Repair Technology Development and Application of Alloy 600 Vent pipe

Kong Chang Sig*, Lee Seon Ho, Park Kwang Soo, Byun Jin Gwi, Lee Sang Cheol
Doosan Heavy Industries & Construction Co., Advanced Process Development Team
555 Gwigok-dong, Changwon, Gyeongnam, 641-792, Korea
**Corresponding author: Changsig.kong@doosan.com*

1. Introduction

Alloy 600 and weld materials are subjected to primary water stress corrosion cracking (PWSCC) with the increase of the power plant operation period. Therefore, each utility is inspected and repaired to improve the integrity of Alloy 600. Alloy 600 is located at the CEDM nozzle, omega seal and vent pipe in upper closure head and these locations are known to have many damages in the reactor. In 2009, the boron deposit is detected for the first time during the refueling outage at the vent pipe on the surface of the upper closure head in Yongkwang unit 3 as shown in figure 1.

This paper shall introduce the repair process developed and experience applied to Alloy 600 vent pipe in Yongkwang unit 3.

Fig. 1 The boron deposit on the closure head

2. Vent pipe in Closure Head

Vent pipe is installed to J-Groove welding in the center of No.3 and No.4 CRDM nozzles in closure head and has a function to drain the air in the reactor. The orifice is installed inside the vent pipe to control the flow rate. The vent pipe in closure head is shown in figure 2.

Table 1 shows the materials of vent pipe in Korea Standard Nuclear Power plant (KSNP). Materials of vent pipe and weld are Alloy 600 in Yongkwang unit 3, 4 and materials of the vent pipes are Alloy 690 and weld is Alloy 600 in Yongkwang unit 5, 6 and Uljin unit 3, 4.

3. Repair process

3.1 Code Application

ASME Code for repair is basically applied to ASME Code XI and Code case is applied when ASME Code is not available in the operating power plant. The Alloy 600 vent pipe shall be repaired by ASME Code XI "IWA-4000 Repair and Replacement" because Alloy 600 is replaced with Alloy 690 vent pipe.

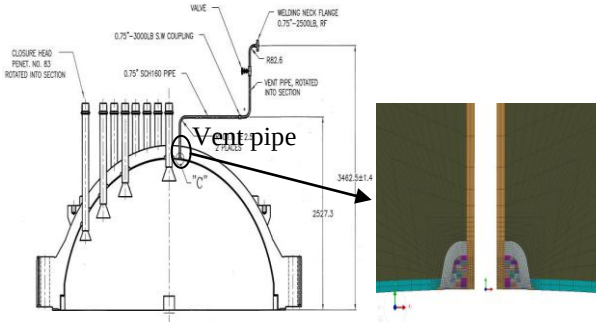

Fig. 2 Vent pipe drawing

Table 1. Dimension and materials of vent pipe

Units	Materials	
	Vent pipe	Weld
Yongkwang #3/4	Alloy 600	Alloy 82/182
Yongkwang #5/6	Alloy 690	Alloy 82/182
Uljin #3/4	Alloy 690	Alloy 82/182
Uljin #5/6	Alloy 690	Alloy 152

3.2 Machining

The machining is an important process for analyzing damages and for an accurate repair. If the defects exist in vent pipe and weld region, the volume of the defects needs to demount to analyze the cause of defect by boat sampling method. The machining processes consist of the removal of vent pipe and the J-Groove machining. The detail processes of machining are as follow. Firstly, the vent pipe is machined in order to separate the vent pipe from weld region and cut the coupling region of the pipe and then the vent pipe is removed from outer closure head. Secondly, the J-Groove region is machined to the same shape and dimension as the origin of J-Groove. The machining scene of vent pipe is shown in figure 3.

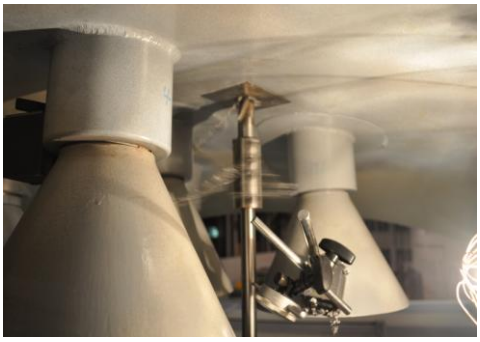

Fig. 3 The machine scene of vent pipe

3.3 Welding

The welding condition is determined by Welding Procedure Specification (WPS) which is set up in the ASME Code IX according to repaired materials, weld shapes and dimensions.

The welding of Alloy 690 vent pipe consists of two steps. The first step is to inserts Alloy 690 vent pipe in the hole inside the head. The next step is to weld the J-Groove using Alloy 52M filler metal which has a high PWSCC resistance. In the case of Alloy 690 vent pipe and Alloy 600 weld, the repair welding process includes machining the original Alloy 600 weld surface and welding two layers on the Alloy 600 weld surface using Alloy 52M filler metal. The requirement of Cr concentration in repaired weld of the Alloy 52M must be above 24% so that the welding condition could reach the required satisfaction. The welding head is shown in figure 4.

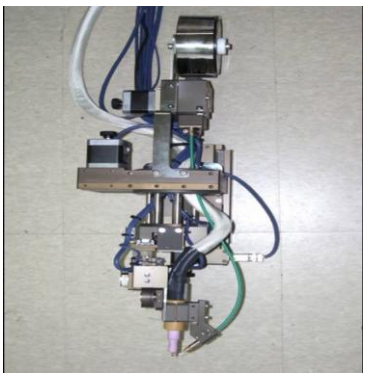

Fig. 4 Welding head

3.4 Inspection

The inspection regions consist of machining and welding region to repair vent pipe. The inspection of machining region is applied to Liquid Penetration Test (LPT) for machining surface and the welding region is inspected by LPT on the first layer, half layer and final layer, respectively.

3.5Orifice Installation

Orifice is installed by welding between outer surface of orifice and inner diameter of end region in vent pipe. However, this installation method is not suitable because the inspection of vent pipe inside is impossible in refueling outage period. Therefore, the orifice needs to change the installation location to flange inside.

4. Field Application

Doosan had repaired successfully to replace Alloy 600 with Alloy 690 vent pipe. The repair process consists of the removal of origin Alloy 600 vent pipe, J-Groove machining, repair welding, and inspection. The welding scenes are shown in figure 5.

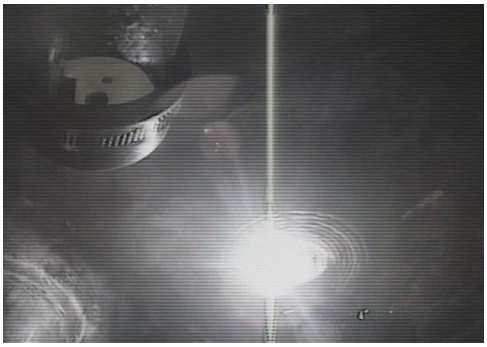

Fig. 5 The welding scene of vent pipe

5. Conclusions

The alloy 600 vent pipe was successfully repaired with Alloy 690 in Yongkwang unit 3 with the machine, inspection and welding process Doosan has developed.

REFERENCES

[1] C. King, “Materials Reliability Program: Generic Guidance for Alloy 600 Management (MRP-126), Final report, November 2004.
[2] C. King, “Materials Reliability Program: Reactor Vessel Closure Head Penetration Safety Assessment for U.S Pressurized Water Reactor (PWR) Plants (MRP-110), Final report, November 2004.