X-RAY ANALYSES OF LOW-ALLOY STEEL FROM STEAM PIPINGS SUBJECTED TO CREEP

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The use of steam pipings in thermal power plants in the conditions of high temperatures and creep in metal leads to changes in the fine structure and metal's properties and this requires the use of complex control over operating life.

Using a Philips-Mikro 111 X-ray difractometer we investigated samples 1-5 of pieces of steam pipings of steel grade Cr(0.7%)Mo(0.5%)-V(0.3%) with different operating life at temperatures 773-813K. The microdeformations were determined by (110) and (220) lines, and dislocations density by line (211) of α-Fe. Size of blocks, D and the microdeformations, $\Delta a/a$ were estimated by the method of approximations /1/, and dislocation density, ρ by the method described in /2,3/ as $\rho = B \times \beta^2$ and $B = 4 \times 10^{13}$ mm^{-2}. The results of the X-ray analyses are given in Table 1 which includes data about $\Delta a/a$, ρ and the working hours of the steam pipings, t_e, and the relative elongation, A_5 and the relative shrinkage, Z of the samples subjected to tension tests at 293K.

Fig. 1 shows the value of the relation $\Delta d/d - t_e$ which are close to one another for the range 100-150 thousand hours and increase over two times at 200 thousand hours. Concerning the relation $\rho - t_e$ Fig. 2 shows an increase of ρ with increase of operating hours. Table 1 shows that no significant changes in plasticity have been found(A_5 and Z).

Based on data about $\Delta d/d$ we have calculated the 3rd order stresses in metal of the samples by the formula $\sigma = E \times \Delta d/d$ (E - modulus of elasticity). Comparison of these values of σ with data given in Table 2 for the mechanical properties (standard yield point $R_{po,2}$

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TABLE 1. Results from analyses of samples

N	t_e,hrs	$\Delta a/a \times 10^{-3}$	$\rho \times 10^{8}$ mm^{-2}	A_5, %	Z, %
1	200000	1.00	16.38	25.8	64.2
2	170000	0.57	13.40	26.1	62.5
3	150000	0.37	11.30	24.6	61.7
4	110000	0.47	6.86	23.9	60.8
5	100000	0.42	3.02	25.1	69.0

TABLE 2. Calculated stresses and strengths of metal

Sample N	1	2	3	4	5
σ , MPa	206	121	190	95	89
$R_{p0,2}$, MPa	384	286	374	398	362
R_m, MPa	558	425	524	565	523

and tension strength R_m) of samples at 293K /4/ shows that the microstresses are considerably lower than $R_{po,2}$ in the area of the elastic deformations.

The results of the X-ray analysis point to a definite coordination between the parameters of fine structure with mechanical properties of steel and the duration of operation in the conditions of creep. More detailed characteristics of these relations require consideration of more X-ray analyses and data about heat-resistant properties of the metal.

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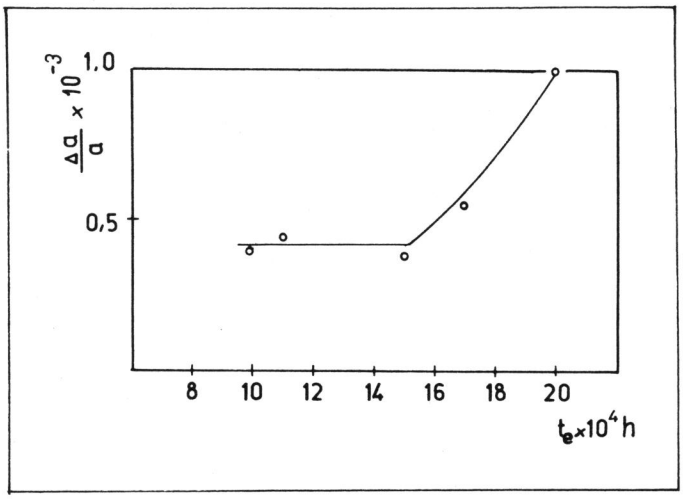

Fig. 1. Microdeformations $\Delta a/a$ depending on time of operation t_e.

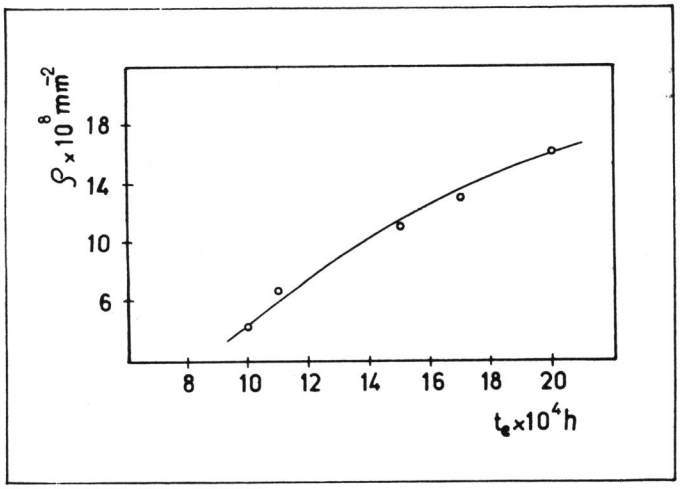

Fig. 2. Dislocation density ρ depending on time of operation t_e.