ABSTRACT

To withstand the high temperature (>700°C) and pressure demands of steam turbines and boilers used for energy applications, metal alloys must be economically viable and have the necessary material properties, such as high-temperature creep strength, oxidation and corrosion resistance, to withstand such conditions. One promising class of alloys potentially capable of withstanding the rigors of aggressive environments, are alumina-forming austenitic stainless steels (AFAs) alloyed with aluminum to improve corrosion and oxidation resistance. The effect of aging on the microstructure, high temperature constant-stress creep behavior and mechanical properties of the AFA-type alloy Fe-20Cr-30Ni-2Nb-5Al (at.%) were investigated in this study.

The alloy's microstructural evolution with increased aging time was observed prior to creep testing. As aging time increased, the alloy exhibited increasing quantities of fine Fe_2Nb Laves phase dispersions, with a precipitate-free zone appearing in samples with higher aging times. The presence of the $L1_2$ phase γ'-Ni_3Al precipitate was detected in the alloy's matrix at 760°C.

A constant-stress creep rig was designed, built and its operation validated. Constant-stress creep tests were performed at 760°C and 35MPa, and the effects of different aging conditions on creep rate were investigated. Specimens aged for 240 h exhibited the highest creep rate by a factor of 5, with the homogenized sample having the second highest rate. Samples aged for 2.4 h and 24 h exhibited similar low secondary

creep rates. Creep tests conducted at 700ºC exhibited a significantly lower creep rate compared to those at 760ºC.

Microstructural analysis was performed on crept samples to explore high temperature straining properties. The quantity and size of Fe_2Nb Laves phase and NiAl particles increased in the matrix and on grain boundaries with longer aging time.

High temperature tensile tests were performed and compared to room temperature results. The high temperature results were significantly lower when compared to room temperature values. Higher creep rates were correlated with lower yield strengths.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES