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ELEVATED TEMPERATURE PROPERTIES OF 18Cr-15Mn+0.5N AUSTENITIC STEELS WITH AND WITHOUT 0.5 PERCENT Cb

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ELEVATED TEMPERATURE PROPERTIES OF 18Cr-15Mn+0.5N AUSTENITIC STEELS WITH AND WITHOUT 0.5 PERCENT Cb

Two heats of a 15-percent manganese 18-percent chromium austenitic steel were investigated for creep-rupture properties. Both contained slightly more than 0.5-percent nitrogen and one heat was further modified with about 0.5-percent columbium.

The interest in these alloys stems from the absence of nickel with the possibility of creep-rupture properties equal to or higher than those of the Cr-Ni austenitic steels. The higher manganese allows the addition and retention of large amounts of nitrogen as a strengthener. The materials studied had 0.07 to 0.08-percent carbon. Specimens were obtained from barstock (water quenched from 2150°F) made from laboratory induction furnace heats.

Survey type rupture tests at 1200° and 1350°F were used to check the level of creep-rupture properties.

CONCLUSIONS

The limited number of tests conducted indicate that in comparison with 18Cr-8Ni type steels the Mn modified steels had:

(1) Short time strengths at 1200°F high in rupture tests. Extrapolated strengths for 100,000 hours, however, were below average but above minimum for Type 304H and 347H steels. The high short time strengths at 1200°F were in agreement with the very high tensile strengths at room temperature reported by The Timken Roller Bearing Company.

(2) Rupture strengths at 1350°F which appeared to be about the same as those for type 304H and 347H steels. 100 hour strengths for the heat without Cb were somewhat high compared with Type 304H, while the heat with Cb was similar to Type 347H.

It should be noted that the investigation was very limited. Only barstock from induction heats, heat treated at 2150°F, was studied. Because nitrogen tends to go into solution at lower temperatures than carbon, lower temperature heat treatments should be investigated before drawing too definite conclusions.

MATERIAL

Tensile specimens, 0.505-inch in diameter, were supplied from two heats of 18Cr-15Mn+0.5N austenitic steels. In addition to nitrogen one heat contained columbium plus tantulum. The analysis for the heats as reported by The Timken Roller Bearing Company was as follows:

Heat No.	C	Mn	P	S	Si	Cr	N_2	Cb + Ta
A311	.081	15.00	.012	.015	.20	18.14	.53	-
A312	.073	15.80	.015	.013	.26	17.27	.57	.53

Barstock from both heats was water quenched from 2150°F. The following room temperature physical properties were reported by The Timken Roller Bearing Company:

Heat	BHN	0.2% Offset Yield Strength (psi)	Tensile Strength (psi)	Elongation (%)	Reduction of Area (%)
A311	241/255	70,000	122,500	58.0	70.4
A311	241/255	71,000	125,500	62.0	73.0
A312	255/285	75,000	131,500	48.5	58.6
A312	255/285	76,250	132,000	47.0	56.5

These tensile and yield strengths as well as the hardness values are considerably higher than is usual for standard austenitic steels of the 18Cr-8Ni type. Ductility values were, however, excellent.

RESULTS

The rupture tests at 1200°F (Table 1 and Figure 1) indicated rupture strengths at 100 hours (Table 2) considerably higher than those for 18Cr-8Ni steels. Extrapolation to 100,000 hours, however, indicated that the rupture strengths had fallen off to the levels for 18Cr-8Ni type steels. The values from the tests at 1350°F(Table 1 and Figure 1) indicated 100 hour strengths (Table 2) similar to those for 18Cr-8Ni+Cb steels and somewhat higher than those for 18Cr-8Ni steels. The 100,000 hour strengths were similar to Type 347 steel for the Cb bearing heat and low in comparison with Type 304 for the heat without Cb.

The heat with 0.5-percent Cb plus Ta had somewhat higher rupture strengths than the heat without Cb plus Ta. Elongations and reductions of area were, however, considerably lower.

The microstructures (Plate 1) showed the heat without Cb + Ta to be single phase austenite with a fairly coarse grain size. The heat with Cb + Ta apparently was finer grained with stringers of columbium carbonitrides.

DISCUSSION

These data indicate that the alloys had exceptionally high strength at low temperatures and for short times under rupture test conditions. Evidently the strengthening mechanism was not stable so that long time strengths at 1200°F were no better than 18Cr-8Ni type steels. Available data at 1350°F are rather meager. Evidently the Mn modified steels were reasonably similar to the regular 18Cr-8Ni steels from 100 to 100,000 hours at 1350°F. The comparative values for 100,000 hours at the bottom of Table 2 show the minimum and average values of all available test data for Type 304H and 347H steels.

The investigation did not cover variations in temperature of heat treatment. Nitrides generally can be dissolved at lower temperatures than carbides. Treatment at temperatures lower than 2150°F might therefore be worthwhile investigating.

TABLE 1

Stress-Rupture Time Data at 1200° and 1350°F of 18Cr-15Mn+0.5N (With and Without Cb) Austenitic Steels Water Quenched from 2150°F

Heat No.	Cb+Ta (%)	Stress (psi)	Rupture Time (hrs.)	Elongation (% in 2 ins)	Red. of Area (%)
			1200°F		
A311	nil	35,000	200	11.0	13.5
A311		30,000	295	9.0	13.5
A311		20,000	2012	12.5	12.5
A312	0.53	38,000	302	4.0	6.0
A312		30,000	842	4.0	4.0
			1350°F		
A311	nil	20,000	119	19.0	21.0
A311		12,000	755	30.0	30.0
A312	0.53	20,000	182	6.0	9.0
A312		13,000	1108	6.0	6.5

TABLE 2

Rupture Properties at 1200° and 1350°F of 18Cr-15Mn+0.5N (With and Without Cb) Austenitic Steels Water Quenched from 2150°F

Heat	Cb+Ta (%)	Temp. (°F)	Rupture Strength (psi) and Fracture Elong. (%) 100 hr.	1000 hr.	10,000 hr.	100,000 hr.
A311	nil	1200	38,000(11)	23,000(13)	(14,000)	(8,900)
A312	.53	1200	(48,000)(9)	29,000(4)	(17,000)	(10,000)
Type 347[1] (1900°F WQ)		1200	26,000	22,000	17,500	14,000
Type 347[2] (H.R. + WQ 1750°F)		1200	28,000	22,000	17,500	14,000
A311	nil	1350	21,000(19)	11,000(30)	(5,900)	(3,150)
A312	.53	1350	23,000(6)	13,000(6)	(7,800)	(4,500)

	1200°F	1350°F
Average values for Type 304H for 100,000 hours (psi)	11,400	5,400
Average values for Type 347H for 100,000 hours (psi)	12,250	4,500
Minimum values for Type 304H for 100,000 hours (psi)	6,900	3,270
Minimum values for Type 347H for 100,000 hours (psi)	10,000	3,680

(1) - Digest values for Type 347 1-inch diameter barstock (grain size 4-6)

(2) - Digest values for Type 347 10.5-inch O.D. x 1.58-inch wall tube (grain size 3-5)

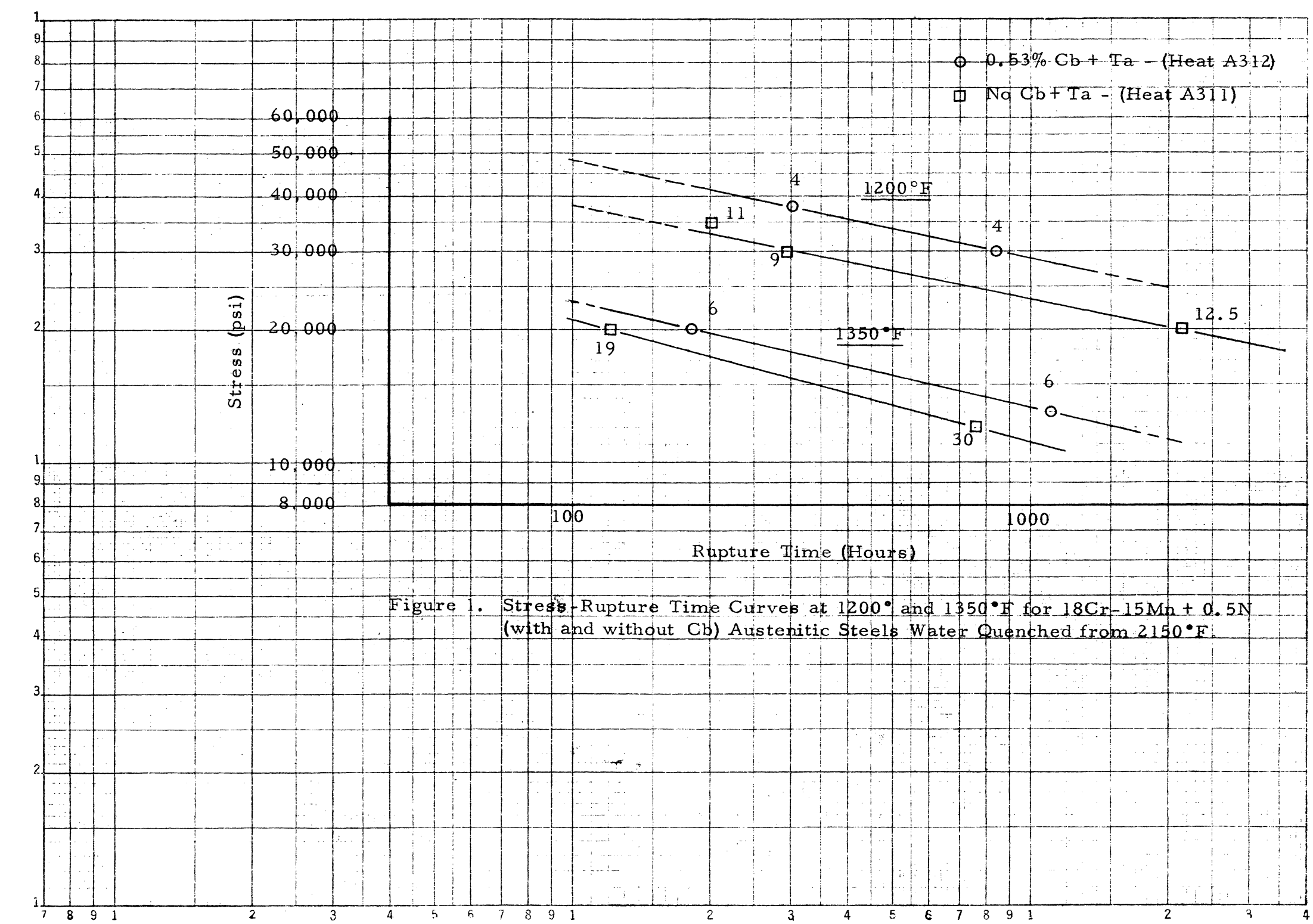

Figure 1. Stress-Rupture Time Curves at 1200° and 1350°F for 18Cr-15Mn + 0.5N (with and without Cb) Austenitic Steels Water Quenched from 2150°F.