TEST OF THE MODEL PNEUMATIC EXPANSION SEAL

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Abstract

The sealing method with the pneumatic expansion seal is to be used between each vacuum chamber section for the RIKEN SSC. 1/3 scale models of the seal were constructed and tested to investigate the performance.

Introduction

The vacuum chamber for the RIKEN SSC is divided into 8 sections. One reason is that the RF resonators must be withdrawn backwards from the stationary position so that tuning and repair can be done easily, and the other reason is that operational equipment of the magnetic and electric injection channels, and of the beam diagnostic device of the injection system must be installed at the central region in the atmosphere.

In narrowly restricted space where bolt-nuts cannot be used, a sealing method with a pneumatic expansion seal[1] was considered to allow reasonable dimensional tolerances and to simplyfy the connecting and disconnecting procedures. The seal is made by welding together two thin stainless-steel plates shaped like a race-track. The size of seal is about 3.5 x 1.5 m. The seal is put on the both flanges which have O-ring in grooves, and is inflated with compressed air to seal against the flanges. On evacuating the seal, the seal contracts and can be removed and replaced. This seal is adopted for sealing between RF resonator and magnet sections. Figure 1 shows vertical cross section of the vacuum chamber between the magnet and RF resonator sections. Three different types of 1/3 scale model of the seal were constructed to investigate the performance. Figure 2 shows a photograph of one of the model pneumatic expansion seal.

Test

At first, we investigated relation between expansion of the seal and the applied pressure. Figure 3 shows the results measured along the seal. The seal was deformed non-elastically by a force stronger than the substance's elasticity limit.

Next, we fixed the gap and measured the stress of the seal and the squeezed O-ring force along the seal produced by applied pressure. When we fixed the gap which is considered to be about 14 mm between each vacuum chamber section, the squeezed force at the straight section of the seal was about 10 kg/cm, in the case of A type (width = 100 mm, thickness = 1.0 mm), it was about 12 kg/cm in the case of B type (width = 120 mm, thickness = 1.0 mm). The squeezed force at the circular section was in both cases half compared with that of the straight section.

When a single O-ring was used to seal, applied force to the O-ring was about 11 kg/cm, and 15 per cent of O-ring was compressed by the pneumatic seal. It was checked that there was no leakage in the range of expansion of 0 $\sim$ 20 mm. We fixed the gap 14 mm, the applied pressure to the seal was first increased gradually and then decreased to the atmospheric pressure after the test chamber was evacuated. It was found that the seal was free from leakage against the variation of the applied pressure.

The model of which the width of straight and circular section is different was constructed and tested. This seal is improved the expansion length along the seal. Figure 4 shows the distribution of the improved pneumatic expansion seal.

Using a finite element method, the elastic and plastic analysis of the seal is in progress.

Reference

1) C.J. van Lamp: NAC/AR/80-01 Annual Rep., 3.4, p. 105 (1978).

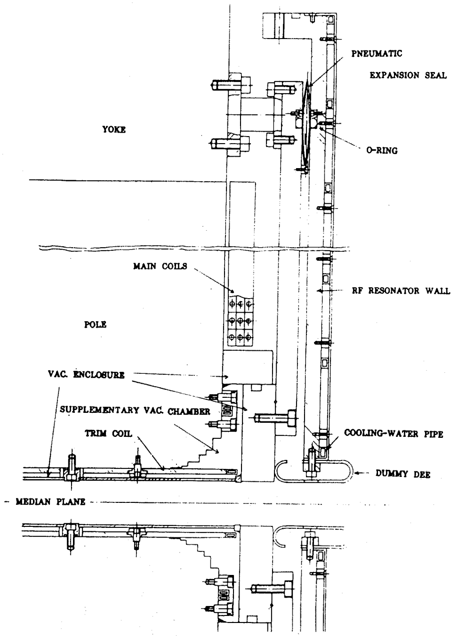

Fig. 1. Vertical cross section of the vacuum chamber showing the method of sealing between the magnet and the RF resonator sections.

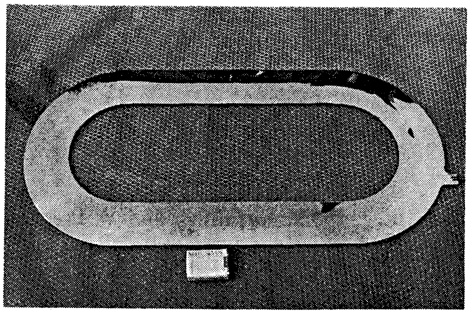

Fig. 2. A photograph of 1/3 scale model pneumatic expansion seal.

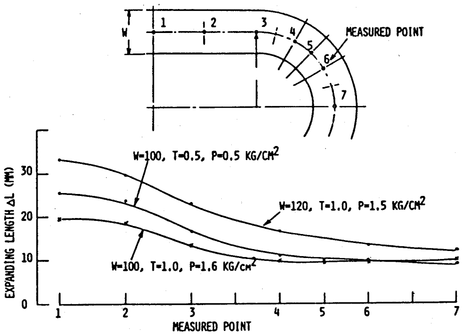

Fig. 3. The distribution of the expanding length along the seal.

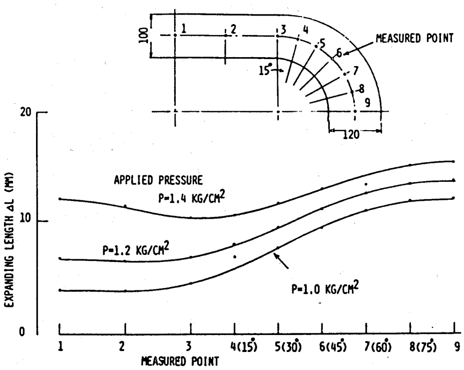

Fig. 4. The distribution of the expanding length along the improved seal.