

## **Evaluation of the influence of selected inoculants on the crystallization process and quality of ductile iron in thick-walled castings**

### **Abstract**

The study presents various aspects related to the modification of ductile iron and examines the effect of selected modifiers on the crystallization process of thick-walled castings. The primary focus is on the possibility of implementing the modification method for casting from various grades of ductile iron into large-scale manufacturing processes. The paper includes a literature review that discusses the impact on selected aspects of ductile iron production, detailing its crystallization, the formation of the final microstructure, and the strength properties that characterize it. The production methods of ductile iron and methodologies for refining the liquid metal, such as the spheroidization procedure, are discussed. Additionally, the casting defects accompanying the production of thick-walled castings from ductile iron are described and analyzed.

The research part describes the course of castings made according to the established plan of the casting experiment, divided into two stages. The first stage included castings 1-4 and consisted of checking the effect of four selected modifiers on the results of thermal analysis, mechanical properties, and microstructure images obtained for samples cast from EN-GJS-400-15 and EN-GJS-500-7 grades. Based on the results obtained, two sets of modifiers were selected for the second stage of the casting experiment. The second stage included castings 5-8, during which the "cube" technological trial was implemented using cubes with sides of 6cm, 9cm and 12cm (they simulate thermal center in large-size castings). In castings 5 and 6, cube samples of EN-GJS-400-15 and EN-GJS-500-7 grades were cast, with one set using the selected modifiers and the other set without additional modification as a reference standard, cast from the same vat with liquid metal of the same chemical composition. Structural analysis was then carried out using light microscopy to compare the effect of modification on the amount of spheroidal graphite precipitates in castings prepared from all three sizes of cubes.

Three sets of cube samples with the selected modifier from EN-GJS-400-15, EN-GJS-500-7, and EN-GJS-600-3 grades were prepared in casting 7 to test the effect of the selected modification methodology on different grades of ductile iron. For the fissures of the cube samples obtained from this casting, structural analysis of graphite precipitates was carried out using scanning electron microscopy. The last part of the second stage of the casting experiment was carried out in casting 8. Sets of cube samples from EN-GJS-400-17 and EN-GJS-500-7 grades were cast; for one set, the selected modification methodology was applied, while the other set was poured from the same metal vat as a reference metal. The cube samples with 6cm, 9cm and 12cm sides obtained from this casting were analyzed by CT scanning. The tomography results were then compared with the actual cube cross-section and contrasted with the cubes without modification, showing the positive effect of the selected set of modifiers on the final quality of the cube samples for both grades of ductile iron.

Based on the research, calculations, and analysis of the results obtained, a preferable methodology for modifying ductile iron was selected, making it possible to obtain a good quality final microstructure in large-scale castings. The production implementation of the modification methodology was carried out, examples of which are described in the penultimate chapter of the work.