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Assessment of Durability Soundness Domestic 48Y Type UF_6 Cylinder

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1. Introduction

A 48Y type UF_6 cylinder has been used as a storage container depleted UF_6, DUF_6, which is a by-product of the enrichment process. Currently, more than a million of tones of DUF_6 are stored. And at least ten cylinders have breached during the last 40 years [1]. DUF_6 is used as a resource such as an upgrading raw material or a mixed oxide fuel. However, most DUF_6 should be disposed. About 200 tones of DUF_6 were imported into the Korea Atomic Energy Research Institute from the United State of America in 1986. Until making a decision to reuse or dispose of the DUF_6, a 48Y cylinder must maintain its structural soundness.

We performed a review of the state of the art reports for cylinder safety and evaluated the durability of the 48Y DUF_6 cylinder which was imported and managed. On the other hand, cylinder wall thickness measurements have been performed, and the cylinder corrosion and maintenance are discussed.

2. Durability of 48Y Cylinder

The durability of the 48Y cylinder is considered from an operational perspective. The safe operational condition should be satisfied for DUF_6 handling [2]. To convert DUF_6 for reuse or disposal, first the cylinder is heated to a controlled temperature, and the cylinder is then pressurized by DUF_6 vapor pressure. Therefore, it is important that the cylinder keep its structural soundness corresponding to the initial products for safe operation. The parameters affecting the cylinder structural soundness are corrosion of the steel cylinder which results from wall thinning and stress impacting the cylinder, resulting in material weakening. Empirically, the best way to prevent the steel cylinder corrosion is keeping the cylinder surface coated with paint. For long-term storage of domestic DUF_6, the durability of the cylinder is considered and evaluated. The direct assessment of the durability of the cylinder can be made from information regarding the wall thickness of the cylinder.

2.1 Internal/External Corrosion of 48Y Cylinder

An internal corrosion of the cylinder can occur by the reaction of water leaked into the cylinder and steel material. However, water first reacts with UF_6 contained in the cylinder, and then produces UO_2F_2 and HF which do not react with steel the cylinder. Thus, a small amount of water leakage into the cylinder does not affect the internal corrosion of the cylinder.

The external corrosion of a cylinder is affected by the cylinder surface state and the environmental condition of the storage site. Cylinder surface corrosion occurs upon the reaction of water and steel, and is initiated from the weakening point which is stressed and scratched on the surface, and different metallic materials attached such as a name plate, valve, or plug enforcing electric potential difference. Generally, cylinder corrosion occurs of the cylinder surface by the reaction of water. Consequently, cylinder corrosion can be prevented by preventing water contacting the cylinder surface by coating it with paint. Thus, keeping the surface coated is the key point in preventing cylinder corrosion.

2.1.1 Wall thickness measurements

Domestic 48Y cylinders have been imported two times from the United States, and stored in an open field for about 23 years, and then moved into an indoor warehouse in October 2009. Since then cylinder arrival, the cylinder surface was coated with paint to maintain its good appearance. Recently, the cylinder wall thickness was measured for a period of one year and ultrasonic thickness measurement data are shown in table 1. The average wall thickness of the 48Y cylinder is 16.06 mm, and the maximum difference according to the measuring position is 1.70 mm. The average wall thickness shows the cylinder manufacturing specification value, and no wall thickness change appeared. This indicates no sign of corrosion and having structural soundness after 27 years.

Table I: Ultrasonic Thickness Measurements

48Y Cylinder No.	Sample No.	Age, Year
1st Import; 6	36x4	26
2nd Import; 9	54x4	27

Six points, the front, rear, side, an upper and lower parts were selected for each cylinder. The wall thickness distribution appears from 15.31 mm to 16.99 mm. This comes from the manufacturing process of the sand blaster treatment for the surface coating of the cylinder inside. Wall thickness measurement data over a year shows no wall thickness change. The wall thickness measurement values for the same position of each

cylinder are in accord to measurement error range. In the case of the United States, a wall thickness change appears in a similar study of wall thickness measurement for a period of three years for cylinders unpainted [3]. This means the corrosion reaction, once initiated, is accelerated.

2.2 Physical Stress on 48Y Cylinder

About 12 tones of solid DUF_6 is positioned from bottom part to center of a 48Y cylinder, and occupied around half volume of each cylinder. A 48Y cylinder is stored horizontally supported by two blocks fixed to the cylinder. Therefore, each cylinder has a stress corresponding weight contained DUF_6. In particular, in the case of transferring or handling the cylinder, specific precautions are needed to prevent impact on the cylinder. History on the stress impacted on the cylinder becomes a factor when assessing the cylinder's structural soundness.

2.3 Storage Status

Currently, domestic DUF_6 cylinders are stored in a warehouse preventing exposure to rain. Figure 1 shows the 48Y cylinders stored.

Fig. 1. 48Y cylinder stored status.

The cylinders lie in two lines on a concrete floor. The surface of the cylinders has been coated with paint every 5 years.

3. Conclusions

The loss of durability of DUF_6 cylinder, for example, breached or damaged cylinders reported till now is derived from the corrosion of cylinder surfaces during the long-term storage or an impact to the cylinder during the transportation or the movement of the cylinder. These can be overcome by performing good management of the cylinder. The durability of a cylinder, when stored for the long-term, can be achieved to exclude an environment of corrosion induction or an impaction from the outside. Domestic 48Y DUF_6 cylinders are stored in a warehouse and kept with a clean coated surface. Thus, a loss of durability due to corrosion can be eliminated. Wall thickness measurements of the cylinder are a direct method to evaluate the cylinder corrosion state. However, for a new and well maintained cylinder, it is very hard to sense the change in wall thickness. Thus, in the case of a domestic cylinder, much time, 20 years or more, is needed to evaluate the cylinder corrosion using a wall thickness measurement technique. Domestic 48Y cylinders are still kept as good as new. Other parameters such as fire, the geological environment, and natural disasters could be considered for the long-term storage of DUF_6 cylinders.

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