Vacuum Chambers for Injection Section

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1. Introduction

The final specification of the injection chambers of the SPring-8 Storage Ring were decided, but some conceptual designs were changed from the previous report[1]. The main reason of these changes were reduction of the manufacturing cost and to get profits from the manufacturing easiness. The new concepts and computer analysis for the final chambers are described below, and the layout of the new injection section and the vacuum chamber are shown in Fig. 1. and Fig. 2.

2. Helium Gas Shield

In the previous design, the septum 8 (SEP-8) vacuum chamber of the storage ring and the SEP-8 magnet were installed in the vacuum tank which structure was complicated so as to keep the continuous of the vacuum from the beam transfer line (SSBT) to the beryllium window of the SEP-8 vacuum chamber.

In the new design, instead to use the vacuum tank, the polyimid film window will be fabricated at the down stream of the SEP-7 vacuum chamber to separate the vacuum of the SSBT, and the section between the beryllium window and the polyimid film window will be filled with the atmospheric pressure of the helium gas, using the copper magnet shield box of the SEP-8 magnet for the gas shield cover. We estimate that the helium gas increases the energy loss of the beam about 0.13% compared to the vacuum condition, but it is acceptable. The helium gas flow also shields the beryllium window from the air to protect the corrosion which is produced by the interaction between the synchrotron radiation and the air.

3. SEP-8 Vacuum Chamber

In the previous design, a magnetic stainless steel pipe was adopted for the vacuum chamber in the section of the SEP-8 magnet for its magnetic characteristics, but this material needs deep hole machining and magnetic annealing after machining which increase the manufacturing cost and difficulty. So we decided to separate the function of the vacuum chamber and the magnetic shield to be able to use ordinary materials, and we also estimated that about 0.7 mm can be added for the shield material between the vacuum chamber and the magnet, if all dimensions are arranged suitable. Thereby the SUS316L stainless steel pipe is adopted for the vacuum chamber and silicon steel thin plates for the magnetic shield. The increase of the stray leakage magnetic fields from the SEP-8 magnet is estimated to be not serious.

4. Pressure Profile

A pressure profile is calculated along the injection section cell. Calculation results of the pressure profiles after the dose (integrated stored beam current) of 1, 10, and 100 A.H. are shown in Fig. 3. The average pressure after 100 A.H. is approximately 7.0E-8 Pa and is well satisfied with the specification.

5. Stress Analysis

The vacuum chamber must be designed so as to stand the pressure difference between the atmospheric pressure and the vacuum. Calculation results of the aluminum straight chamber is shown in Fig. 4, which reveal that the maximum deformation is 0.05 mm, and the maximum stress is 1.34 kgf/mm^2 where the wall thickness of the chamber is decreased to avoid the interference with the magnets. The values of the stress are less than the allowable stress of 4.3 kgf/mm^2 for the materials (A6063-T5 at 150℃) to be used as a chamber.

References

[1] T. Bizen et al., SPring-8 Annual Report, p.118 (1994).

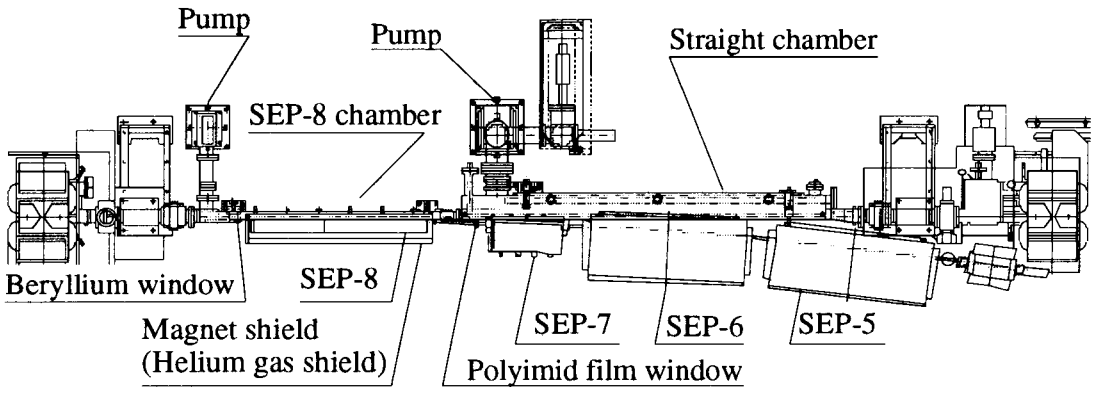

Fig. 1. Layout of the injection section

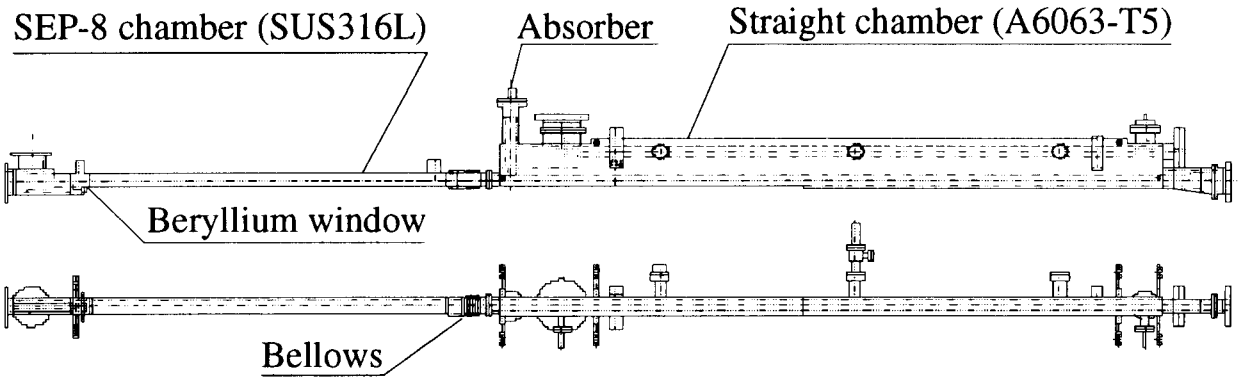

Fig. 2. Layout of the vacuum chambers of the injection section

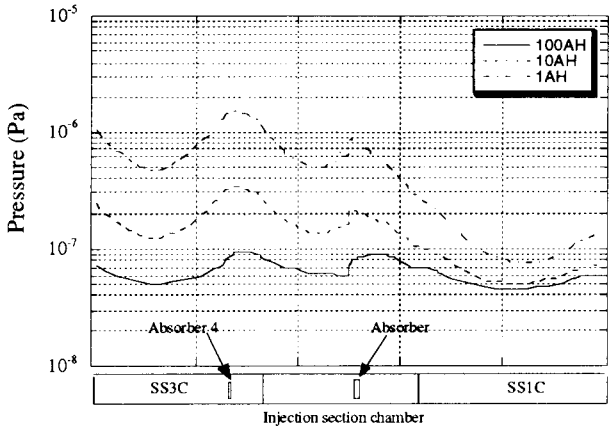

Fig. 3. Pressure profiles

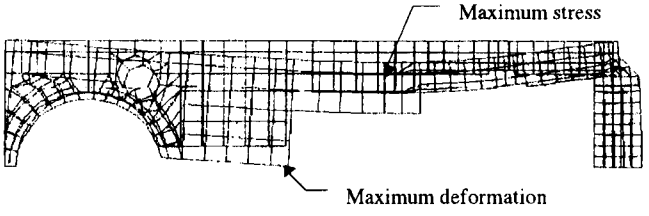

Fig. 4. Results of the stress analysis