Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 18-19, 2017

Slitting Test of Zry-4 and SUS316 Tube using 2-CUT module

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 be pyro-process head-end, the mechanical head-end should be previously conducted by disassembling process for spent fuel such as extraction, and shearing, also, head-end process needs spent fuel slitter for rod-cuts decladding. To design this device, we manufactured slitter for testing on the consideration with decladding and shearing conditions about hulls and pellets. In this paper, we aimed at gradient for optimum shearing by using the fine stainless and zry-4 instead of spent fuel tube with high toxicity. We conducted experiments with various gradients about tubes, and obtained data with load cell and RS232 for shearing force. As major requirements, throughput of 50 kg HM/day and 250 working days per year were assumed, and based on KSFA type (16x16), 85% availability was set as a condition.

2. Methods and Results

2.1 Summary of slitter

As in figure 1, screw press-in part transfers the force to the screw by the servo motor, and the load for slitting force is operated at the bottom. The cutting blade module installed at the bottom has the structure of measuring the cutting force when the rods are penetrated and cut, and standard TM screws and nuts are used. The length of the part of the simulated rods and punch where they go through the cutting module and reach the bottom was set to be about 420 mm or more. Ball bush and guide axis were installed on both ends for the balance and for soft press-in without external interference. Capacity of 100~1000 kg was selected for load cell, and RS232C is embedded in the controller.

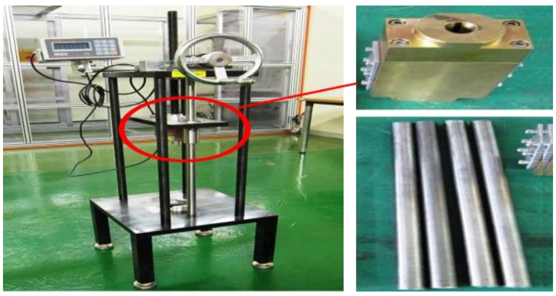


Fig. 1. Slitter, 2-CUT module and fuel rods for slitting test.

2.2 Experimental method

As in figure 2, the roller gradient of the cutting module 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 communication. During the slitting using Zry-4 and SUS tube, the gap in the cutting blade was measured, and Ø 9.5 mm was used for Zry-4 rods and Ø 9.55 mm was used for SUS 316 rods. Also, 2-CUT module is used, and the roller gradient used the adjustment plat as in figure 3. Also, white cement pellet and aluminum pellet were inserted into the blank tube with length 250 mm for the testing to derive the optimal gradient value.

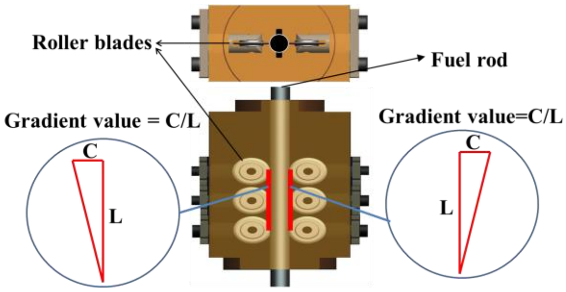


Fig. 2. Rollers gradient of 2-CUT module.

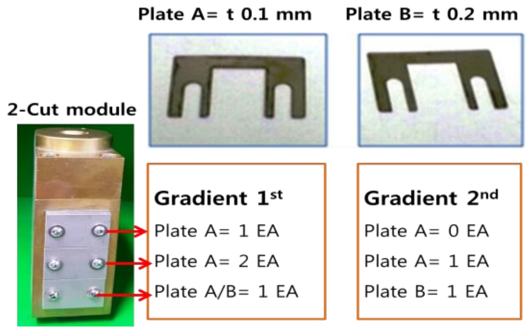


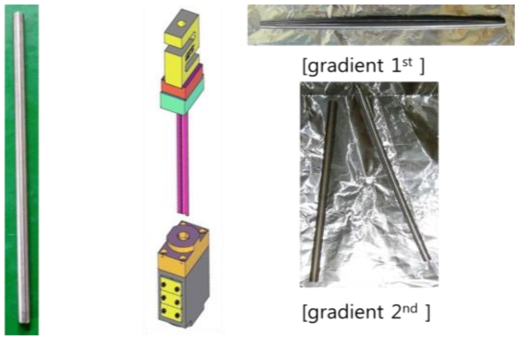
Fig. 3. Gradient variable of 2-CUT module using the plate.

2.3 SUS and Zry-4 slitting test

Vernier calipers was used as the measurement tool, and the average thickness of the zircaloy and SUS tube with length of 250 mm was obtained from 4 measurements. As a result, the average thickness of Zry-4 was 0.61 mm, and the average thickness of SUS 316 was 1.14 mm. The gradients of the 2-CUT module blades were 200 and 133. But in the results, regardless of gradients, both the blank SUS and blank zircaloy tube were not slit. Also, both the SUS and zircaloy rod-cuts (tube+white cement) were not slit. This means that, for empty tubes, the gradient value of 200 and 133 could not overcome the plasticity yield strength and it was not slit.

2.4 Zry-4 and aluminum rod-cut slitting test

Zry-4 rod-cuts (tube+Al pellets) were used, 2-CUT module blades of gradient of 200 for #1 and 133 for #2 were used. As a result, gradient #1 was not slit before and after the rods slitting, and gradient #2 was slit nicely. Figure 4 are the results of slitting on the Al rod-cut, and figure 5 is the results of slitting force. As you can see in the figure 5, there is excessive slitting resistance at the time of finishing the cutting, the load problem shall be solved in the future.



(a) before slitting (b) slitting (c) after slitting

Fig. 4 Slitting results of aluminum rod-cuts.

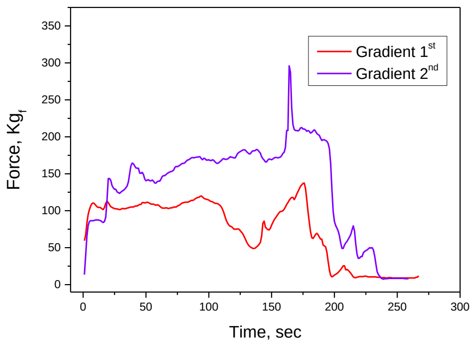


Fig. 5 Synthesis slitting results on the gradient conditions.

3. Conclusions

A slitting test of SUS 316 and zircaloy-4 tube was carried out. As a result of this evaluation test, without directly using SF rods which are harmful with toxic radiation, the fresh stainless zircaloy tube were used to derive the gradient value of the cutting module for the optimal cutting of SF rods. The optimal gradient of 2-CUT module blades was 133, the gap of 1st blade was 8.9 mm, the gap of 2nd blade was 8.5 mm, and the gap of 3rd blade was 8.28 mm. But, SUS, Zry-4 tube (blank), and rod-cut (white cement) were not slit. This means that, for blank tube and white cement rod-cut, a gradient value of 200 does not overcome the plasticity yield strength, and it was not slit, but a gradient of 133 was slit nicely. Also, there is excessive slitting resistance at the time of finishing the slitting of tube, the load problem shall be solved in the mechanism in the future.

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.