§38. Study of Pellet Injection for Efficient Core Plasma Fuelling in Heliotron J

Motojima, G., Sakamoto, R., Ohyabu, N., Yamada, H., Okada, H., Kado, S., Nagasaki, K., Mizuuchi, T., Nakamura, Y., Sano, F. (Kyoto Univ.)

The pellet injection system required in Heliotron J has been successfully developed. A cooling test and an injection test have been conducted using the manufactured injection barrel for small size pellets. Shadowgraph measurements show the intact pellets with the size of 0.8 mm as expected.

One of the advantages of the pellet injection compared with other fuelling methods is that particles are deposited into the core plasma efficiently. Although gas puffing and super molecular beam injection are already used for the high density experiments in Heliotron J. The pellet injection is expected to be a higher efficient refuelling system. Also, Heliotron J has a robust NBI system compatible with the pellet injection. There is a potential of high performance and high density plasmas using the pellet injection. The pellet size, speed, acceleration method and injector size required in Heliotron J have been investigated in NIFS Collaboration Research program (NIFS09KUHL026). The study reveals that the pellet size of 0.8 mm ϕ $\times$0.8 mml (cylindrical shape) and the pellet speed of 300 m/s-500 m/s are required in order not to perturb the core plasma by too much penetration in Heliotron J. The pellets could be injected with the speed mentioned above by an in-situ technique and pneumatic acceleration when the barrel length is optimally minimized as less than 10 mm. Based on the above concept, the injection barrel was designed.

Figure 1 shows the photo of the manufactured barrel. The stainless tube with the inside diameter of 0.8 mm was firstly attempted for manufacturing the barrel. However, it was difficult to obtain the strength enough to maintain itself. Also, there was a technical problem of the soldering between the thin cupper and the minute stainless steel. Therefore, the barrel is manufactured by the hot isostatic pressing material of cupper and stainless steel. Moreover, in order to propagate the propellant gas efficiently, the taper structure is applied.

Figure 2 shows the result of cooling test. The temperature less than 4 K possible to produce the ice pellet has been confirmed. Figure 3 shows the pellet measured by shadowgraph. The intact pellet injection has been confirmed. The pellet speed has been determined by light gate measurement. The speed is about 1000 m/s, which is higher than assumed. This is attributed to the high acceleration pressure of 5 MPa. It will be possible to inject the lower speed of pellet speed by adjusting the pressure.

In the next experimental campaign, the injector will be moved to Heliotron J. The high density experiments will be attempted by using the pellet injection.

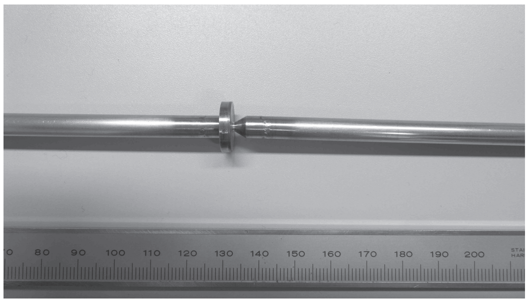

Fig. 1. Manufactured injection barrel.

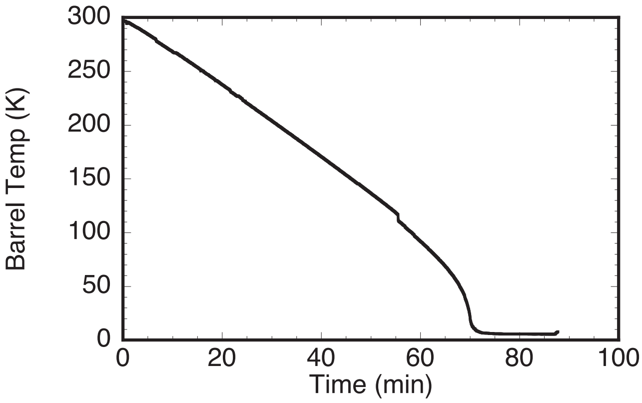

Fig. 2. Result of a cooling test.

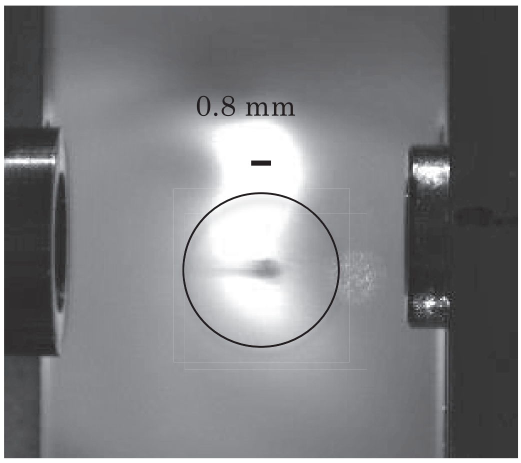

Fig. 3. Shadow-graphic image of the pellet.