REPORT

ON

VARIABLE TENSILE PROPERTIES OF 1015 STEEL AT 1600° TO 2000°F

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INTRODUCTION

Very wide variations in ductility were obtained in this investigation between heats of 1015 steel in the temperature range between 1600° and 2000°F. At present, the reasons for the variations are not apparent. A very striking effect is shown, however, which should be important in the processing and fabrication of such steels. Rather low ductilities in particular ought to cause difficulties in brazing, welding, and, possibly, hot-working operations.

SUMMARY

Of eight heats of 1015 steel subjected to tensile tests at temperature from from 1600° to 2000°F, four gave elongations ranging between 65 and 82 percent. For the other four, the range was from 13 to 39 percent, with a minimum between 1700° and 1800°F of 13 to 21 percent.

Similar variation in reduction of area occurred. The range in tensile strengths was small, although the more ductile heats tended to have lower tensile strengths.

There was no apparent relationship between reported variations in chemical analysis and the ductility characteristics.

TEST MATERIALS

Tensile specimens, 0.505 inches in diameter, were supplied from eight heats of 1015 steel reported to have the analysis shown in the following tabulation:

Chemical Composition of 1015 Steel Heats

Code No.	Heat No.	C	Mn	P	S	Si	Cr	Ni	Mo
1	40915	.12	.44	.010	.024	.15	.18	.11	.04
2	41038	.16	.41	.009	.015	.17	.20	.06	.02
3	41037	.13	.46	.010	.022	.16	.20	.06	.02
4	40960	.13	.45	.016	.026	.15	.17	.08	.03
5	50682	.14	.50	.009	.023	.21	.09	.09	.04
6	50748	.13	.41	.011	.022	.17	.21	.10	.04
7	41095	.15	.45	.012	.030	.30	.08	.09	.02
8	11626	.19	.45	.008	.030	.11	.02	.04[(a)]	.02

(a) + Cu.

The prior history (melting practice and condition of heat treatment) was not reported.

RESULTS AND DISCUSSION

Short-time tensile data were obtained for 1600°, 1700°, 1800°, 1900°, and 2000°F. The tensile tests, particularly at 1700°F and higher, were run at a free head speed of 0.2 inches per minute in order to decrease the amount of oxidation at these high temperatures and to more nearly equal the condition of strain that the material would probably undergo during fabrication processes.

The tensile test data are tabulated in Table I. The variations in elongation, reduction of area, and tensile strength with temperature are shown in Figures 1, 2, and 3, respectively.

Figures 1 and 2 show remarkable differences in ductility of the various heats in that they fall into either a high or low ductility group.

The lower ductility heats had slightly higher tensile strengths. The variation in tensile strength between heats at any temperature was nowhere near as pronounced as were the variations in elongation or reduction of area.

The cause of the differences in tensile data between heats is not apparent from the reported chemical compositions. A possible explanation might be that there was a distinct difference in melting or deoxidation practice. Another possibility would be the presence of some contaminating element not normally analyzed. Inasmuch as the tests were carried out in the austenite region, it seems doubtful that prior processing could have been responsible.

TABLE I

Short Time Tensile Tests: 1015 + Cr Steels

Code No.	Heat No.	Tensile Strength (psi)	Elongation (% in 2 in.)	Reduction of Area (%)
		1600°F		
1	40915 (a)	9,300	78.0	94.5
1	40915	9,850	71.0	73.0
2	41038 (a)	8,830	22.5	21.5
2	41038	9,700	24.0	23.5
3	41037 (a)	8,880	22.0	19.0
3	41037	8,800	21.5	21.5
4	40960 (a)	9,475	83.0	82.0
4	40960	10,450	82.0	86.0
5	50682 (a)	9,100	18.5	14.5
5	50682	9,700	16.5	16.5
6	50748 (a)	9,325	83.5	80.5
6	50748	9,550	78.5	90.0
7	41095	10,125	20.5	18.5
8	11626	7,870	71.5	97.5
		1700°F		
1	40915	7,725	73.0	97.0
1	40915	6,970	81.0	96.5
2	41038	7,825	20.0	17.5
3	41037	7,675	20.0	18.0
3	41037	8,075	21.5	21.5
5	50682	8,070	13.5	15.5
5	50682	7,750	15.0	14.5
6	50748	7,770	78.0	91.5
6	50748	7,700	77.0	94.5
7	41095	8,150	17.5	16.5
8	11625	5,840	79.5	85.0
		1800°F		
1	40915	6,050	70.0	98.5
3	41037	6,500	25.0	21.0
5	50682	6,350	13.0	13.0
6	50748	6,300	72.0	88.0
7	41095	6,650	15.0	15.5
8	11626	4,920	75.5	99.5

TABLE I, Continued

Code No.	Heat No.	Tensile Strength (psi)	Elongation (% in 2 in.)	Reduction of Area (%)
		1900°F		
1	40915	4,900	68.5	97.5
3	41037	5,600	29.5	34.0
5	50682	5,780	17.0	17.5
6	50748	5,050	69.5	99.0
7	41095	5,720	19.5	20.5
8	11626	4,200	68.5	99.5 (b)
		2000°F		
1	40915	3,880	77.0	99.5 (b)
3	41037	4,280	38.5	72.5
5	50682	4,540	30.0	41.0
6	50748	4,200	64.5	99.5 (b)
7	41095	4,875	30.0	37.0
8	11626	3,610	75.5	99.5 (b)

(a) These tensile tests were run at a free head speed of 0.1 inches per minute. All others were run at 0.2 inches per minute.

(b) Necked to a point.

NOTE: For Figures 1, 2, and 3 consult file copy.