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## SENSITIVITY OF CHARACTERISTICS OF HEAT-RESISTANT STEEL TO OPERATIONAL DEGRADATION

A feature of high-temperature (up to 540 °C) degradation of heat-resistant steel is the changes in its structure. Due to the diffusion, alloying elements and carbon are released in the form of complexly alloyed carbides along the grain boundaries that weaken cohesion between grains. Thus, the resistance to brittle fracture of steel reduces, and it becomes susceptible to cracking [1, 2].

The steel 15H1M1F in the initial state and after  $2 \times 10^5$  h of operation, subjected to 501 (No.1) and 576 (No.2) shutdowns of power units, has been analysed using the most sensitive characteristics to operational degradation: impact strength  $KCV$ , fracture toughness  $K_c$  and the effective fatigue threshold  $\Delta K_{th\,eff}$  (Table 1). The results of all tests showed that the metal from the block No.2 is more sensitive to degradation than that from the block No.1.

Table 1 – Mechanical properties of 15H1M1F steel

State		$KCV$ [MJ/m <sup>2</sup> ]	$K_c$ [MPa m <sup>1/2</sup> ]	$\Delta K_{th\,eff}$ [MPa m <sup>1/2</sup> ]
Initial		1.68	100	4.1
Operated for $2 \times 10^5$ h	No.1	1.25	67	1.76
	No.2	1.05	58	1.17

To visualize fractographic peculiarities of steel's degradation, the specimens after the tests for impact strength, fracture toughness and fatigue crack growth resistance were examined. Fragments of intergranular fracture were identified on the fracture surfaces of the examined specimens. The obtained results allow recommending the area of intergranular fracture in the unit area of the fracture surface of the operated steel specimens as a quantitative indicator of the structural and mechanical state of the steel.

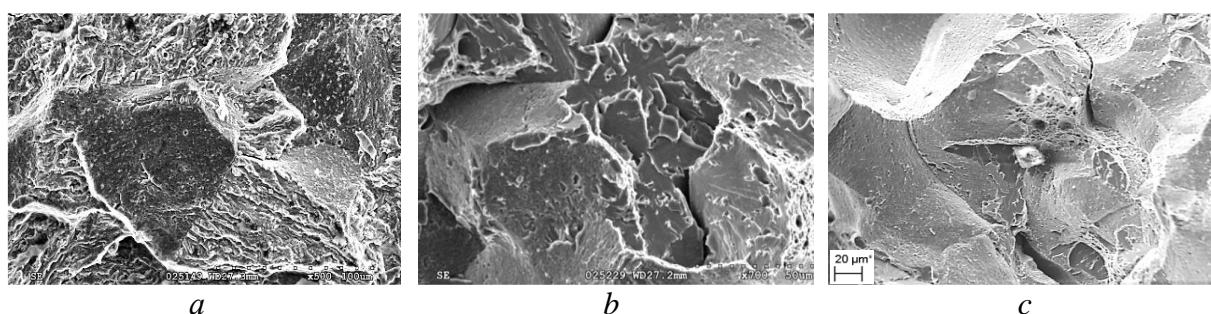


Fig.1 – Fracture surfaces of 15H1M1F steel after  $2 \times 10^5$  h of operation and 576 shutdowns after (a) impact tests, (b) fracture toughness tests and (c) fatigue crack growth test.

### References

1. Krechkovska H. Predicting the state of heat-resistant steel of a steam pipeline at a TPP taking into account changes in its strength due to operational damage / H. Krechkovska, V. Sylovanyuk, O.Student, A. Chornenkyi // Procedia Structural Integrity. – 2022. – 36. – P.43–50.
2. Romaniv O.M. Effect of damage in service of 12Kh1MF steam-pipe steel on its crack resistance characteristics / O.M. Romaniv H.M. Nykyforchyn I.R. Dzyuba et al. // Materials Science. – 1998. – 34 (1) – P.110–114.