Effect of aging on fatigue properties of Type 316 stainless steel

Dae Whan Kim*, Eun Jeong Kim, Sung Soo Kim, and Young Suk Kim
Nuclear Materials Research Division., Korea Atomic Energy Research Institute,
989-111 Daedeok-daero, Yuseong, Daejeon, 305-353, Korea
*Corresponding author; dwkim1@kaeri.re.kr

1. Introduction

The reactor internals support the core, maintain fuel alignment, limit fuel assembly movement, maintain alignment between fuel assemblies and control rod drive mechanisms, direct coolant flow past the fuel elements, direct coolant flow to the pressure vessel head, provide gamma and neutron shielding, and guides for the incore instrumentation in PWR operating at around 315°C. The major materials for reactor internal components are type 304 and 316 stainless steel. Type 316 stainless steel is a candidate material for the reactor vessel of SFR operating at around 550°C. Short range order could be formed in the temperature range of 300°C-550°C for type 316 stainless steel. In this study, the effect of aging at 475°C on low cycle fatigue properties was investigated.

2. Experimental procedure

Commercial type 316 stainless steel was prepared for low cycle fatigue tests. Chemical composition is shown in Table 1. This material was aged at 475°C for 1000 hrs. Low cycle fatigue specimens with 6.5 mm diameter and 12 mm gage length were machined. Low cycle fatigue tests were conducted under strain control in the temperature range of RT-700°C. Total strain range was in the range of 0.8%-1.5%. Fatigue life was defined as 25% reduction of tensile peak saturation stress. Strain rate was 2×10^{-3}/s. Temperature was controlled within ±2°C.

Table 1. Chemical composition (wt%)

C	Mn	Cr	Ni	Mo	N
0.02	1.06	16.71	10.17	2.02	0.03

2. Results

Fatigue life is shown as a function of temperature in Fig. 1 for solution annealed and aged 316 stainless steels. Aging increased slightly fatigue life before 500°C and decreased a little fatigue life after 600°C. Cyclic tensile peak stresses are shown as a function of strain range at each temperature in Fig. 2 for solution annealed and aged 316 stainless steels. Aging increased a little cyclic stress before 500°C but little changed cyclic stress after 600°C. Cyclic tensile peak stresses are shown as a function of temperature in Fig. 3. Cyclic saturation stress increased with increasing temperature in the temperature range of 300°C-600°C for solution annealed and aged steels. This behavior was attributed to dynamic strain aging.

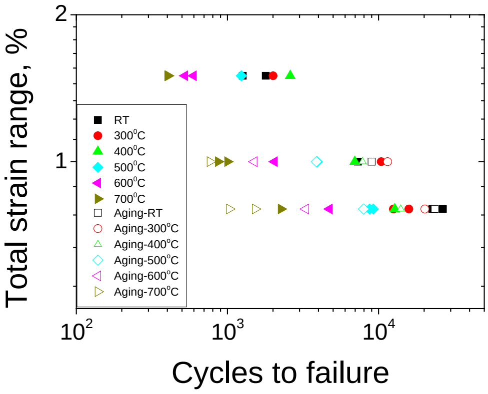
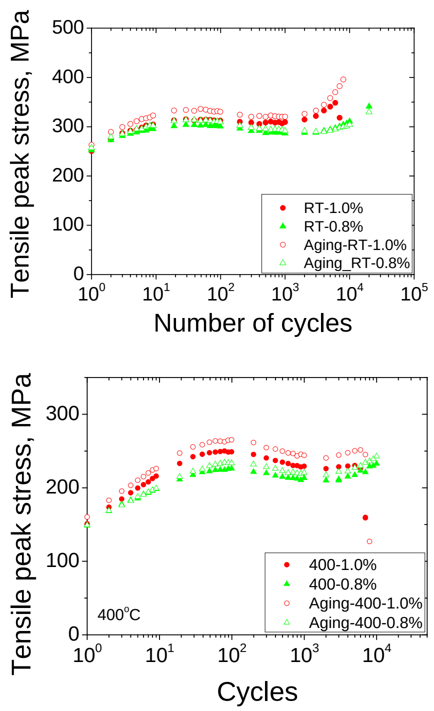


Fig. 1. Fatigue life as a function of temperature for solution annealed and aged steels.



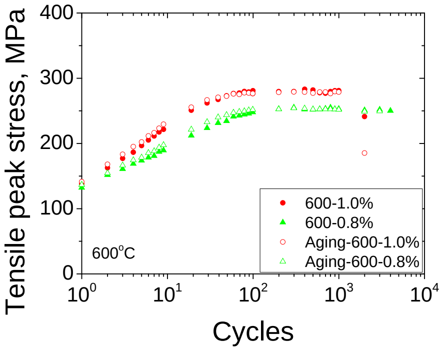


Fig. 2. Cyclic tensile peak stress as a function of strain range at each temperature for solution annealed and aged steels.

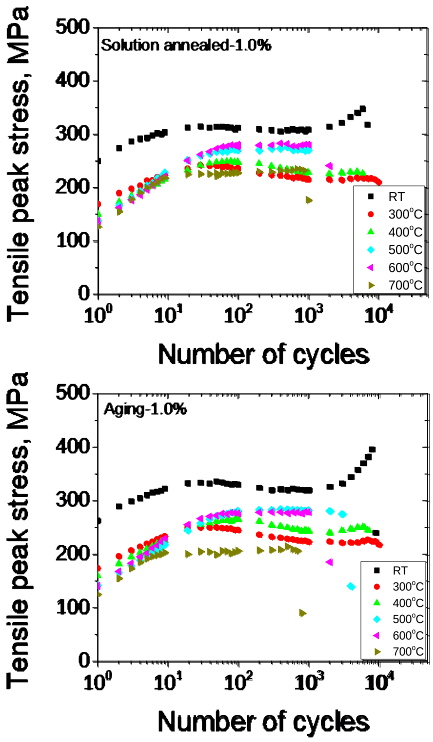


Fig.3. Cyclic tensile peak stress as a function of temperature for solution annealed and aged steels.

3. Conclusion

Aging increases slightly fatigue life before 500°C and decreases a little fatigue life after 600°C. Aging increased a little cyclic tensile peak stress before 500°C but little changed cyclic tensile peak stress after 600°C.