MICROSTRUCTURAL AND MECHANICAL CHARACTERISTICS OF DESTRUCTED METAL TAKEN FROM ELEMENTS SUBJECTED TO CREEP IN THERMAL POWER STATIONS

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Conclusions about the destruction of three elements of steam pipelines used under creepage conditions in thermal power plants based on characteristics and microdefects of samples of Cr(1%)-Mo(0.3%)-V(0.2%) have been made.

INTRODUCTION

Metal from destructed and healthy sections of a header and two bends of superheated steam pipelines from high-parameter boilers has been studied. The enclosed Table 1 contains basic information about the elements, covering outside diameter D_{out}, tube wall thickness S, average operating temperature of metal T_{op}, number of start-up cycles N, operating hours before destruction t_e.

TABLE 1 - Basic information about analyzed elements

Element	DxS, mm	T_e,K	N, pcs	t_e, hrs
Header	273x24	773-803	106	15400
Bend 1	273x20	773-803	113	34300
Bend 2	273x32	813-843	932	94000

Chemical composition, structure characteristics and mechanical properties (in the healthy sections) meet all requirements toward steel. The structure consists of ferrite (and in the header and bend 1 of up to 10% perlite) and coagulated carbides on the boundaries of the grains. The main crack in the header runs longitudinally along the holes of the connections. The microdefects in the zone next to the break, 120 mm away from it and in healthy undeformed sections of the elements have been established by means of optical and scanning electron microscopy.

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Pores number in the area of the breaks next to bend's external surface is up to 1000 per sq mm with size 3 μm in the case of bend 1, and size 6.2 μm in the case of bend 2, ref. Fig. 1. In the wall their amount decreases, namely up to 200 per sq mm with size up to 2.1 μm, Figure 2, in the case of the internal surface of bend 1 and up to 30 per sq mm with size up to 1.8 μm in the case of bend 2. At a distance of 120 mm from break the amount of pores increases from 440 to 1400 per sq mm with size up to 3.1 μm from outside to the internal surface in the case of bend 1, Fig. 3 . In the case of bend 2 the pores are considerably less - from 70 to 220 per sq mm with size up to 0.07 μm in the intermediate sections and practically single at the internal surface. Pores in the header in the area of the break are about 5 times less than in the same sections of the bends, their size being up to 6 μm. At 120 mm from they are even less, their size being up to 2 μm. No pores in the metal of the healthy sections of bend 1 and the header were detected; in bend 2 single pores with size up to 0.07 μm were detected next to the external surface. Other differences were also established, namely round pores along the boundaries of bend 1 and wedge-shaped pores at the joint among three grains. Pores in the header next to the break combine into intercrystalline microcracks without prior concatenation, Fig. 4.

The analyses have revealed certain localization of the microdefects and have confirmed again the posibility to evaluate the basic factors which have caused the destructions by determining the parameters and pores arrangement in metal.

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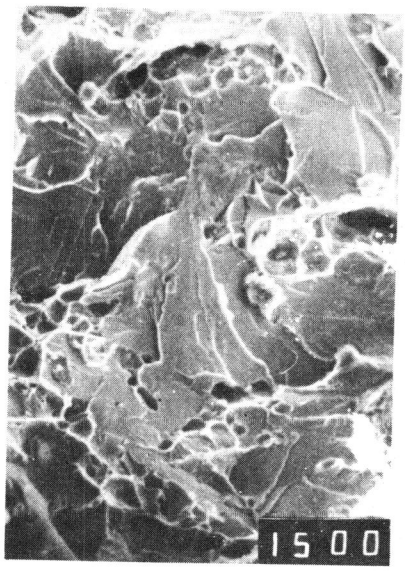

Fig. 1

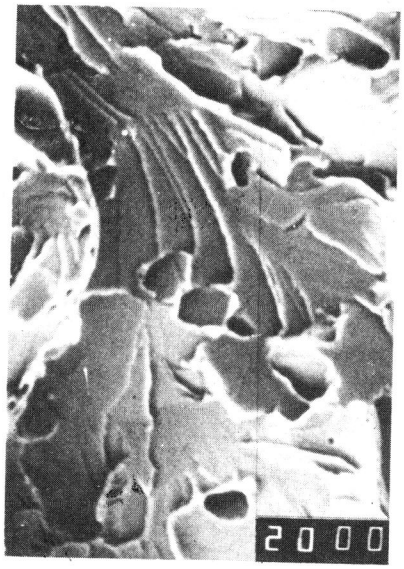

Fig. 2

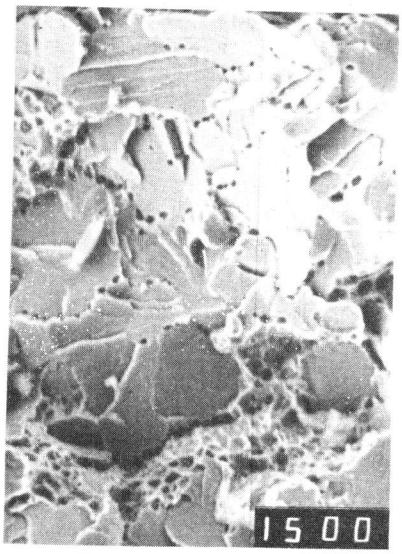

Fig. 3

Fig. 4