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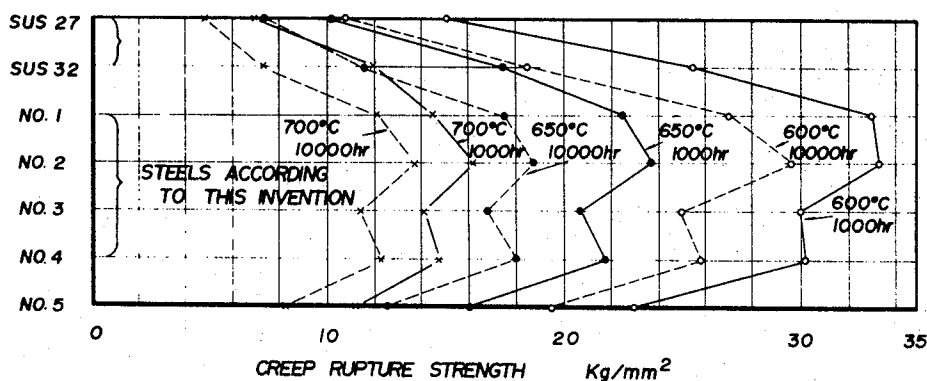
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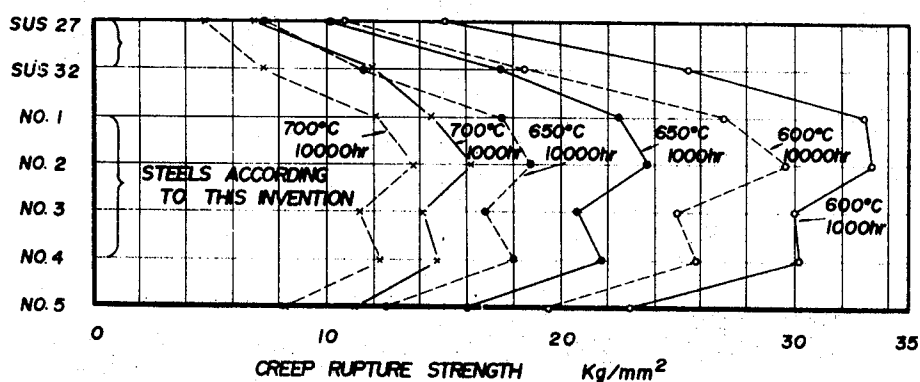
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[54] **AUSTENITIC HEAT RESISTING STEEL**
1 Claim, 1 Drawing Fig.
 [52] U.S. Cl..... **75/128 G,**
75/128 T, 75/128 V
 [51] Int. Cl..... **C22c 39/20**

ABSTRACT: Cr-Ni type austenitic heat resisting steel having about twice the heat resistibility of common stainless steel by the addition of 0.001% to 0.30% by weight Ti, 0.001% to 0.30% by weight Nb + Ta and 0.05% to 2.50% by weight V to a well-known Cr-Ni type steel composition for elevated temperature service.





AUSTENITIC HEAT RESISTING STEEL

BACKGROUND OF THE INVENTION

This invention relates to Ci-Ni type austenitic stainless steels of improved heat resistibility for elevated temperature service.

DESCRIPTION OF THE PRIOR ART

It is well known that higher strength and oxidation resistibility of steel at higher temperatures are required in some fields, e.g. boiler industry. As the above boiler becomes larger in size and of the ultra-critical pressure type, higher strength steel has been called for said service.

At present, JIS (Japanese Industrial Standards) SUS-27, SUS-29, SUS-32 and the like (AISI-304, 321 and 316 steels are similar standards) 18 Cr-8 Ni austenitic stainless steels are generally employed for elevated temperature and high-pressure services. The fact is that said SUS-32 steel (AISI-316 steel) among the above-mentioned steels is commonly employed in consideration of having superior strength at high temperature in spite of a high cost which is due to Mo of 2% to 3% content. The cost of SUS-27 steel (AISI-304) is relatively low, while its high-temperature strength is inferior to other stainless steel. SUS-29 steel (AISI-321 steel) with the addition of Ti to said SUS-27 steel composition has higher heat resistibility than said SUS-27 steel. It is, however, found that the strength of said SUS-29 steel fails remarkably in a long period of service such as 650° C.×100,000 hours. Consequently, the strength is of the same degree as that of said SUS-27 steel.

Thus, a heat-resisting steel being in cost and having a higher strength is not yet available for industrial circles. Accordingly, the development of more economical heat-resisting steels is required today.

The present invention has been developed in order to meet the above requirement. The heat-resisting resisting steel of this invention is characterized by the addition of 0.001% to 0.30% by weight Ti, 0.001% to 0.30% by weight Nb+Ta, and 0.05% to 2.5% by weight V to compositions of the above Standards steels.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an economical heat-resisting steel not containing Mo, which is expensive, and having higher strength and heat resistibility for elevated temperature service than those stainless steels in the JIS (Japan Industrial Standard) e.g. especially SUS-32 steel (AISI-316 steel).

Another object of this invention is to provide a heat-resisting steel having higher strength and heat resistibility for elevated temperature service than those stainless steel in the JIS (AISI Standard) by substituting other elements, namely Ti, Nb+Ta and V in place of expensive Mo.

BRIEF DESCRIPTION OF THE DRAWING

Additional objects of this invention will become apparent by the following description reference being made to the examples and the accompanying drawing in which:

The FIGURE is a graph showing the relation of the creep rupture strength in the case where steels subjected to elevated temperature service are JIS SUS-27 (AISI-304) and SUS-32 (AISI-316) steels, this invention steels No. 1, No. 2, No. 3 and No. 4 and No. 5 steel not containing V.

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, the steels of this invention have the following composition, that is, the steels consist of (by weight percent) 0.03% to 0.30% C, up to 1.00% Si, up to 2.00% Mn, 15.0% to 26.0% Cr, 7.0% to 22.0% Ni, 0.001% to 0.30% Ti, 0.001% to 0.30% Nb+Ta, 0.05% to 2.5% V, the balance being Fe and unavoidable impurities.

As mentioned above, the reason for making said additional elements, that is Ti, Nb+Ta and V coexist lies in the fact that

the coexistence of the above elements is very effective in arresting the agglomeration of those carbides produced by the above additional elements and in making carbides disperse uniformly and finely by interaction of said additional elements.

C content of the present invention steel is higher in value in order to cause Ti-carbide and Nb-carbide to produce and then cause Cr-carbide and V-carbide to precipitate and disperse around said Ti and Nb-carbide. Consequently it causes the strength under elevated temperature service to improve.

The content of Ti should be defined to be within the above range. More than 0.30% Ti causes its carbide to coarsen and causes its strength to lower at high temperatures, while less than 0.001% Ti brings about a lowering of precipitation amount of Ti-carbide and is ineffective for improving its strength.

An effect of Nb+Ta, too, is similar to that of Ti. That is, both more than 0.30% Ti and less than 0.001% Ti are impossible to cause high-temperature strength to improve.

Less than 0.05% V is ineffective for improving its strength at high temperatures by reason of which the amount of V-carbide precipitated is decreased, while more than 2.50% V brings about a lowering of high-temperature strength and causes its oxidation-resisting ability by reason of which the amount of V-carbide precipitated remarkably increases and the crystal grain coarsens.

Referring now to FIG. 1, each graph is plotted on the basis of the following examples.

The chemical composition of the examples is shown in Table 1.

TABLE 1

[The compositions of SUS-27 steel (AISI-304 steel) and SUS 32 steel (AISI-316 steel) are based on the Standard respectively.]

Number:	By weight percent							
	C	Si	Mn	Cr	Ni	Ti	Nb+Ta	V
1	0.16	0.58	1.47	18.29	9.86	0.061	0.13	0.25
2	0.13	0.58	1.47	18.47	9.98	0.054	0.21	0.51
3	0.16	0.50	1.45	18.20	9.96	0.126	0.11	0.34
4	0.14	0.68	1.45	17.65	9.57	0.115	0.22	0.61
5	0.12	0.68	1.20	20.28	9.16	0.02	0.098	

Notes: 1. All compositions of No. 1, No. 2, No. 3 and No. 4 steels are within the range defined as the present invention steel.

2. The composition of No. 5 steel is within the range as defined as this invention steel, exception being for V.

Having manufactured through the well-known process, said heat-resisting steels of the above seven compositions were subjected to the creep rupture test under 600° C., 650° C. and 700° C. in 10³ hr. and 10⁴ hr. respectively. The results are shown in the following Table 2.

TABLE 2

Number:	Kilograms mm. ²					
	600° C., hour		650° C., hour		700° C., hour	
	10 ³	10 ⁴	10 ³	10 ⁴	10 ³	10 ⁴
SUS-27	15.1	10.8	10.2	7.3	7.0	4.9
SUS-32	24.5	18.0	16.2	11.5	10.5	7.0
1	33.0	27.5	22.5	17.5	14.6	12.2
2	33.3	29.6	23.7	18.8	16.3	13.8
3	30.0	25.0	20.7	16.8	14.2	11.5
4	30.2	25.8	21.8	18.0	14.8	12.3
5	23.0	19.5	16.0	12.5	11.2	8.2

As mentioned above, the only difference of those steels, No. 1 to No. 4 and No. 5 in composition was V. Referring now to the above Table 2 and FIG. 1, it is clearly indicated that there is a great difference of those creep rupture test values. That is, it should be understood that the existence of V has an important effect upon the creep rupture strength. Even No. 5 steel attained a higher strength, as compared with said SUS-27 and 32 steels by reason of which Ti and Nb+Ta is added to said SUS steels. This fact evidently explains that the addition of Ti, Nb+Ta and V causes the high-temperature strength to im-

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prove to a great degree. The creep rupture test value of this invention is more than twice in comparison with that of said SUS-27 steel and is about twice as much compared to said SUS-32 steel.

Thus, according to the present invention, the insufficient heat-resisting strength of steel will be remarkably improved with a lower cost by reason of which expensive Mo was omitted.

The austenitic heat-resisting steels of the present invention may be broadly employed in many fields of industrial circles.

We claim:

1. An austenitic heat-resisting steel consisting essentially of, in weight percent:

C	0.03 to 0.30
Si	up 1.00
Mn	up to 2.00
Cr	15.0 to 26.0
Ni	7.0 to 22
Ti	0.001 to 0.30
Nb+Ta	0.001 to 0.30
V	0.05 to 2.5
balance	Fe and unavoidable impurities

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