

Abstract

This dissertation fills a research gap in the subject of copper-free duplex cast steel burnishing. The thesis subject, defined as “Assessment of functional properties of copper-free duplex cast steel following the process of static pressure roller burnishing”, covers two grades of duplex cast steel, specifically GX2CrNiMoN22-5-3 and GX2CrNiMoN25-6-3.

The thesis is presented in two sections. Section one discusses theoretical issues, section two concerns the experimental part of the study. The theoretical issues include a characterisation of the burnishing processing technology and its impact on shaping the properties of surface layers of engineering materials. The origins, development, production and properties of duplex cast steel are also examined.

The choice of a specific technological solution depends on the functional assessment of the process, its technical and economic attractiveness, and the viability of deployment, highly important from the practical perspective of business operations. The above warrants discussing the issues related to the assessment tools available in literature, which can be used to verify the pragmatic value of implementing the duplex cast steel burnishing process in a particular business. To ensure adequate clarity of the paper, the literature section focuses mainly on describing the methods and indicators that are used in the research section of the dissertation.

The hypothesis, as well as learning and utilitarian goals are formulated next, and a research plan that enabled completing the assumed goals of the dissertation is presented.

In the experimental part of the paper the research methodology and characteristics of the test material are presented, and experimental test results for the process of burnishing GX2CrNiMoN22-5-3 and GX2CrNiMoN25-6-3 duplex cast steel grades are shown. The properties of the surface layer following the static pressure roller burnishing (SPRB) process are determined. Two groups of parameters: geometric and functional were analysed as part of the thesis objectives. A preliminary assessment of the material’s surface was performed by means of macroscopic analysis with the naked eye and using a microscope. The geometric parameters were analysed by testing surface roughness before and after the burnishing process. When analysing the effect of the burnishing process on the test material, sample macro- and microstructure, cross-sectional hardness, and surface were

examined. Additionally, resistance to corrosion, abrasive wear, and mechanical fatigue of the surface was verified. The tests provided a basis for assessing the effect of the SPRB process on the properties of copper-free grades of duplex cast steel. The laboratory tests results were subsequently analysed.

Based on the technical and economic analysis tools available, the analysis in question was performed for a selected production facility – PGO S.A. PIOMA Odlewnia in Piotrków Trybunalski, the only domestic manufacturer of duplex steel casts. For this purpose, a multi-criterion method that included threshold and supplementary criteria was used, and the results are shown in section 3.7.

Based on the laboratory tests and a technical and economic analysis, it is demonstrated that the duplex cast steel SPRB process has a high potential for implementation. Implementation for industrial conditions is justifiable both from the technological and economic point of view.

The paper concludes with a summary, conclusion section, list of references, and a list of tables and figures.