Remarks on the Special Issue on Steelmaking

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This "Special Issue on Steelmaking" reviews 20 years of R&D on steelmaking at our company and describes the development and application of new technologies relating to hot-metal pretreatment, high-speed converter blowing, high-cleanliness secondary refining, and high-quality and high-productivity casting. The hot-metal pretreatment that began with desulfurization in the 1960s was expanded, in the wake of the first and second oil crises of the 1970s, to save both energy and resources. Later on, it was expanded further toward the high-speed production of high-purity steels. Muroran Works was the first to include the desiliconization of hot metal. Then, Kimitsu Works successfully developed technology for desiliconizing and dephosphorizing hot metal using a torpedo car. In order to desiliconize and dephosphorize hot metal at higher speeds, we developed and refined, in the 1990s, converter-type hot metal pretreatment processes (LD-ORP, MURC) capable of intensely stirring the hot metal. As a result, the necessary amount of steelmaking slag was reduced dramatically. This flow of converter-type hot metal pretreatment–converter decarbonization–secondary refining, aimed at an environment-friendly process, has become the standard refining process at our company. Many modern steelworks in China employ the converter-type hot metal pretreatment process. Moreover, in Europe, steelmakers are paying increasing attention to the above process as a very promising means of reducing steelmaking slag.

On the other hand, we are never satisfied with the present conditions. The hot metal pretreatment desiliconizes and dephosphorizes hot metal by oxidation reactions. In principle, therefore, low-temperature pig iron can be treated efficiently since its reaction potential is high. However, since the rate of melting reaction decreases, the available refining capacity is not fully utilized. Besides, in the succeeding decarburization process, which uses a higher temperature, the pretreated slag will not be completely separated from the molten metal. As a result, the phosphorus fixed in the slag is decomposed under the high temperature and a certain amount thereof returns to the molten steel. This phenomenon is known as rephosphorization. The same phenomenon occurs in the secondary refining process. In order to solve these problems, we are studying the process of hot metal pretreatment from the very beginning from the standpoint of promoting the dephosphorization of a highly reducing hot metal at low temperature, separating slag from the hot metal completely, and promoting the recycling of slag.

The strip casting process for direct production of steel sheets, which was developed in the 1980s, was put into practical use in 1997. However, it was eventually removed from operation. Although strip casting was an advanced technology, allowing for omission of the hot-rolling process, it was not found to be the ideal solution. Therefore, our efforts were focused on improving existing continuous casting technology, and those efforts led to an amazing enhancement in product quality and productivity. The successful result was attributable to a close cooperation among the manufacturing, sales, and engineering departments, specifically the sophisticated application of electromagnetic force, the control of nonmetallic inclusions, the refinement of oxide metallurgy, the progress of analytical and measurement techniques and computational engineering, and the application of advanced equipment operation technology. At present, we have continued to manufacture numerous new advanced steel products to meet customer needs. For example, the high-tensile steel sheet that is subjected to environment-friendly precipitation strengthening and dual-phase hardening rather than solution hardening, which consumes a considerable amount of costly alloying elements, is highly rated by customers. It should be noted, however, that the performance of such new steel grades is influenced by the quality of continuously cast slab to a greater extent than that of conventional steel grades.

Under these conditions of rapid advancement, technical reports on continuous casting operation and slab quality improvement are announced at a pace of at least one paper a day in the advanced countries of the world. In order to efficiently manufacture excellent steel products that contribute to an environment-friendly society, our company is tackling development of technologies that contribute to alleviating the problems and trade-offs mentioned above. Although this special issue focuses on the technologies that have already been established, it also touches on the outlook for specific technologies. I hope that the reader will enjoy reading every part of this issue.