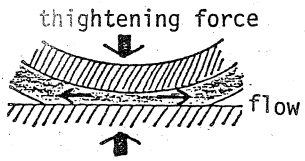

Fig. 6

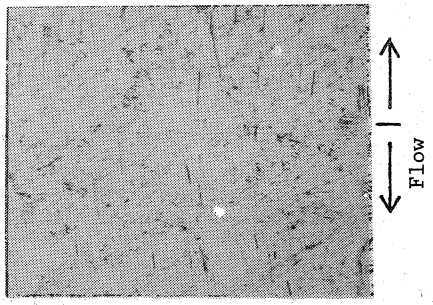

Fig. 7 Surface of the gasket pressed by the smooth mirror finished flanges x100

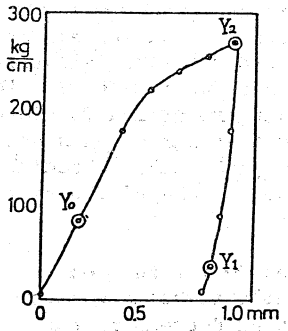

Fig. 8 Elastic sealing characteristic of"Helicoflex"