# Impact fretting wear of alloy 690 tubes at 290°C

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## 1. Introduction

Recently, steam generator tubes were changing Alloy 600 to Alloy 690 in the plant. Alloy 690 has two times chromium content than that of Alloy 600. Chromium increases the corrosion resistance of material.

However, Alloy 690 tube bundles have inferior mechanical characteristics than that of Alloy 600 [1]. The heat conductivity of Alloy 690 is lower than that of Alloy 600. So steam generator cubes of Alloy 690 are about 10% longer than that of Alloy 600. So wear damage of steam generator tubes was one of the most severe degradation in PWR plant. Especially, impact fretting wear occurred between U-tube region and anti-vibration bar (AVB) [2].

Wear tests of steam generator tube were performed from the early 70's and many empirical models were proposed. Recently the work-rate model was proposed by Frick, et. al., and used widely for the fretting wear analysis of steam generator tubes [3]. To reduce the wear damage of steam generator tubes, various tests may be required for analysis of effects about normal load, sliding displacement, temperature and relative material.

## 2. Methods and Results

Usually there was a trend of increasing in the volume loss, with the applied work rate and normal load. The work-rate model is the mostly used method to compare the wear characteristics of the steam generator tube [4, 5].

### *2.1 Experimental Procedure*

The impact fretting test was performed in distilled water which had been de-aerated by nitrogen purging at the 25°C and 290°C. To estimate the wear rate, the specimen weight was measured before and after the experiment. The experiment was performed in the 33 Hz impact motion and 32Hz sliding motion. And the test temperature was 25°C and 290°C.

### *2.2 Results and discussions*

The wear rate increased with increasing work rate. The wear rate of Alloy 600 was about two times grater than that of Alloy 690 as in Fig 1. And the resistance to the impact fretting at 290°C was about 40% greater than that at 25°C.

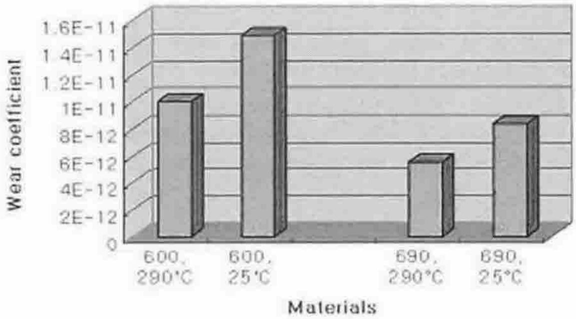


Figure 1. Comparison of wear coefficients between Alloy 600 and Alloy 690 after the impact fretting test against 409 SS at 290°C and at 25°C.

The worn surface was covered with layers made of wear particles and smooth glazed layer as in Fig 2. And abrasion and plastic deformation shapes are clearly seen in Fig 3.

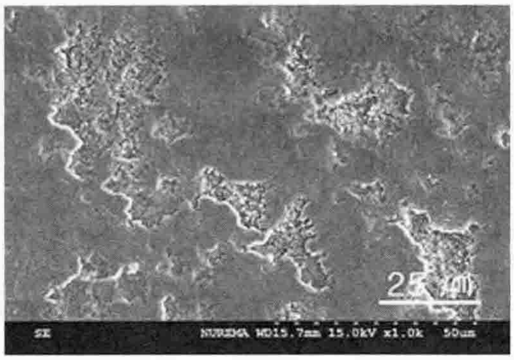


Figure 2. SEM microphotograph of the worn surface of Alloy 690 after the impact fretting test against 409 SS at 290°C.

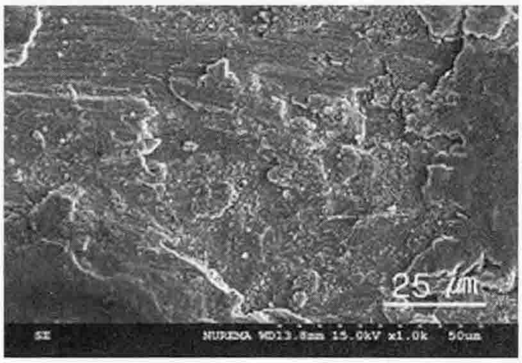


Figure 3. SEM microphotograph of the worn surface of Alloy 690 after the impact fretting test against 409 SS at 25°C.

## 3. Conclusions

The wear rate of steam generator tube materials increased with increasing work rate. This led to that work-rate model was applicable in the small displacement region about 120μm. The wear rate increased with impact normal load too. In the de-aerated water condition, wear rate of Alloy 600 was higher than that of Alloy 600. At 290°C, were rate was about 40% lower than that at room temperature. For Alloy 690, at 290°C, the worn surface was covered with smooth glazed layers at 290°C and abrasion and rough wear particle layer were found at room temperature.

## Acknowledgement

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