2.2.5 0.5Cr-0.5Mo-0.25V steel

2.2.5.1 Introduction

0.5Cr-0.5Mo-0.25V steel (14MoV6-3, 12MoCrV6-2-2) is primarily used as a steam pipe material in the normalized and tempered heat treatment condition. The microstructure is typically tempered bainite, the creep resistance being derived from a fine distribution of V_4C_3 precipitate.

The requirements for 0.5Cr-0.5Mo-0.25V steel as 14MoV6-3 in EN 10216 replace those for BS 3604 (Grade 660) and DIN 17 175 (14MoV6-3).

2.2.5.2 Material standards, chemical composition and tensile requirements

Table 31. Chemical requirements of 0.5Cr-0.5Mo-0.25V steel, 14MoV6-3 (EN 10216)

Standard	Std. No.	Designation	Chemical composition [wt%]								
			C	Si	Mn	P	S	Cr	Mo	V	Al
EN	10216	14MoV6-3	0.15 - 0.10	0.35 - 0.15	0.70 - 0.40	≤ 0.025	≤ 0.020	0.60 - 0.30	0.70 - 0.50	0.28 - 0.22	≤ 0.040

The material is usually supplied in the normalized and tempered condition. The recommended austenitizing temperature range is 930 - 990 °C with tempering in the range 680 - 750 °C.

Table 32. Room temperature mechanical property requirements for 0.5Cr-0.5Mo-0.25V steel, 14MoV6-3 (EN 10216)

Standard	Std. No.	Designation	Heat treat	Thickness [mm]	$R_{p0.2}$ [Nmm^{-2}]	R_m Nmm^{-2}	A [%]	K_v(RT) [J]
EN	10216	14MoV6-3	N+T	≤40	320	610 - 460	≥20	≥40
EN	10216	14MoV6-3	N+T	>40	310	610 - 460	≥20	≥40

Table 33. Minimum 0.2 % proof strength, $R_{p0.2}$, values at elevated temperatures for 0.5Cr-0.5Mo-0.25V steel, 14MoV6-3 (EN 10216) (wall thicknesses ≤60 mm)

Standard	Std. No.	Designation	Heat treat	$R_{p0.2}$ [Nmm^{-2}] at a temperature [°C] of									
				100	150	200	250	300	350	400	450	500	550
EN	10216	14MoV6-3	N+T	282	276	267	241	225	216	209	203	200	197

2.2.5.3 Creep rupture strength

The creep rupture strength of 0.5Cr-0.5Mo-0.25V steel is shown in Fig. 61. The analysis from which the data in the figure are derived was carried out as part of the activities of the European Creep Collaborative Committee and additional details can be found from their published data sheets [1].

The creep rupture properties have been obtained by analysis of (i) tube material with outer diameters in the range 162 - 521 mm and thicknesses of 19 - 89 mm, (ii) forgings with sections sizes in the range 381 - 508 mm. The test data were from 46 heats with test temperatures of 475 - 740 °C. The distribution of test durations is shown in Table 34.

Table 34. Distribution of test durations used to derive the stress rupture properties of 14MoV6-3 (12MoCrV6-2-2).

Number of test points at the various test durations						
<10,000 h	10,000 - 20,000 h	20,001 - 30,000 h	30,001 - 50,000 h	50,001 - 70,000 h	70,001 - 100,000 h	>100,000 h
331 (3)	81 (5)	30 (4)	29 (4)	11 (1)	13 (1)	5 (3)

( ) denotes unbroken tests

The data were assessed using the BS PD6605 procedure and the following master equation was derived:

$$\ln(t_u^*) = \beta_0 + \beta_1 \log(\sigma) + \beta_2\sigma + \beta_3\sigma^2 + \beta_4 T + \beta_5/T$$

where t_u^* is the predicted rupture time in hours, T is the absolute temperature and σ is the stress in Nmm^{-2}.

Table 35. The β_i are constants with the following values

β_0	β_1	β_2	β_3	β_4	β_5
−39.7658730	−8.43513298	−0.00186616660	-2.91037377×10^{-5}	0.00935613085	49662.4102

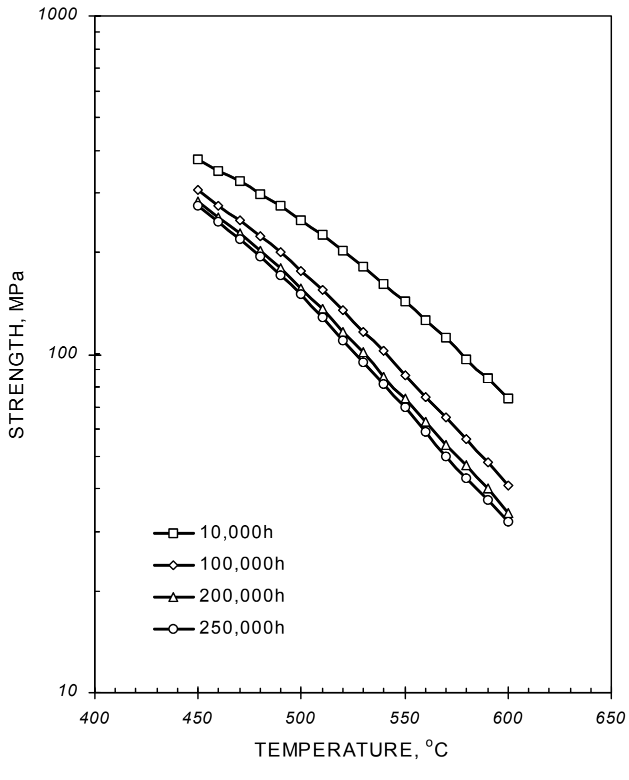

Fig. 61. Creep rupture strength data of 14MoV6-3 (12MoCrV6-2-2).

2.2.5.4 Estimated long term creep rupture strength

Based on the data shown in Fig. 61 the 100,000 h rupture strength values for a range of temperatures are as follows:

100,000 h rupture strengths [Nmm^{-2}] at specified temperatures [°C]								
Temperature	450	460	470	480	490	500	510	520
Stress	305	276	249	224	200	177	155	135

100,000 h rupture strengths [Nmm^{-2}] at specified temperatures [°C]								
Temperature	530	540	550	560	570	580	590	600
Stress	117	102	87	75	65	56	48	41

2.2.5.5 Reference

[1] ECCC Data Sheet for 12MoCrV6-2-2, European Creep Collaborative Committee, BRITE EURAM Thematic Network BET2-0509 “Weld Creep”, (1999).