Abstract

Slurry erosion is a complex phenomenon related to the repeated impact of solid particles in a liquid with an eroded surface. The scientific purpose of this work was to analyze the impact of the intensity of erosive loads (rotational speed and impact angle) on the X10CrAlSi18, S235JR, S355J2 and AISI 304 structural steels in the delivery condition and after heat treatment. The dissertation was focused on extending the scope of knowledge on the erosion resistance of single-phase and two-phase steels with an emphasis on ferritic and ferritic-pearlitic steels.

The dissertation consists of two main parts. The first part presents a review of the literature characterizing the current state of knowledge on test rigs, factors influencing erosive wear, erosion mechanisms, erosive wear models and methods to increase erosion resistance. The second part contains the thesis, objectives and scope of the dissertation, description of the measurement stand, selection of erosion test parameters, characteristics of the tested materials, description of the research methodology, as well as the results, discussion and conclusions.

The microstructure of selected structural steels, hardness and roughness parameters (*Ra* and *Rz*) were examined. The impact velocity of the solid particles was controlled by the rotational speed of the mixing system of the slurry pot tester. The tests were carried out at three rotational speeds: 562 rpm, 787 rpm and 1012 rpm, and two impact angles: 30° and 90°. The increase in the rotational speed corresponded to an increase in the erosion rate, while the higher mass losses at the impact angle of 30° showed the dominance of plastic deformations for all tested steels. The erosion rate generally shows power-law dependence on impact velocity (rotational speed). It has been proved that the velocity exponent is closely related to the material properties of the tested steels, and its range for metals and alloys should be increased. The hardness and percentage elongation (plasticity) of the tested steels had a significant impact on the erosion resistance. The final hardness and the hardness exponent were significantly influenced by the rotational speed. The erosion tests revealed that the determination of the relative change in microhardness (ΔH) to determine the erosion resistance was appropriate for single-phase steels (ferritic and austenitic). During repeated impacts with solid particles on the eroded surfaces, the surface layer was hardened. The increase in the hardening depth and the decrease in the ratio of solid particles' hardness to the hardness of the tested steels (H_p/H_{tp}) showed a reduction in the erosion rate. The increase in the ratio of yield stress to ultimate tensile strength (R_e/R_m) represented a decrease in the kinetic energy of the solid particles absorbed as a result of the collision with the tested materials, and thus a weaker hardening of the surface layer. The increase in the erosion rate was represented by an exponential increase in the R_e/R_m ratio. The surface roughness parameters (*Ra* and *Rz*) did not show an unequivocal trend in relation to the erosion rate, where related to the number of craters and inclusions on eroded surfaces were *Ra* and *Rz* parameters. Nevertheless, the increase in the rotational speed and the impact angle contributed

to the increase in *Ra* and *Rz* parameters, while the hardness of eroded steels - to their decrease. Single-phase steels achieved better erosion resistance compared to two-phase steels. The increase in the grain size of the tested steels contributed to an increase in the erosion rate. The erosion efficiency parameter η was used to characterize the erosion mechanism, whether the material from the eroded surface was removed mainly by plastic deformation or brittle fracture. The conducted research showed that the parameter η correlates well with the obtained experimental results in the case of the impact angle of 90°. However, this parameter does not work for ferritic-pearlitic steels at the impact angle of 30°. Furthermore, an increase in the rotational speed caused an increase in the parameter η and the increase in the parameter η was attributed to a decrease in erosive resistance. In addition, the erosion models were validated. A new erosion model should be developed that will take into account, for example, a different range of the velocity exponent, surface roughness, the ratio of the yield point and tensile strength as well as the duration of the interaction of the solid particles on the eroded surface.