Fundamental study to manufacture thermal fatigue crack of SA106 Grade B.

Woong-Gi Hwang,a, Sang-Yun Lee,a, Jae-Seong Kim,a, Bo-Young Lee,a
a Faculty of Aerospace and Mechanical Engineering, ,
Korea Aerospace University, Goyang-city, 412-791, Kyunggi-do, Korea
**Corresponding author: wkhwang@kau.ac.kr*

1. Introduction

Thermal fatigue crack is one of the life-limiting mechanisms in nuclear power plant conditions. During the operation of a power plant thermal fatigue cracks can initiate and grow in various components (straight pipe sections, valve bodies, pipe elbows, and collector head screw holes). Causes for this are mixing, striping or stratification of hot and cold water. A typical component, where thermal fatigue cracking occurs, is a T-joint where hot and cold fluids meet and mix. The turbulent mixing of fluids with different temperatures induces rapid temperature changes to the pipe wall. The resulting uneven temperature distribution prevents thermal expansion and gives rise to thermal stresses. The successive thermal transients cause varying, cyclic thermal stresses. These cyclic thermal stresses cause fatigue crack initiation and growth similar to cyclic mechanical stresses [1].

The aim of this study is to fulfill the need by developing an artificial crack manufacturing method, which would produce realistic cracks. The test material was used SA106 Grade B. pipes.

2. Methods and Results

2.1 Experimental Method

2.1.1 Block diagram of thermal fatigue crack producing apparatus

The test material was SA106 Grade B. pipes(length=500mm, O.D=89mm, thickness=5t, 7.6t), and periodic change of temperature was applied in pipe. For heating up to 550℃ HF induction heating coil was used. Applied thermal differences are above 300℃.

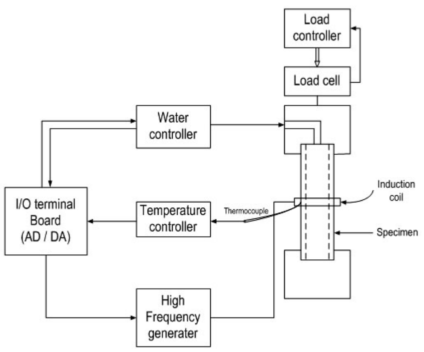
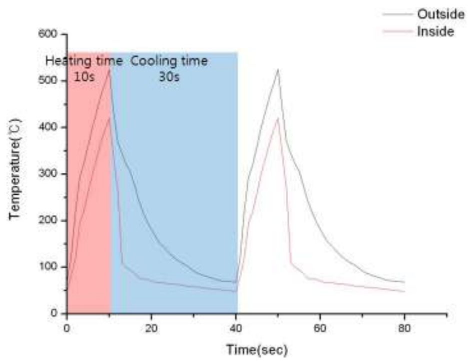


Figure 1. Mechanism of thermal fatigue crack formation

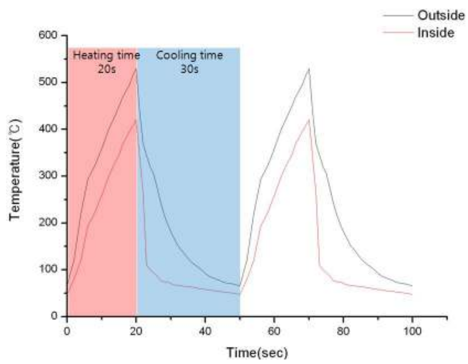
2.2 Experimental results

2.2.1 Thermal fatigue crack manufacturing

Fig 2.shows the inner and outer temperature of pipe. Temperature differences of heating and cooling on experiments were above 450 ℃. In this experiment condition, experiments were ended after penetration crack manufacturing.



(a) Thickness 5mm, heating and cooling time (10sec-30sec)

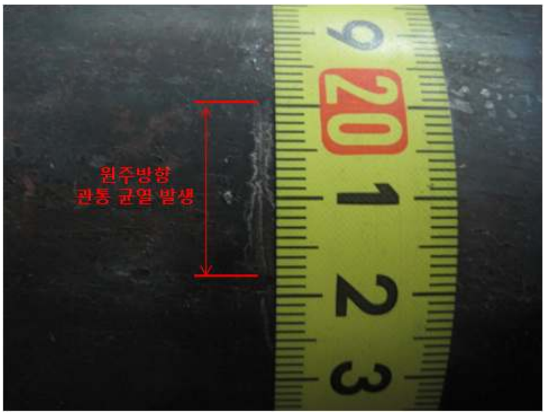


(b) Thickness 7.6mm, heating and cooling time (20sec-30sec)

Figure 2. Inner and Outer temperature of SA106 Grade B.

Fig 3. shows manufactured penetration crack. SA106 Grade B. specimen of thickness 5mm was fabricated circumference direction crack of 1.7mm. And thickness 7,6mm specimen was manufactured circumference direction crack of 1.8mm.

(a) Thickness 5mm



(b) Thickness 7.6mm

Figure 3. Penetration crack of thickness 5mm, 7.6mm

3. Conclusion

These experiments were performed to fundamental study about crack manufacturing of the SA106 Grade B. specimen in order to produce mock-up specimens for the NDT of nuclear power plant components.

1. It is possible to produce a mock-up specimen for the test of thermal fatigue crack on SA106 Grade B.

2. Temperature differences of heating and cooling on experiments were above 450 ℃.

3. Thermal fatigue crack of the specimens is propagated from inner surface to outer. And penetration cracks in 5mm, 7.6mm specimen are manufactured.

4. Acknowledgments

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