CONVERTER STEELMAKING: SECRETS OF ITS LONGEVTIVITY

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The Congress of Converter Steelmakers of the USSR opens in Moscow in September. Experts from well-known metallurgical firms in Austria, Germany, Japan, France, Luxembourg, and other nations will also be in attendance. The speeches and discussions will cover a wide range of issues — from current trends in oxygen-converter steelmaking to steel production in general. The Congress is being organized by the All-Union Scientific Research Society and is timed to coincide with the 55th anniversary of the advent of oxygen-converter steelmaking in the USSR.

For the first time in world practice, in April of 1936 Soviet engineer Nikolai Illarionovich Mozgovoi injected molten pig iron in a converter steelmaking furnace with pure oxygen. The oxygen was blown onto the metal from above the bath. The process has since undergone many modifications and improvements, but there are still large reserves for making it even more efficient.

Let's look back at the beginnings of converter steelmaking and see how it has evolved. One hundred and forth-five years ago, it was not called the oxygen converter process because atmospheric air was used instead of oxygen. We can take August 8, 1856, to be the birthdate of the converter process. On this day, English inventor Henry Bessemer obtained a patent on a method of converting pig iron into steel by blowing it with air delivered through the bottom of a cylindrical cast-iron vessel lined inside with refractory brick. Bessemer called this unit a "converter," from the Latin word "convertere" — to transform.

Converters rapidly replaced primitive, behemoth furnaces used to produce puddling iron and crucible steel. They were put to use in England, Switzerland, France, and Germany. In Russia, the first attempts to use the Bessemer process were made at the Kyshva, Nizhne-Isetsk, and Sysert' plants. The capacity of these converters was several tons.

Despite the fact that Bessemer steel was superior to puddling iron, the potential of the converter process was limited. It yielded good results only in the conversion of low-phosphorus and low-manganese pig irons, since phosphorus and sulfur could not be removed in a converter with an acid lining. When this was attempted, the lining separated from the shell, and the metal that was produced was plagued by hot-shortness.

English engineer Sydney Thomas solved the problem of removing phosphorus from pig iron. Metallurgists who came before Thomas had concluded that the fault was with the acid lining. Thomas developed a basic lining, the first having been based on magnesite with lime and sodium silicate. He was awarded his first patent on November 23, 1877. His other important contribution to steelmaking was his refinement of the blowing practice: he proposed that it be prolonged until white fumes begin to rise from the converter, i.e. until phosphorus combustion begins.

The development of the converter method of steelmaking is undoubtedly an evolutionary milestone in metallurgy. However, the production of high-quality steel became possible only when steelmakers began to top-blow the bath with oxygen through a refractory lance. Unfortunately, although we were the first to study this technique, we began to use it commercially only in 1955 (at the Dnepropetrovsk plant). We were preceded by Austria: in 1952, two Austrian plants (in Linz and Donavitz) began to make steel in oxygen converters. The Austrians called this technology the LD process (from the first letters of the respective towns).

Today, research into new technologies for the production of high-quality converter steel occupies laboratories at five large scientific research institutes (in addition to academic laboratories). The Central Scientific Research Institute of Ferrous Metallurgy (TsNIIChermet) is one of them. Indeed, the oxygen converter process was born in the laboratory of this facility. We had a conversation with the head of the laboratory, Dr. of Engineering Sciences and Professor Petr Ivanovich Yugov.
— Petr Ivanovich, why did you become a metallurgist? Now, young people shun this profession: it is seen as physically demanding and low in prestige — in addition to the dust, fumes, and heat.

— "I am sorry that metallurgy is now viewed in this way. No developed nation can exist without a healthy metallurgical industry. We first came to the institute during years of intensive industrialization — when metal was much in demand. We were full of optimism and wanted to make our country the most advanced and most powerful in the world. Metallurgy was a respected calling, even celebrated in song, and we were proud of our profession.

I was glad to become a steelmaker, especially one who worked on a converter. When I was a student, the oxygen converter process was considered the most modern method of steelmaking and thought to be the future of the industry. Electric-arc furnaces appeared later, and it was then believed that they would replace all other types of furnaces used in steel production. But while open-hearth steelmaking did steadily decline, the proportion of steelmaking furnaces that were of the converter type held steady and now accounts for 34% of domestic steel production. And the full potential of the oxygen converter process has yet to be realized.

— Why is it that the converter process has been able to maintain its position?
— High-quality metal can be produced at high levels of productivity by the converter process. This is its main advantage over open-hearth steelmaking. Also, unlike electrical steelmaking, the converter process does not pose any problem with the removal of copper and nickel from steel. The problem with electric furnaces is that they use only scrap, which is often contaminated by uncontrolled, hard-to-remove impurities. In the converter, the scrap is joined by pig iron — a pure charge material. The metal in the converter is less saturated with gases than in an electric furnace — in which considerably more hydrogen is assimilated, for example.

Secondly, the converter process is flexible. It has now been refined to the extent that it can be used to make almost any grade of steel. With the converter, it is possible to regulate carbon content and degree of oxidation of the metal, as well as to influence its structure.

Thirdly, this method of steelmaking is less energy-intensive than electric steelmaking. The problem of ensuring a sufficient energy supply is acute in the large industrial cities — Chelyabinsk, Dnepropetrovsk, etc. — and special schedules have even been drawn up for energy-intensive commercial activities. For example, it is hard to imagine that the electric steelmaking shop at the Dnepropetrovsk combine — working with solid (scrap) charges — would not have a lower priority than the converter shop when energy supplies are apportioned.

This is why the converter process will not give way to other steelmaking methods in the foreseeable future.

— Petr Ivanovich, how has this process evolved in our country?
— Experiments begun by N. I. Mozgovoi on the blowing of pig iron in a converter with pure oxygen were continued in 1939-1941 at the Moscow plant “Stankokonstruktsiya.” Work was temporarily halted during the war. Beginning again in 1945, TsNIImetmetall continued to explore the potential of the process. This effort, headed by Academician I. P. Bardin, involved the participation of scientists N. I. Mozgovoi, S. G. Afanas’ev, M. M. Shumov, Z. D. Epshtein, and T. V. Andreev, as well as production engineers I. I. Korobov, O. N. Kostenetskii, P. S. Rubinskii, N. I. Beda, and D. V. Rudikov. The mechanism and kinetics of refining processes were studied at different plants (“Dinamo,” Mytishchinski, Enakievo, Novotul’sk) in converters ranging in capacity from 1.5 to 15 tons. The technology was optimized as a result of this research. Researchers tested all possible methods of blowing: top, side, and bottom. They used oxygen-carbonic-acid, steam-oxygen, and nitrogen-oxygen blows. They also injected the bath with a powdered mixture in an oxygen jet and tried combination (top and bottom) blowing with oxygen. They simultaneously designed slot-like bottom lances to inject oxygen in a stream of protective gas.

A single variant was chosen from among all those tested — top-blowing with oxygen. This variant was found to be the most suitable for industrial use, the most reliable, and the simplest to control. It is important to note, however, that some of the above-mentioned techniques — combination blowing, the injection of powdered lime, etc. — are being successfully used today throughout the world.

Our laboratory conducted almost all of its studies in a small 10-ton converter located at the Novotul’sk plant. We used this converter to try out the conversion of pig irons of different chemical compositions: manganese, vanadium, and chromium-nickel, as well as ferronickel.

The industry subsequently began the active construction of converter shops. In 1957-1965, shops were built at the Krivorozhstal’, Nizhni Tagil, and Mariupol’ combines. Converters of 100-130 tons capacity were considered large furnaces.