Alloy Localized Corrosion in Steam Turbines

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Abstract: In the presented paper the determination of pits nucleation due to alloy corrosion in steam turbines by microscopy technique is described. Parameters of pitting corrosion are essential for formulating a damage function and predicting of damage development.

Keywords: Corrosion; Damage; Steam Turbines.

1 Introduction

The development of effective localized corrosion damage prediction methods is essential for the successful avoidance of unscheduled downtime in steam turbines. It is reported that damage in steam turbines initiates in highly localized areas, most commonly at corrosion pits that act as stress raisers. Therefore, the evaluation of pits distribution and depth is necessary.

2 Evaluation of Pitting

The number of pits in different areas and pit depth/density can be determined by microscopy technique with image analysis. As an example for the analysis the corrosion of segments of the seal rings have been chosen. A microscopy system Nikon Eclipse ME600 with image analysis software Nikon Elements has been used. The max. and min. depths of pits and their densities have been found for areas shown at Fig. 1. Tab. 1 comprises the parameters of corrosion evaluated for part of turbine packing ETU23 (alloy X22CrMoV12-1).

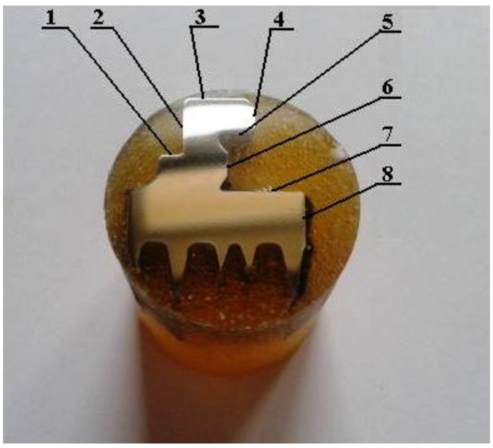

Fig. 1: Pitting corrosion after 6700 hrs in 650 °C steam, turbine packing ETU23.

3 Formulating of Integral Damage Function

The integral damage function (IDF), $F_k(x,t)$ is defined as the number (per cm^2) - density of corrosion events with depths larger than x for a given observation time t. It is evident that

$$\Delta N_k(x_1, x_2, t) = F_k(x_1, t) - F_k(x_2, t) \tag{1}$$

Tab. 1: Parameters of pitting determined experimentally.

Area	No of Pits	Σ L i [mm]	Density	Oxide [%]	Depth [µm]			
					Max	Min	Mean	St. Deviation
1	6	1.5567	3.85	79.00	35.39	13.06	25.95	6.997
2	31	3.9507	7.85	66.74	36.39	5.65	21.58	7.825
3	17	0.7627	22.29	12.09	29.05	5.80	19.73	5.802
4	15	0.8248	18.19	33.35	30.00	14.52	20.78	5.079
5	18	0.8534	21.09	28.19	28.08	7.40	19.05	5.113
6	3	2.8381	1.06	99.22	32.88	29.19	30.81	1.540
7	42	5.3321	7.88	64.00	39.71	4.35	21.91	8.932
8	29	2.4345	11.91	41.68	36.76	9.67	22.65	7.453

$$F_k(x,t) = \int_x^\infty f_k(x',t)\,dx' \qquad\qquad f_k(x,t) = -\frac{\partial F_k(x,t)}{\partial x} \qquad (2)$$

The parameters of integral damage function can be determined from experimental data as shown in Tab. 1.

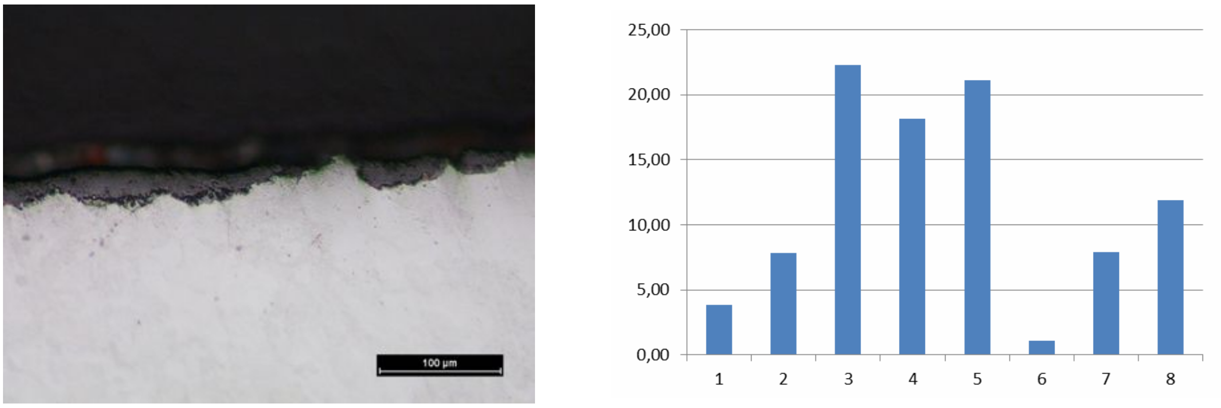

Fig. 2: Distribution of pits and density of pitting.

4 Conclusion

In the presented paper the determination of pits nucleation due to alloy corrosion in steam turbines is described. For two-dimensional task the number of pits in different areas is determined by microscopy technique with image analysis as the basis for predicting a complete cycle of damage development.

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