Dismantling Experiment of Mock-up Tube Bundle of Steam Generator

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1. Introduction

A SG (steam generator) is one of the biggest decommissioning components in nuclear power plants and one has been replaced 2~6 times during the whole operation of a nuclear power plant. The old SG should be decommissioned for the purpose of the volume reduction of radioactive waste. Among the components of SG, the tube bundle is one of the most difficult items to be dismantled due to the fact that it is very hard to cut since it is made of Inconel 600 which has high resistance of corrosion and abrasion. Moreover, All cutting process should be performed by remotely since radioactive contamination of the internal surface of SG tubes is very high (about 150,000~300,000 Bq/cm^2). Therefore, it is necessary to choose the appropriate cutting methods by the pros and cons analysis for candidate dismantling technologies and to do experiment study for the validation. In this study, the results of cutting experiment for a mock-up bundle by using band saw cutting method are described herein.

2. Methods and Results

In this section, the band saw as a cutting method for dismantling the SG tube bundle is used. The experiments for finding appropriate band saw speed and cutting position are conducted.

2.1 Band saw cutting speed

When the band saw cutting method is applied to cut the SG tube bundle, the most critical problem is the vibration. The vibration affects to increase the dullness rate of saw's blades rapidly. The vibration depends on the cutting speed and distance apart from the fixed end. First, the experiment of cutting a specimen which is similar to a SG tube was conducted as varying the linear velocity of a band saw. When the band saw speed is over 5.9 m/sec, it was impossible to do the cutting experiment because the band saw blades were broken. When the band saw speed is 5 m/sec, it was able to cut specimen but the dullness rate of the blade was too fast. Last, when the band saw speed is 2.5 m/s the dullness rate was slow and the heat which results from cutting is much lower than other speeds. Therefore it was found that the appropriate cutting speed of a band saw method is 1.5~3 m/s when cutting a SG tube bundle.

2.2 Mock-up cutting experiment

When the tub bundle is cut, tubes are vibrated by a saw and the oscillating amplitude depends on the distance apart from the fixed end. In order to find the appropriate cutting position where the oscillating amplitude does not affect to increase the dullness and to do damage of blades when the SG tube bundle is cut by the band saw, the cutting experiment is conducted as varying the distance apart from the fixed end. As shown in Fig. 1, the oscillating amplitude was measured by using the wire type amplitude measurement system. The amplitude was measured at the distance 100, 80, 60, 30, and 15 cm from the fixed end.

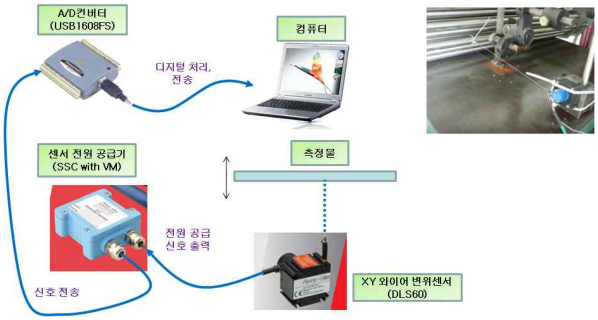
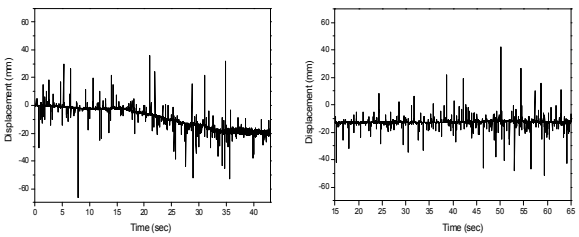
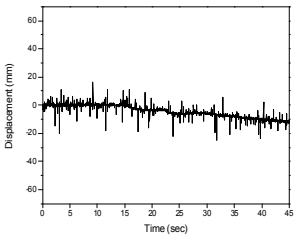


Fig. 1 Layout of wire amplitude measurement system



(a) 60 cm (b) 30 cm



(c) 15 cm

Fig. 2 Amplitudes of a tube in case of the distance apart from the fixed end

Fig. 2 shows the amplitude in case of the distance apart from the fixed end. In the cutting positions, where the distance is 100 and 80 cm, it was impossible to cut a mock-up bundle due to the high vibrating amplitude. Fig.

2(a), (b), and (c) show the amplitude of a tube at the distance of 60, 30, and 15 cm respectively. As you can see, the amplitudes at the distance 60 and 30 cm are so high that it is impossible to cut specimen. On the contrary to this, the amplitude at the distance 15 cm is much lower than the other cases and the cutting works fine. It is found that the appropriate cutting position of band saw is less than 15 cm away from the fixed end. Fig. 3 shows the cutting surface of the mock-up tube bundle after cutting.

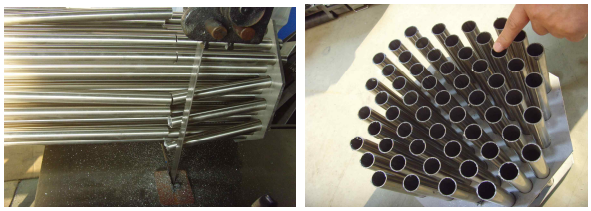
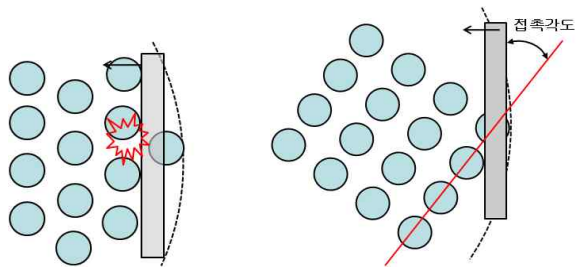


Fig. 3 Photos of cutting surface of the tube bundle

2.3 Band saw contact angle

During the band saw cutting experiment it was found that the tube bundle dynamic characteristics for the band saw blade approaching angles are quite different. In case of the vertical blade approach as shown in Fig. 4(a), the blade cuts tubes column by column and for that reason, the tube bundle was shook violently whenever the blade starts to cut a new tube column. However, in case of blade tilted as shown in Fig. 4 (b) the vibration of the tube bundle is quite lower than Fig. 4(a) case. The reason is that since the blade contacts any tube among the tube bundle at that position and it plays to hole the tube bundle, its vibration is much lower than the vertical case. Therefore it is known that the band saw blade should approach with some tilted angle for minimizing the vibration of tube bundle.



(a) vertical type (b) contact angle type

Fig. 4 Band saw blade approaching angle

3. Conclusions

In this paper the band saw cutting experiment for dismantling the SG tube bundle was performed. Especially the appropriate band saw cutting speed and cutting position which can minimize the vibration of the tube bundle was determined through the experiment. And it is also known that the band saw blade should be tilted with 5~10 deg. in order to reduce the vibration.

The band saw cutting method is one of the candidate methods for dismantling the SG tube bundle and its applicability was reviewed through these experiments.

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