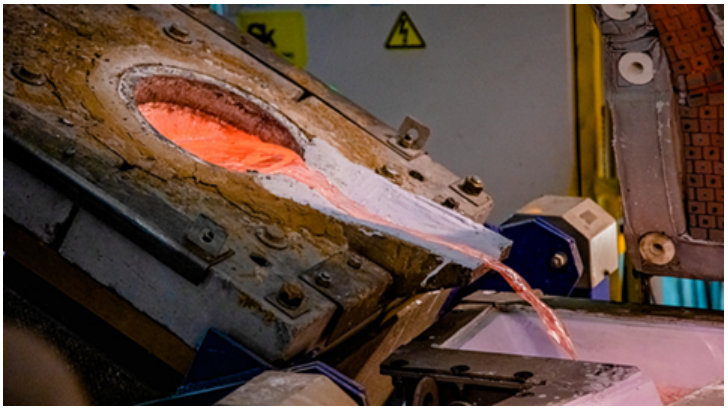
SibFU Metallurgists Have Determined the Best Composition of the Most "Extreme" Steel



The scientists of the School of Non-Ferrous Metals and Material Science, SibFU have determined the optimal chemical composition of Gadfield steel in order to increase the impact strength of this material. After analyzing the effect of alloying additives (manganese, silicon and chromium) on the steel properties, the experts used mathematical statistics and forecasting tools to find out what proportion of these elements in the alloy composition will improve the performance properties of Gadfield steel.

Gadfield steel is one of the most peculiar materials in metallurgy. This is the first mass produced alloy steel with a high content of carbon and manganese, which finds a wide range of applications. The material is used in harsh conditions: Gadfield steel has excellent wear resistance to impacts, high pressure and temperature changes. It is suitable for use in aggressive environments and extreme conditions, including for the manufacture of parts for mining, crushing and grinding equipment; cores for rolling pipes; crawler tracks and all devices where increased resistance to abrasion and impact destruction is required.

"*The material properties are known to directly depend on its chemical composition. We can control it by introducing alloying additives. If we manage to find the right ratio, we can significantly increase the performance of the material. We determined the optimal chemical composition of 110G13L steel (Gadfield steel), taking into account the requirements for the impact strength, analyzed data on the range of basic elements (carbon and manganese). Methods of mathematical statistics have confirmed that the refined chemical composition (Fe–1,1C–12.87Mn–0,6Si–0,4Cr) will be really good for use in extreme conditions,*" said **Alexander Kosovich**, co-author of the study, senior researcher at the Laboratory of Physical Chemistry of Metallurgical Processes and Materials at SibFU.

To achieve the properties for which this "super steel" is so valued - low thermal conductivity, high impact strength and high wear resistance, multiple heat treatment is required. Hardening is also achieved by explosive or electrophysical methods. These methods (especially explosive ones) carry high risks for workers. A much simpler solution may be to optimize the chemical composition of steel.

Scientists of the School of Non-Ferrous Metals and Material Science smelted Gadfield steel in production conditions and received a line of cast blanks that had different compositions due to different proportions of alloying additives. The heat treatment of the workpieces was carried out next in the mode that is usually used in production. Having cut out samples to determine the impact strength, the scientists conducted a statistical analysis of the results and determined the most suitable chemical composition that will provide the finished products with a long service life and maximum "endurance".

"*After studying 28 samples, in particular, their impact strength, we assessed the effect of the interaction of additives and adjusted their values to the specified parameters using special data analysis techniques. Due to technologically correct melt preparation operations, there was very little sulfur and phosphorus in the samples, they can be neglected. Iron, manganese and chromium raised more concern. The system Fe–1,1C– 12.87Mn–0,6Si–0,4Cr obtained as a*

result of experiments and calculations has the potential for further transformation. It is possible to flexibly vary the amount of magnesium in order to synthesize more economical compositions of high-manganese steels. But one should be more careful with silicon — with an increase in the content of this element, the properties of steel decrease," **Alexander Kosovich** continued.

The scientist said that this research has already been continued in the context of the combined alloying of steel with a complex of elements Cr, Mo, Ni, as a result of which a patent application was filed.

An important scientific contribution to the work on the "hardening" of Gadfield steel was made by Sergey Belyaev, Head of the Department of Foundry Production and Stanislav Arapov, a young scientist of the School of Non-Ferrous Metals and Material Science.

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