Posco’s Finex test facility has already demonstrated its advantages. The plant produces 90 percent less air pollution and 98 percent less water contamination than conventional blast furnaces.

**Smarter Smelting**

Finex, a technology developed by Siemens and Korean steel company Posco, is revolutionizing the iron smelting industry. The new technology is more efficient, more environmentally friendly, and less expensive than any previous process.

Pohang doesn’t look like a place for launching a world revolution. The South Korean port city, which has 300,000 inhabitants, was a fishing village up until the early 1970s, when the government decided to make it the home of the Posco steel company. Operations began with a workforce of only 39 people. Today, Posco has more than 50,000 employees, and with an annual production volume of 30 million tons, the company is now the world’s fourth-largest steelmaker. Everyone in Pohang has some kind of connection to Posco.

This may also soon be the case for anyone involved in the steel industry worldwide, because in April 2007, a facility went into operation at Posco that has solved a decades-old iron smelting problem. Extracting pig iron from iron ore in a blast furnace requires sintering the ore and producing coke from coal, both of which are extremely labor- and energy-intensive processes. Sintering involves partially melting the millimeter-large crumbs of ore dust known as “fines” at around 1,200 degrees Celsius to form lumps of ore. Otherwise, the ore fines would clog up the gas channels in the furnace through which carbon monoxide passes. The latter reduces the iron oxide in the ore to elementary iron. Coke is produced by heating coal to 1,000 degrees Celsius in the absence of air. The process releases tar and other gaseous by-products, leaving only the coke as a solid residue. Pure coal cannot be used in a blast furnace because its tar by-products would also clog up the gas channels. Without sintered ore and coke, the furnace can’t be heated to the more than 2,000 degrees needed to make pig iron.

That was the case until recently. Now, however, a technology called Finex, which was developed by Posco and Siemens, has eliminated the need for sintering furnaces and coking plants. “For the first time ever, we have a process that enables us to directly use ore and coal fines,” says Johannes Schenk, who played a major role in the development of Finex as the project manager at Siemens. “Substances created at one point during the Finex process are reused in the process via internal recycling systems,” he explains. As a result, Finex is not only more environmentally friendly and energy efficient than conventional processes; it’s also much more economical. “Production costs are around 15 percent lower than with a conventional blast furnace,” says Lee Hoo-geun, the Posco manager responsible for operation of the Finex facility. “Our competitors are very jealous of our new technology, of course,” Lee adds. Their envy is justified, as the Finex facility has passed its practical tests with flying colors. Lee originally expected it to take until the end of 2007 to fine-tune the processes at the facility. However, 95 percent of all parameter targets (mainly with regard to availability, consumption values, and quality) had already been met by July. “We’re extremely satisfied with the results,” Lee says.

**Testing a New Technology.** A perfect example of how to combine resources and expertise in a worldwide network, Finex confirms many of the benefits of globalization. Its development started more than 15 years ago, when the economic boom in emerging Asian markets led to a rapid increase in demand for steel. Posco, which was the main supplier of body panel
sheets for Hyundai, wanted to use each expansion of its capacity to develop new technologies. The search for new techniques led the Koreans to Voest-Alpine Industrieanlagenbau (VAI) in Linz, Austria in 1991. VAI, which became part of Siemens in 2005, had developed a new smelting procedure known as Corex that required no coking but was nevertheless unable to directly process ore fines (see Pictures of the Future, Fall 2006, p. 38).

“Corex was the best technology back then — but we knew it would be possible to develop an even better system,” recalls Joo Sang-hoon, who headed the team of engineers that built the first Finex facility in Pohang. This assessment was shared by VAI, which had already developed a concept that would eliminate the need for sintering and coking. “Of course, our idea was only one of many,” says Schenk. However Posco had faith in the VAI approach, and the two companies signed a development agreement in 1992. VAI provided its facility construction and process development expertise while Posco contributed its experience as a plant operator and the muscle to carry out and finance such a complex project.

After years of development work and the registration of over 100 patents, construction began in Pohang in 1998 on a test facility with a capacity of 50,000 tons per year. The facility’s principle new feature was the inclusion of a fluidized bed reactor in which carbon monoxide stirs up ore fines at a temperature of around 800 degrees Celsius. The system utilizes four reactors in series. By the time the process is complete, the fine particles of ore have been transformed into small pieces of sponge iron. Rollers compact this hot sponge iron into lumps that are fed into a melter gasifier. The gasifier is similar to a blast furnace, the difference being that only iron and slag need to be melted in it. The temperature of over 2,000 degrees Celsius required for this is achieved by gasifying coal with oxygen, whereby the resulting gas mixture consisting of carbon monoxide and hydrogen is fed into the fluidized bed reactor as reduction gas. The Finex method also creates a valuable byproduct in the form of an export gas that is used to fire a power generation plant. The iron and slag are tapped from the melter gasifier in the same way as from a blast furnace.

The first Finex demonstration facility exceeded its annual production target by one third. But it’s a long way from theory to practice. Success can only be attained by precisely aligning hundreds of parameters — starting with the properties of raw materials, the setting of temperatures and gas pressures, and the efficient use of by-products. “There are many potential sources of problems,” says Schenk, “and it’s often peripheral defects that cause shut-downs. Engineers love to make jokes like The process works but the facility doesn’t’ in such situations, but in reality this is never a laughing matter.”

Great Expectations — and Results. In the case of Finex, both the process and the test facility worked. The plant quickly achieved 95 percent availability, and the quality of its pig iron was just as good as that from a blast furnace. In addition, gaseous emissions such as dust and sulfur and nitrogen oxides were 90 percent lower than those produced by a conventional facility. Water contamination was also reduced by up to 98 percent; conventional facilities — especially coking plants — tend to produce wastewater containing large quantities of hydrocarbons and cyanide, and this water has to be purified in a lengthy and costly process. In 2001, Posco decided to build a demonstration facility with an annual capacity of 600,000 tons — around half the output of an average plant. By May, 2003, the plant entered service and has since reached 800,000 tons per year.

Transcontinental cooperation was the right move. “VAI is totally reliable,” says Joo. The Austrians have also benefited from this intercultural cooperation. “It’s impressive how Posco never wavers in pursuit of its goals,” says Schenk, who is impressed by the Korean’s dedication. “Everyone worked around the clock in the weeks leading up to the facility’s commissioning.”

In 2004, Posco and VAI began jointly building the first major Finex facility, which went into operation in April 2007 with a rated capacity of 1.5 million tons per year. “Construction costs were around 80 percent of what you’d spend on a comparable blast furnace facility,” says Lee. “I can’t imagine Posco building anything other than Finex facilities in the future.”

The company is now planning to build facilities in India and Vietnam — and steel manufacturers from other countries have expressed interest. China’s Baosteel, for example, is designing its newest plant near Shanghai in a manner that will enable it to be expanded later on into a Finex facility. Finex engineers have long ceased to worry about the success of their invention and have instead focussed on finding ways to further improve it. “Right now we’re looking at how to better combine the fluidization bed reactor and smelter gasifier, and we’re also trying to find a way to forgo the process of drying out the ore,” says Schenk. Joo also believes there’s potential for improvement. “We’re far from having fully exploited the process; after all, technological development never stops,” he says.

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