Corrosion behaviour of heat - treated steel in marine environment

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This study deals with the effect of heat treatment of steel with 0.17%C at three different temperatures selected through metallographic analysis viz. untreated, 873, 1073 and 1223K on the corrosion behaviour in aggressive tropical marine environment. Accelerated salt spray test has also been conducted to compare the actual field data. The corrosion rates are in tune with the meteorological data collected. The heat treatment process is graded according to the performance in combating corrosion. Results are discussed in the light of micro structure levels of pollutants and other meteorological data.

Key words: Corrosion, heat treated steel, marine environment

INTRODUCTION

Heat treatment involves phase transformation of steel. The present study is of significance because the heat treatment effect is judged from the corrosion behaviour of steel. Three different temperatures have been chosen for the process and the treated specimens have been exposed for their corrosion endurance at the tropical marine environment prevailing at Mandapam Camp.

MATERILS AND METHODS

Hot rolled carbon steel (0.17% C, 0.46% Mn, 0.074% Si, 0.028% S, 0.07% P) sheet of $150 \times 100 \times 2$ mm size were used. Three sets of panels were held isothermally at 873K (6 hours water quenched), 1073K (2 hours, water quenched) and 1223K (5 mts, normalized) in a well sealed muffle furnace and these three temperatures and the (normalization/quenching) heat treatment processes were selected using the SE metallography of the specimens which reveals the grain refinement. The location and the meteorological data for the site have been explained elsewhere [1]. Triplicate panels were withdrawn from the exposure at regular intervals viz. monthly, quarterly, half-yearly and yearly. Panels were derusted in Clark's solution [2] and the corrosion rates were calculated.

RESULTS AND DISCUSSION

The results of Table 1, monthly and quarterly corrosion rates have no appreciable degree of variation, whereas those of long term exposures have experienced marked variation. This could be attributed to the delayed response of morphological transformation showing up in terms of corrosion rate. The cumulative corrosion rates of treated and untreated steels are shown in Fig. 1. The untreated steel recorded higher corrosion rate compared to that of treated steel from the sixth month. The changes occurred to the grains show a marked variation in the corrosion rates though not initially but at a later stage of exposure. Untreated steel shows considerably higher corrosion rate: this could be due to the residual stresses and the presence of uniformly distributed impurities. The lower corrosion rate of the treated panels could be attributed to the impurities moving to the grain boundary at the elevated temperatures and thereby decreasing the microgalvanic cells. The scanning micrographs (Figs. 2 to 5) reveal the thickening of the grain boundary and the transformation in the grain size at different temperatures.
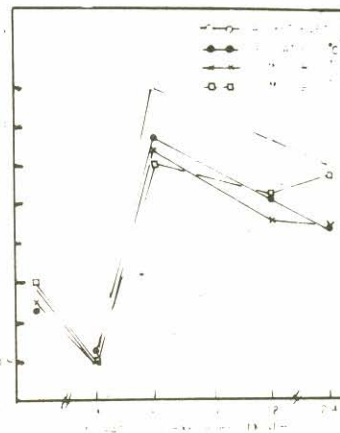

Fig. 1: Cumulative corrosion rates of untreated and heat treated steels

TABLE–I: Corrosion rates of untreated and heat treated steel

| Period	Corrosion rates (mdd)			
	Untreated	Heat-treated		
		873K	1073K	1223K
March'87	29.12	25.40	26.80	29.85
April'87	25.20	25.70	24.60	25.50
May'87	24.98	19.20	25.70	25.70
June'87	34.60	34.90	41.20	41.80
July'87	47.70	45.30	48.60	53.90
August'87	110.04	106.30	118.80	120.70
September'87	48.49	60.60	58.80	60.40
October'87	13.79	13.40	16.75	16.08
November'87	8.10	7.74	8.60	9.84
December'87	10.77	12.80	12.80	18.50
January'88	6.45	8.17	6.50	7.12
February'88	17.54	16.40	13.00	14.60
Mar'87-May'87(Qly)	17.20	19.11	17.41	17.81
June'87-Aug'87	86.30	89.50	67.72	73.36
Sept'87-Nov'87	13.80	18.80	19.15	48.60
Dec'87-Feb'88	8.05	7.59	9.225	9.08
Mar'88-May'88	20.90	23.20	21.20	21.60
June'88-Aug'88	117.80	122.20	92.50	100.20
Mar'87-Feb'88(Yly)	52.18	42.96	39.53	43.44
Mar'88-Feb'89	48.23	38.28	38.67	47.62

Fig. 3: SEM of 873K treated steel

Fig. 4: SEM of 1073K treated steel
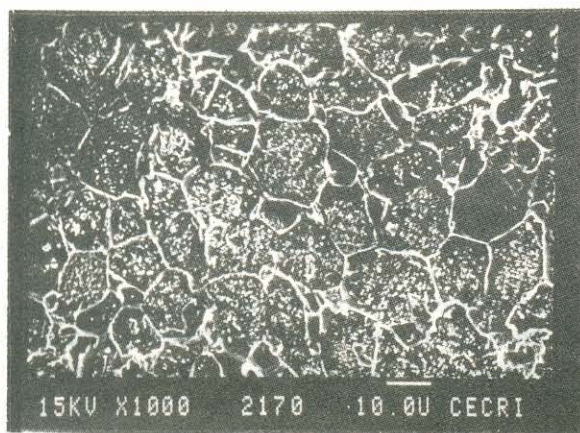
Fig. 2: SEM of as received steel

Fig. 5: SEM of 1223K treated steel

CONCLUSION

In the initial stages, there is no difference in corrosion rates between the treated and the untreated specimens. But considerble difference in corrosion rates occurs over longer period of exposure.

REFERENCES

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