Abstracts of technical articles

Introducing carbon constraint in the steel sector: ULCOS scenarios and economic modeling **318**
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The "Cost Tool": operating and capital costs of existing and breakthrough routes in a future studies framework **337**
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Simplified physico-chemical modeling for the Classical Iron and Steelmaking Route and ULCOS Breakthrough Processes Life Cycle Inventory **350**
O. Mirgaux, D. Ablitzer, A.-M. Iosif

Modeling activities and scenario building are at the heart of the economic analysis delivered by the ULCOS program. Two main objectives were followed in the framework of SP9. First the modeling team had to provide a set of coherent energy economic scenarios using POLES model. Second, the economic conditions for the emergence of the ULCOS technologies were analyzed. ULCOS contributes to the elaboration of contrasted scenarios that the steel industry could face in the long term. To aim at these objectives specific tools have been used: POLES model for the global energy system modeling and ISIM model for the steel sector based prospective (Hidalgo, 2003). The most promising steel production technologies identified in ULCOS Phase 1 have been introduced into ISIM as generic technologies. ISIM was then integrated as a module into POLES modeling system. The main model outputs are the energy prices and mixes and the steel sector balances with a focus on the technology mix. Actually the climate policy scenarios developed in project allow making recommendations to the steel industry in terms of sustainable development but also in terms of business strategy.

An important task in the structure of the ULCOS program has been to provide a fair and homogeneous comparison among the elements of the initial and the short lists of processes, which are candidates to become the ultimate ULCOS, carbon-lean breakthrough steel production processes of the future. Eventually, that information is being used to provide the rationale for moving forward in the selection of the future best technologies. The CO_2 tool, developed within SP9, the subproject devoted to measuring the sustainability of the proposed ULCOS processes, is one of the key tools worked out but also used to carry out this essential part of the ULCOS program.
The CO_2 tool is a mass and energy balance model of a complete steel mill, i.e. a steel mill simulator, which focuses on estimating energy consumption and GHG emissions of a hot mill site. It applies a standard analysis to all the process routes proposed in the course of the ULCOS program, by normalizing the size of the site (4 Mt/y), the nature of the raw materials it uses, the scrap input in the steel shop and a number of other parameters. The tool is fed by process data of the various plants lined up in the steel mil, which have been generated by more detailed models and also arise from experimental data, when they are available. The tool is meant to feed a further tool that compares the production and investment costs in various scenarios extending until 2050, with a series of mild to strong carbon constraints.
The structure of the tool as well as the results it brought about are presented here. The major conclusion is that several solutions offer the possibility to cut steel mill emission by more than 50% compared to the baseline "best technology" steel mill, provided that breakthrough solutions are taken into account, based on the uncoupling of energy savings and CO_2 mitigation targets.

The "cost tool" is a model that calculates the CAPEX & OPEX of the ULCOS routes. Along with the "CO_2 tool", it provides one of the key elements necessary for selecting the best routes: it was used for decision making when the program moved from phase I, where 80 different routes where under investigation, to phase II, where 5 routes only are studied further; it now provides updated information on the on-going routes of the last phases of the program. OPEX are calculated by an extension of the CO_2 tool, based on plant by plant simulation of the flow sheet, and CAPEX result from the concepts provided by the line SPs scaled by standard chemical engineering design rules. The tool is embedded in a sophisticated futures studies framework, using the same long-term (2050) scenarios as the economic modeling of energy futures carried out by LEPII [4], which assumes a series of futures ranging from mild to strong CO_2 constraint. This gives an unusual vision of when and how the CO_2 externality will be internalized in the economy. Indeed, as claimed by the Steel Industry, the existing process routes are very efficient and, therefore, in the context of prices encountered since 2000, there are not any no-regret ULCOS routes. The selection of ULCOS routes has been carried out in coherence with the tool conclusions, although other, non-model based considerations have also been taken on board.

Life Cycle Assessment is a powerful method to compare the full environmental burden assignable to products, services or processes. In the framework of ULCOS project, this method was chosen to assess the environmental burden of future iron and steel making processes. We propose here a novel methodology which consists in replacing the traditional data collection by a rigorous physico-chemical calculation. Such an approach allows precise environmental assessment of existing or future processes.

Air Dispersion Modeling for the Assessment of ULCOS Technologies 357
M. Vannucci, V. Colla, N. Haines

Among the local impacts which are considered within the Sub Program 9.3 of the ULCOS project for the assessment of technologies sustainability, air quality is a key issue for the evaluation of the environmental impact of a steel plant in its surrounding area. In this paper a method based on the use of air dispersion modelling is proposed for the assessment of the ULCOS technologies on the basis of the concentration in the atmosphere of the main pollutants (NOx, SO2, TSP, PM10, PM25, CO, Pb, PCDD) produced by the plant. For performing this task the AERMOD model, a widely used model belonging to class of Gaussian models, was used. For exploiting AERMOD it was necessary to characterize the case base plant specifying the positions and dimensions of its main parts and its stacks as well as the characteristics of their emissions. Furthermore it was necessary to collect information on the meteorological conditions and the terrain of the considered zone. The results, measured in terms of average concentration of the pollutants at ground level, show that such concentrations are below the limits established by current legislation. In the future these results will be used for comparisons of the case base with new technologies.

KPI- Economic Indicator: Effect on EU/Rest of the World Steel Trade 363
V. Colla, B. Fornai, A. Amato

SSSA is involved in the Subproject 9 Scenarios, Sustainability, Dissemination & Training, in particularly in the Work Package 4. This KPI, developed at SSSA, measures the most important effects in the EU/Rest of the World Steel Trade due to the implementation of a new technology: a quantitative approach has been used in order to evaluate the EU raw material dependence from the rest of the world and an approach both qualitative and quantitative has been used in order to calculate the variations in the EU competitiveness. An important consideration in the development of KPIs is the selection of the appropriate measurement categories. The selection is based, first of all, on the quantification of the European dependence through the weight of the non EU supplier countries and through the weight of the most important raw materials in the production process, then on the measurement of the European competitiveness. The article describes the methodology and the algorithms applied in the steel sector. Finally, some results are shown and discussed.

A KPI for Local Community Impact of the ULCOS technologies 373
T.- A. Branca, M. Vannucci V. Colla

This paper presents a part of work developed inside the ULCOS project, which aims at the radical reduction of CO_2 emissions from iron and steel production, through new routes that must be sustainable, i.e. environmentally-friendly, economically viable and socially acceptable. In order to demonstrate their sustainability, Key Performance Indicators are the main tools developed inside the work package 9.4, "Sustainability Model & Process Selection Tool", which aims at making complex issues more manageable. Key Performance Indicators (KPIs) are the most useful tools for evaluating and managing not only the environmental and economic impacts, but also the social impacts. The assessment of social aspect of sustainability must be taken into consideration, nevertheless the prediction of social impacts is often hard to be done, not only because of the lack of a clear cause-effect relationship but also because of the difficulty to analyse and to predict social phenomena, especially through a quantitative approach. The purpose of this work is to present a methodology, based on both quantitative and qualitative approaches, carried out in order to develop the social indicator (Local Community Impact Indicator), which has primarily taken into account possible impacts of a current integrated steelworks on the communities within the close vicinity of the plant operations.

Modelling of the blast furnace internal state with MOGADOR 382
G. Danloy

MOGADOR is a 2D mathematical model of the blast furnace at steady state. In this project, it is used to get a better insight of the internal state of the BF, as the new types of operation differ greatly from the conventional one. Three important applications for the project are illustrated.

The Trial of the Top Gas Recycling Blast Furnace at LKAB's EBF and Scale-up 387
Guangqing Zuo, A. Hirsch

The history of the LKAB's Experimental Blast Furnace is briefly reviewed and an introduction to the ULCOS new blast furnace is presented. The feasibility of the scale-up of the ULCOS New Blast Furnace - UNBF based on previous and new trials results at EBF are concisely discussed.
The historical trial results of using the EBF to simulate the conventional industrial blast furnace processes indicated that the EBF is able to imitate the commercial blast furnaces of different size and burden structure. The trial results can be directly extrapolated to the commercial furnaces. The discussions regarding the scale-up of the UNBF showed that based on the EBF as well as the trials of the UNBF concept it is completely feasible to determine the dimensions of a full scale furnace and the process parameters for an industrial scale trial of the UNBF concept.

Raceway Modelling in the ULCOS Blast Furnace 393
J. Hülstrung

ThyssenKrupp Steel AG has developed a numerical model to study the combustion of coal particles which are fed into the blast furnace through the tuyeres. The basic aim is to evaluate various coal lance / tuyere configurations and assess their advantages or drawbacks for successful operation. In the ULCOS project, this model was used to check the feasibility of some tuyere configurations for the Top Gas Recycling Blast Furnace process, which is especially challenging regarding tuyere design, combustion kinetics and raceway size.

IN THE NEXT ISSUE (OCTOBER 2009)

Modelling of low-CO_2 Steelmaking Processes

Proceedings of a Special Session of the 4th ULCOS Seminar 1-2 October 2008, Essen, Germany

SP11 – New Advanced Carbon-Based Steel production
SP12 – New Direct Reduction
SP13 – New Electricity-based Steel Production