Performance Evaluation of Slant and Horizontal Slitter

Young-Hwan Kim [a*], Yung-Zun Cho [a], Young-Soon Lee [a]
[a]*Korea Atomic Energy Research Institute, Yuseong, Daejeon 305-353, Korea*
[*]*Corresponding author: yhkim3@kaeri.re.kr*

1. Introduction

In order to enhance oxidation treatment of the spent fuel, a slitter for decladding the cut rods is necessary. For the slitter performance evaluation, the simulated rods of zircaloy and stainless were used to carry out the slant and horizontal slitter performance test, and in the slant slitter method, the optimal slope value of the 2 cut module that can split the rods was obtained, and in the horizontal slitter method, the enhancement plan for horizontal device was derived. Also, for the slitting test, prototype horizontal slitter was made and the device is driven with hydraulic pressure. As a result, the enhancements were derived, and performance was compared with the slant type to select the optimal method. Also, the optimal angle of the cutter angle that can process multiple types of nuclear fuel rods was obtained, and the enhancements after the test were reflected for the enhanced design of the horizontal device.

2. Slant slitter evaluation

2.1 Test methods

The slant slitter is cut as follows. When a cutting rod of the spent nuclear fuel is placed in the module entrance, it is inserted into the center of module by the extrusion pin. A cutting rod of spent nuclear fuel is passed through the module and is simultaneously separated into several pieces by the blades inside the module, and the pieces of the pellets in the fuel rod are recovered. As in figure 1, the slope of the cutting module roller was changed to visually observe the slitting degree of SUS and Zry-4 tube, and the data measured in the load cell was obtained using RS232. During the slitting using Zry-4 and SUS tube, the gap in the cutting blade was measured, and vernier calipers was used as the measurement tool.

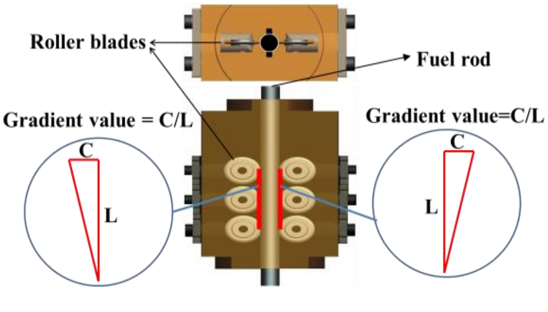

Fig. 1. Roller gradient of 2 row blades module.

2.2 Slitting test and results

Figure 2 is the result of slitting Al rod-cut. Zry-4 tubes with Al pellets were used, 2 cut module blade of slope of 200 for #1 and 133 for #2 were used. As a result, slope #1 was not split before and after the rods, and slope #2 was split nicely. The optimum slitting speed is 12.5 mm/s, and there is excessive slitting resistance at the time of finishing the cutting, the load problem shall be solved in the future.

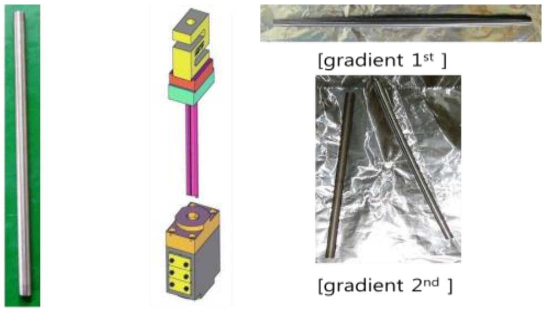

Fig. 2. Before and after slitting.

3. Horizontal slitter evaluation

3.1 Test methods

The distance between each pair of the facing rollers in the roller fixing portion may be reduced in a direction toward the slitting portion. In detail, the rollers are arranged in two rows facing each other. The rollers receive and transfer fuel rods by extrusion. Also, Decladding of the fuel rods may be performed by rotation of two circular cutting blades inserted between the rollers arranged at upper and lower portion. In order to decide the optimal angle, the outer diameter and inner diameter averages of the domestic PWR assembly rods were obtained, and the optimal angle of 32.7° was assumed

3.2 Horizontal decladding and results

Zircaloy rods were used to carry out the horizontal decladding device performance test. As in figure 3, rods were not split by the leveled force of step input part and slitting part with the hydraulic driving. Therefore, enhancement of independent hydraulic system is required for each part.

As in figure 4, the enhancements for horizontal decladding device were derived by the horizontal device performance test. To reinforce the friction of the step input part roller, knurling was reflected in the roller guide surface, and in the double driven hydraulic system shall be changed to single driven type with elastic recovery power. Also, in the hydraulic driving system, it shall be driven with the driving part composed of 2 hydraulic utilities, the slitting part roller enhancement is required, and it was composed of 2 level structure roller slitting parts. The above enhancements were reflected in the enhanced design of the horizontal device.

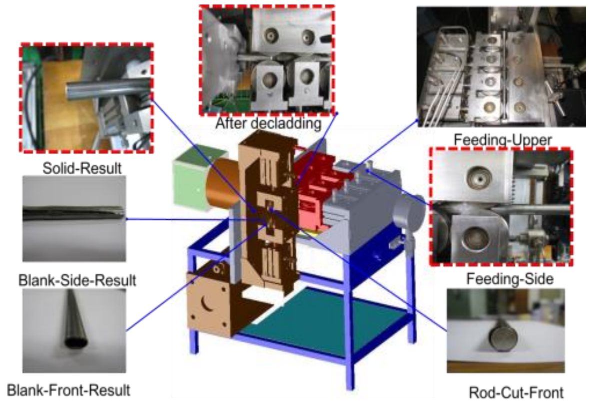

Fig.3. Capacity test of horizontal slitter.

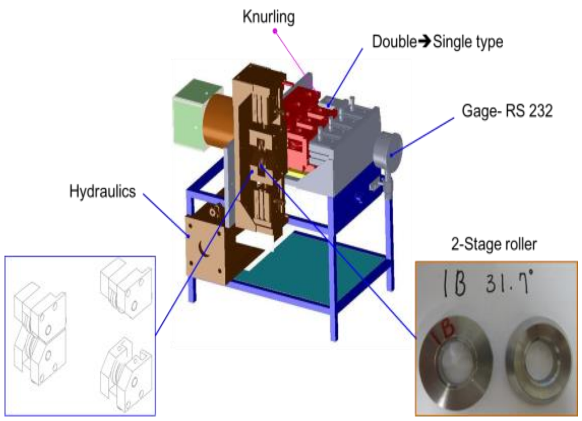

Fig.4. Improvement items horizontal slitter.

3. Conclusions

Simulated nuclear fuel rods were used to carry out the slitter performance evaluation. In the slitting test of the rod-cuts (zircaloy tube+aluminum pellets), the optimal slitting slope value of the cutter roller was 133, the slitting force obtained from load cell and RS232 was 210 kgf, and the slitting speed was 12.5 mm/s, which could split 1 rod within 5 minutes. Also, Solid works was used for modeling of multi types of the rods, and as a result of matching and verifying the cutter roller and various rods, the optimal angle of the cutter roller for multi types of PWR assembly rods splitting was derived as 32.7°, and as a result of using zircaloy rods for the horizontal decladding device performance test, the horizontal slitter enhancements for hydraulic system, rods step input part, and cutter roller output part, etc. were derived and the design data were obtained.

Acknowledgements

This paper is the study carried out with the 2013 funding of the Ministry of Education, Science and Technology and the support from National Research Foundation of Korea (Nuclear Energy Technology Development Project, No. 2012M2A8A5025 696).

REFERENCES

[1] J. Alagy, “Designing a cyclohexane oxidation reactor”, Ind. Eng. Chem., Process Des., 13(4) 1974.
[2] C.T. Kring and S.L, Schrock "Remote maintenance lessons learned on prototypical reprocessing equipment," Proceedings of 38th Conference on Remote Systems Technology, pp.23-27, 1990.
[3] B. D. Cul, R. H. Hunt and B. Spencer, "Advanced head-end processing of spent fuel," 2004 American Nuclear Society Winter Meeting, Washington DC, Nov., 16, 2004.