Link Mechanism of ACPF Argon Cell Gastight Emergency Door

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1. Introduction

The advanced spent fuel conditioning process facility (ACPF), which was constructed with air cell, was modified to consist of an air cell and an argon cell. The argon cell was constructed by isolating a part of the air cell, and argon gas is circulated. This paper describes a gastight door installed in preparation for situations such as installation of equipment and utilities during argon cell construction and emergency operation.

2. Overview of Argon Cell

The argon cell system consists of an argon cell (AC), purifier, cooler, HEPA filter, temperature/pressure sensor, controller and remote handling system. The Argon cell was designed to minimize leakage and was constructed by isolating the first window area with the boundary between the first window and the second window to the right side of the existing ACPF Air Cell (AC). The internal dimensions of the argon cell are 1,728 (L) x 1,990 (D) x 2,740 (H) mm (480 mm in working table height). Figure 1 (a) shows the front view of the argon cell seen in the operating area (OA), and Figure 1 (b) shows the side view of the argon cell seen inside the AC. An electrolytic reduction device was placed on the work table. A pair of master-slave manipulators (MSM) was installed on the left and right sides of the the shield window, respectively, and a 150 kgf capacity crane was installed in the ceiling inside the argon cell.

A material transfer system with internal dimensions of 600 (L) x 600 (D) x 600 (H) mm was installed between the cells as a means of transferring material between the air cell and the argon cell. In addition, a gastight emergency door with an internal size of 600 (L) x 1,000 (H) mm was installed for situations during the construction and emergency operation of the argon cell.

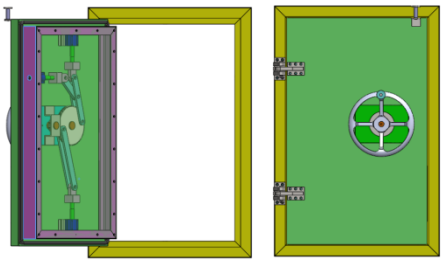
(a) View from OA (b) View from AC
Fig. 1. Constructed Argon Cell.

3. Emergency Door

3.1 Design and kinematics of door

The emergency door should be kept gastight as a door between the argon cell and the air. This is not used during the operation of the argon cell except during an emergency, and it is used for installing the equipment and utilities or an operator entry during the construction of the argon cell. Thus, unlike a material transfer system that transfers process materials during the operation of the argon cell, it is opened only in the air cell by the master-slave manipulator in an emergency situation. The interior width of the door frame is 600 mm, the height is

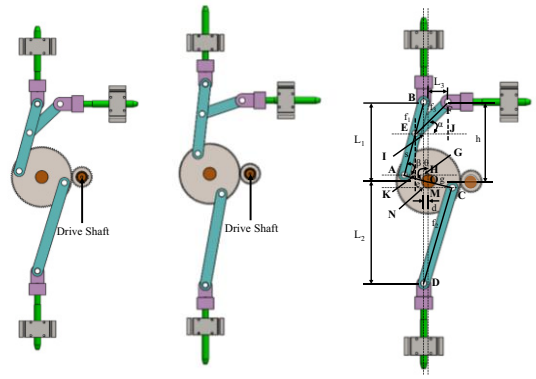
1,000 mm, and the door is composed of three link mechanisms. To maintain the gas tightness of the door, a gasket with an air layer, which is often used in windows, was selected. Its three-dimensional schematic is shown in Figure 2.



(a) open (b) close

Fig. 2. Three-dimensional model of emergency door.

Figure 3 shows the position of the link when the door is opened and closed. When the drive shaft is rotated by the handle, the small gear rotates the large gear to move the three pins simultaneously with a small force.



(a) open (b) close (c) link parameter

Fig. 3. Drive link of door.

Figure 3 (c) shows the schematic diagram for deriving the kinematics of the link mechanism. The calculation formula for the movement of the three pins when the door is opened and closed is shown below.

$$d = offset \tag{1}$$

$$L1 = e\cos\theta + \sqrt{f_1^2 - (e\sin\theta - d^2)} \tag{2}$$

$$L_2 = g\cos\theta + \sqrt{f_2^2 - (g\sin\theta + d^2)} \tag{3}$$

$$L_3 = f_3\cos(\sin^{-1}((h - e\cos\theta - s\sin(\cos^{-1}((e\sin\theta - d)/f_1)))/f_3)) - e\sin\theta + s\cos(\cos^{-1}((e\sin\theta - d)/f_1)) \tag{4}$$

3.2 Installation of emergency door

Figure 4 (a) shows the installation of the emergency door. Figure 4 (b) and (c) show the locking mechanism when the door is closed and opened, respectively.

Fig. 4. Emergency door operated by MSM.

4. Conclusion

The emergency door is designed with three link mechanism, so it can tightly push three surfaces. Also, it can be remotely operated with small force using the MSM.

ACKNOWLEDGEMENT

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