TECHNOLOGY DEVELOPMENT HYDROGEN STEELMAKING

Linz, 10/08/2019 Thomas Buergler



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CLIMATE GOALS CO₂ CONCENTRATION ATMOSPHERE



On May 9th 2013, the concentration of CO_2 surpassed 400 ppm. Before the industrial revolution global average CO_2 was about 280 ppm.

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During the last 800.000 years, CO₂ fluctuated between about 180 ppm during ice ages and 280 ppm during interglacial warm periods.

CLIMATE GOALS CO₂ EMISSION SCENARIOS UNTIL 2100



www.theconversation.com/global-carbon-report-emissions-will-hit-new-heights-in-2014-31834

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Paris 2015 agreement requires CO_2 emissions reduction of 80 % (and lower) by 2050 for a min. global temperature increase of 2 (1,5) °C at 2100 compared to levels before industrialization.

2018: 37,1 GtCO₂ (www.globalcarbonproject.org)

Emission scenarios RCP (Representative Concentration Pathways) show different radiative forcing values in W/m² depending on atmosphere CO₂ concentration.

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IRON AND STEELMAKING PROCESSES GLOBAL MATERIAL PRODUCTION





www.stahl-online.de



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4 10/08/2019 Hydrogen Steelmaking

IRON AND STEELMAKING PROCESSES **STEEL PRODUCTION ROUTES**



Removal of oxygen from the iron oxide is the most energy intensive step in iron/steelmaking:

$Fe_2O_3 + 6CO = 2Fe + 3CO_2 + 3CO$ $Fe_2O_3 + 6H_2 = 2Fe + 3H_2O + 3H_2$

Replacement of carbon by hydrogen ÍS depending on specific process conditions.

IRON AND STEELMAKING PROCESSES SELECTED REGIONS

72 1,8 Bill. t

28



IRON AND STEELMAKING PROCESSES INTEGRATED METALLURGICAL PLANT





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- » Integrated energy cycles on fossil basis via own power plant process gases are converted into electricity
- » Highly self-sufficient with electricity and independent from the external grid
- » Global energy (coal/coke) and raw material sourcing

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7 10/08/2019 Hydrogen Steelmaking

LOW-CARBON STEELMAKING **VISIONS & SCENARIOS**

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10/08/2019 Hydrogen Steelmaking 8



IRON AND STEELMAKING PROCESSES GRADUALLY DECARBONISATION APPROACH

- » Bridge technology: BF/BOF/DR route, increased use of hydrogen (NG, COG, H₂) and integration of EAF technology for flexible raw material use in iron and steelmaking (HM/ Scrap/HBI) depending on economical/CO₂ conditions.
- » H2Future project: Testing PEM (proton exchange membrane) electrolysis technology on an industrial scale in Linz for hydrogen production and grid balancing.
- » SuSteel project: Research project in Donawitz for development of breakthrough technology direct steelmaking by iron ore smelting reduction using hydrogen plasma.
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IRON AND STEELMAKING PROCESSES CARBON, NG AND H₂ IN STEEL PRODUCTION



CO₂ emission core process route ■ PEM ■ DR ■ BF ■ BOF ■ EAF

Iron and steel industry accounts for approx. 7 % of global anthropogenic and 31 % of industrial CO_2 emissions origin and availability of electric energy is essential for renewable H₂ production and use in the DRI/EAF route.

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10 | 10/08/2019 | Hydrogen Steelmaking

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DR TECHNOLOGY FLOWSHEETS FOR NG AND H₂ BASED PROCESS



12 10/08/2019 Hydrogen Steelmaking

HYDROGEN STEELMAKING BREAKTHROUGH TECHNOLOGY



PEM electrolyser unit with 6 MW power and 1.200 m³/h H₂ production at voestalpine Linz site for full scale demonstration of H₂ production and demand-side-management balancing funded by FCH JU.

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Fundamental research project for plasma

smelting reduction with H_2 at voestalpine Donawitz site. This project for the upscaling from lab scale (< 500 g) to batch operation with 50 kg is funded by FFG.

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TRANSFORMATION SCENARIO FROM CARBON TO GREEN HYDROGEN



14 | 10/08/2019 | Hydrogen Steelmaking

HYDROGEN STEELMAKING POSSIBLE CO₂ REDUCTION TREND

CARBON **HYDROGEN** 100 Breakthrough technologies : Indicative range of CO₂ reduction depending on Implementation of steelmaking economical and CO₂ conditions Existing technology: technologies based on hydrogen **BF/BOF** route with 75 (DR/EAF route, smelting reduction) limited potential for CO₂ reduction 50 Bridge technologies : BF/BOF route with increased use of hydrogen (NG, COG, H_2) and integration of EAF technology with flexible raw material for steelmaking (HM/Scrap/HBI) 25 depending on economical/CO₂ conditions Technology development: H2Future, SuSteel 0 2020 2030 2035 2045 2050 2018 2025 2040 voestalpine voestalpine AG

15 10/08/2019 Hydrogen Steelmaking

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CO₂ emissions [%]

TRANSFORMATION SCENARIO ENERGY SYSTEM AUSTRIA

TRANSFORMATION SCENARIO WIND TURBINES FOR STEEL SECTOR

Low-carbon technologies and additional electricity demand from renewable sources are not only a challenge for the steel industry.

Realistic expansion scenarios has to be developed for 2030 and 2050.

ONE STEP AHEAD.

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Thank you! Questions?

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