Ultra Low CO2 Steelmaking

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For more than 25 years， the steel industry around the world has identified climate change as a major environmental challenge. Long before the conclusions of the Intergovernmental Panel on Climate Change (IPCC) in 2007， major steel producers recognized that long-term solutions were needed to address carbon dioxide (CO2) emissions from steel production processes.

As a result， the steel industry has been very proactive in improving energy consumption and reducing greenhouse gas (GHG) emissions.

The GHG most relevant to the world steel industry is carbon dioxide (CO2). According to the World Steel Association (WSA)， an average of 1.8 tons of CO2 gas is emitted for every ton of steel produced. According to the International Energy Agency (IEA)， the steel industry accounted for about 6.7% of the world's total CO2 emissions in 2010.

Now， CO2 emissions are about 50% lower per ton of crude steel， which makes the steel industry's climate impact much lower. High-quality steel mills are now operating close to the thermodynamic limits set by current steel production technology. This， in turn， means that steel producers are limited in further improving energy efficiency. Since most of the major energy savings have already been achieved， it is unlikely that any further significant reductions in CO2 emissions will be possible using current technology.

Further reductions in greenhouse gas emissions mean the introduction of breakthrough technologies. Reducing CO2 emissions to the levels required by post-Kyoto policies requires "out-of-the-box" thinking， as it presents specific challenges. There are no off-the-shelf， simple processes that can be used to achieve this goal. A deep paradigm shift in the way steel

is produced must be imagined， and corresponding breakthrough technologies must be designed and developed. The kind of reductions demanded by governments and international agencies require the invention and implementation of radically new production technologies.

This is the background for the creation of the ULCOS (Ultra Low CO2 Steelmaking) program， a European collaborative research and development initiative launched in 2004 as a result of the Kyoto Protocol. ULCOS seeks ways to further significantly reduce CO2 emissions from steel production. The main goal of the program is to find breakthrough process lines that， when fully developed in the future， can demonstrate the potential for significant reductions in CO2 emissions in iron ore-based steel production. The program's goal is to reduce CO2 emissions by at least 50% compared to today's production technologies. Achieving such an ambitious goal will require a paradigm shift in steel production that will change the way steel mills around the world currently operate. ulcos is part of a global steel industry program to identify steelmaking technologies that have the potential to achieve significant CO2 reductions. Under the program， people are trying to find an answer to making steel in the most sustainable way possible.

The ULCOS program is made up of a consortium of 48 European companies and organizations from 15 European countries， including all major European Union (EU) steel companies， energy and engineering partners， research institutes and universities. It is also supported by the European Commission. ULCOS is a European project， but it is a professional effort in the worldwide steel industry that actively seeks to address the threat of global warming. The consortium's expertise ranges from steelmaking to biomass production and geological storage of CO2， and includes process engineering， energy economics and forward-looking research on climate change.

Today， ULCOS is a professional initiative within the global steel industry that actively seeks solutions to the threat of global warming. ULCOS partners contribute 60% of the €75 million budget. The European Commission provides the remaining 40% through its RTD (Research and Technology Development) framework program and the RFCS (Research Fund

for Coal and Steel) program. Both were established to promote industrial research and technological development within Europe.

Current steel production technologies are based on coal， which is mainly carbon， on a mixture of natural gas based on carbon and hydrogen， and on waste-based electric arc furnaces. In order to define a clean process route for CO2， three main possible paths for solutions are (i) a shift from coal， called decarbonization， where carbon would be replaced by hydrogen or electricity in processes such as hydrogen reduction or electrolysis of iron ore， (ii) the introduction of CCS (carbon capture and storage) and mineral carbonization technologies， and (iii) the use of sustainable biomass.

ULCOS is a large scale program carefully set up to address the long term and complex challenges facing the steel industry and society as a whole. the ULCOS program has four steps， namely (i) establishment of process concepts， (ii) large scale demonstration， and (iii) large scale experimentation in the first commercial plant. (iv) deployment of the technology in Europe and worldwide. ULCOS is a research program that has been transformed into a demonstration program.

Since its inception in 2004， the ULCOS program has conducted a significant amount of research. In the initial phase of its research program， a preliminary feasibility study lasting four to five years investigated more than 80 technologies/concept lines， using modeling and laboratory methods to assess their potential in terms of CO2 emissions， energy consumption， operating costs and sustainability of steelmaking. Several concepts have been investigated in parallel. Of all these concepts， most of the following process route families have been selected in the ULCOS program for further investigation and eventual scale-up to a scale that would allow commercial implementation

A variant of the blast furnace (BF) in which the top gas of the blast furnace undergoes carbon dioxide capture and the remaining reducing gas is reinjected into the bottom of the reactor and is operated with pure oxygen rather than hot air (air). This process is called Top