Serration Behaviors of Ni-based Alloys

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1. Introduction

VHTR is operated at 950℃. Ni based superalloys have been candidate material for hot gas duct and IHX because of good strength and corrosion properties at high temperature. It has been reported that dynamic strain aging is observed at high temperature for Ni based superalloy. Dynamic strain aging increased tensile strength but decreased fatigue life. Dynamic strain aging behavior of superalloys was evaluated with the different alloying composition and was compared with that of Fe based Alloy 800 .

2. Experimental procedure

Alloys for test are commercial Hastelloy-X, Alloy 617, Haynes 230, and Alloy 800. Chemical compositions of alloys are in ASME range. Tensile tests were conducted at RT-1000℃ and strain rate was $2x10^{-3}$/s. Tensile test specimen was 2mm thick, 6.25 mm width, 25 mm gauge length.

All tests were conducted at air environment. Test temperature was maintained constant within ±2℃ during the period of the test.

3. Results

Tensile strength and elongation were show in Fig. 1. Yield stress and UTS of Haynes 230 were the higher than other alloys. Yield and UTS of Alloy 800 were the lowest. Yield stress decreased gradually with temperature to 800℃ and decreased greatly above 800℃. UTS decreased gradually to 300℃, was plateau from 300℃ to 600℃, and decreased abruptly above 600℃. Elongation of Alloy 617 is slightly higher than other alloys. Elongation of Alloy 800 was the lowest. Elongation of all alloys was almost the same to 600℃ and increased with temperature above 600℃. Trend of tensile properties with temperature was the same for all alloys.

Stress-displacement curves for alloys were shown with temperature in Fig. 2. Work hardening was observed below 800℃ but not above 850℃. Serration was observed at 200-850℃ for Alloy 617 and Haynes 230, at 250-600℃ for Haselloy X, and at 250-650℃ for Alloy 800. Serration was one of evidences for dynamic strain aging. Plateau range of UTS was within the serration temperature range. The plateau and serration were due to dynamic strain aging.

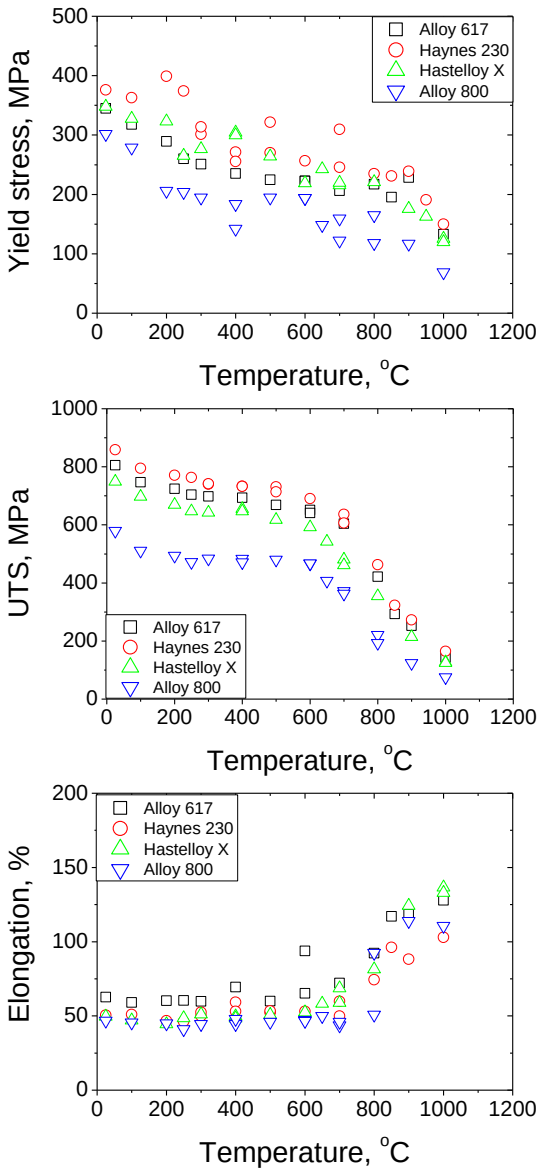
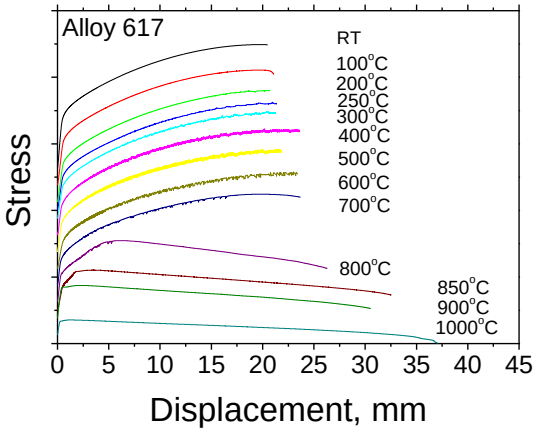
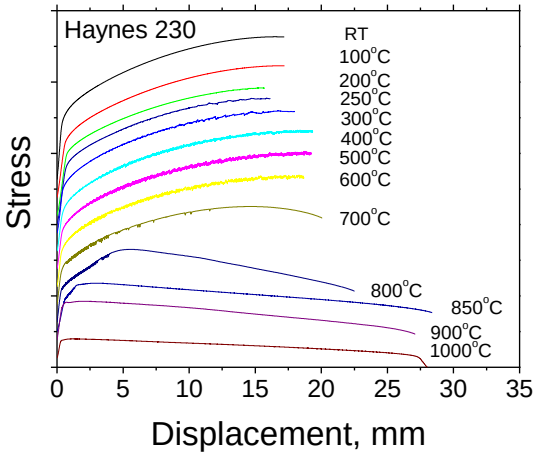


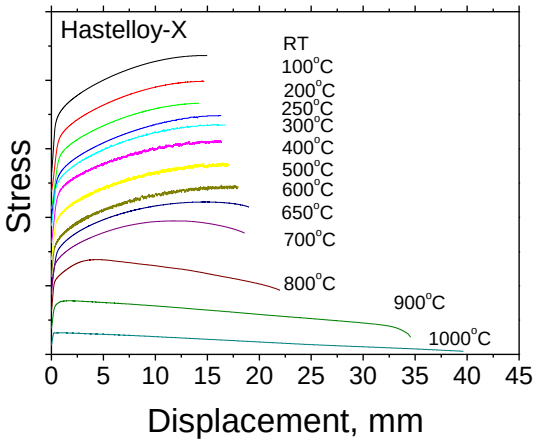
Fig. 1. Tensile properties with temperature for superalloys

Critical displacement for serration onset was shown with temperature in Fig. 3. Critical

displacement was high below 400℃ and decreased with temperature. Critical displacement of Alloy 800 was high below 400℃ but almost the same with alloys above 400℃.







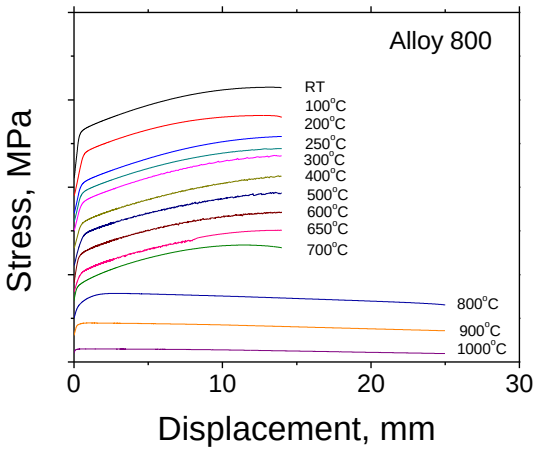


Fig. 2. Stress-displacement curves with temperature for superalloys

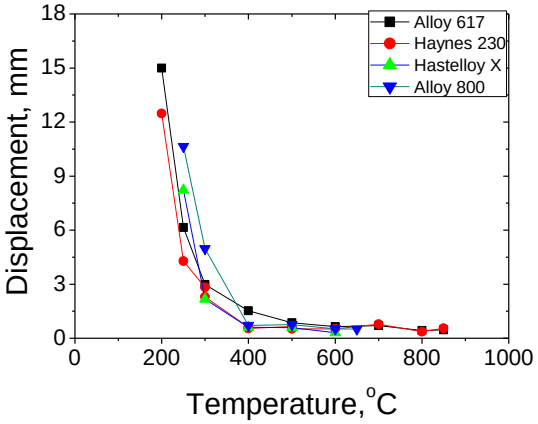


Fig. 3. Critical displacement for serration.

4. Conclusion

Yield and UTS of Haynes 230 were higher than other alloys. Yield and UTS of Alloy 800 were the lowest. Temperature range for serration was 200-850℃ for Alloy 617 and Haynes 230, 250-600℃ for Haselloy X, and 250-650℃ for Alloy 800. Critical displacement decreased greatly with temperature below 400℃ and was almost same with temperature. Critical displacement of Alloy 800 was the highest below 400℃ but almost the same as other alloys above 400℃.