Stahl | Steel Institute VDEh

Steel Academy

Online Seminar / Live Stream

# Hydrogen-based reduction of iron ores


## 2 - 3 November 2021,
## each 8.30 a.m. to 1.30 p.m. CET

## Chairman

Dr.-Ing. Hans Bodo Lüngen

## Online Seminar Concept

### Technical quality

The Steel Academy attaches great importance to the audio-visual quality of its online seminars. This seminar will be broadcast as a live-stream from Steel Academy's film studio in Dusseldorf – with high quality camera, microphone and lighting. In the picture will be shown the speaker and his presentation.

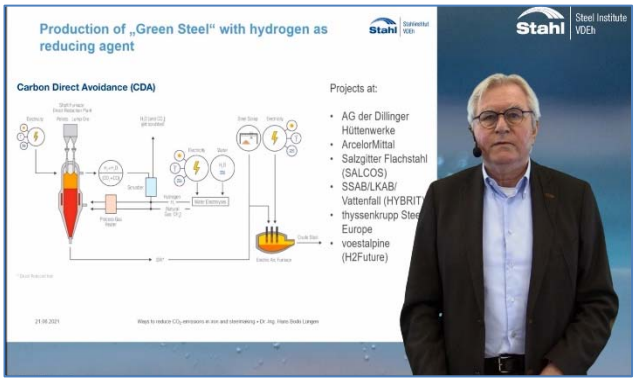


photo: H.B. Lüngen during an online lecture at Steel Academy's studio

### Online seminar - how does it work?

- 2-3 days before seminar's starting you receive an e-mail with a link and a password
- the link leads you to the streaming platform vimeo.com
- you log in with the password

⇨ we recommend using earphones, LAN or good WLAN

### Schedule

2 days, 5 hours from 8.30 a.m. to 1.30 p.m. CET Berlin time

### Seminar handouts

Before seminar's starting the participant can download the presentations as a pdf

## Content

- $CO_2$-emissions and their mitigation in the steel industry
- History, developments and processes of direct reduction
- Thermodynamics and kinetics of hydrogen-based reduction
- Injection of carbon-hydrogen carriers into the blast furnace
- Synthetic gas injection into the blast furnace
- Iron ores for hydrogen-based direct reduction
- Hydrogen-based direct reduction with Midrex
- Hydrogen-based direct reduction with HyL/Energiron
- Melting of DRI in the EAF or in the SAF ("Melter")?
- Refractory material for DR plants / Hydrogen and refractories
- Hydrogen-based direct steelmaking with hydrogen plasma

## Organisation

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## Target Groups

- Supervisors responsible for decisions on metallurgy, energy, strategy, environmental protection
- Analysts, stake holders and decision makers in energy transition, low carbon economy and decarbonization
- Staffs on reduction, R&D, raw materials and refractories

## Registration Fee

€ 590,00* // € 640,00 VAT-free

* for employees of member companies and individual members of the Steel Institute VDEh. Scientific staff of universities gets a 50 % off. Also 50 % discount for each additional participant from the same company. Cancellation free of charge is not possible after receiving of the log-in data.

+++ as part of the VDEh youth development sponsorship also young engineers (up to 35 years) of member companies receive a 50% discount +++

# PROGRAMME

## Tuesday, 2nd of November 2021

8.30 a.m. **Introduction to the seminar**
P. Schmieding

8.45 a.m. **$CO_2$-emissions and their mitigation in the steel industry**
Hans Bodo Lüngen
Requirements of the EC / CO2-emissions of steelmaking routes in use / CO2-mitigation of the European steel industry 1990-2015 / Current projects in Europe to reduce CO2 in steelmaking

9.15 a.m. **History, developments, processes of DR**
Hans Bodo Lüngen
Development and plants of Midrex, HyL and Circored / Other developments without importance or realization

9.45 a.m. questions and answers

10.00 a.m. **Thermodynamics and kinetic fundamentals of hydrogen-based reduction**
Karl-Hermann Tacke
Phases, reactions, equilibria / Kinetic effects: temperature, ore, particle size, porosity, gas properties and other parameters / Morphology

11.00 a.m. questions and answers

11.15 a.m. **Injection of carbon-hydrogen carriers into the blast furnace**
Peter Schmöle
Use of different auxiliary reducing agents / Hydrogen input with hot blast, coke and auxiliary reducing agents / Effects on blast furnace operations (Raceway adiabatic flame temperature, oxygen addition, reduction rates by C and $H_2$, top gas composition)

12.00 a.m. **Synthetic gas injection into the BF *("H2Syngas")***
Klaus Peter Kinzel / Miriam Valerius
Generation and injection of synthetic gas into the BF / Enrichment of synthetic gas with green hydrogen / Coke oven gas reformation / Pilot plant / Lower shaft injection / $CO_2$-mitigation

12.30 p.m. questions and answers

12.45 p.m. **Iron ores for (hydrogen-based) direct reduction**
Rénard Chaigneau
Pellets are the natural choice for conventional DR. Also for efficient hydrogen-based reduction?

1.30 p.m. questions and answers

⇨ afterwards: end of 1st day

## Wednesday, 3rd of November 2021

8.30 a.m. **Hydrogen-based direct reduction with HyL/Energiron**
Markus Dorndorf / Ashton Hertrich
ENERGIRON-ZR process / Principles of design / Process schemes / $CO_2$ removal unit / High-C DRI – link to EAF process / Final products (DRI, HBI, Hot Metal) / Hydrogen utilization in ENERGIRON process

9.30 a.m. questions and answers

9.45 a.m. **Hydrogen-based direct reduction with Midrex**
Christian Böhm
Process Diagram / Core Equipment / Options for hydrogen enrichment / Process limitations

10.45 a.m. questions and answers

11.00 a.m. **Melting of DRI in the Electric Arc Furnace or in the Submerged Arc Furnace ("Melter")?**
Markus Abel
Oxygen-carbon balance / Process differences / Slag / Productivity / Metallurgical challenges with hydrogen-based DRI

11.45 a.m. questions and answers

12.00 a.m. **Refractory material for DR plants / Hydrogen and refractory materials**
Jens Sperber
Refractory lining for conventional DR plants / Effects of hydrogen on refractory materials / Refractory lining of a pilot plant

12.45 p.m. questions and answers

1.00 p.m. **Hydrogen-based direct steelmaking with hydrogen plasma**
Johannes Schenk / Michael Zarl (Speaker)
Direct steelmaking / Hydrogen plasma / Smelting reduction / Kinetics and thermodynamics of hydrogen atom and ions

1.30 p.m. questions and answers

⇨ afterwards: end of seminar

**SPEAKERS** Dipl.-Ing. Markus Abel, tripleS GbR, Durbach ■ Dipl.-Ing. Christian Böhm, Primetals Technologies Austria GmbH, Linz ■ Dr. ir. Rénard Chaigneau, Baffinland Iron Mines Europe B.V., Amsterdam ■ Dr.-Ing. Markus Dorndorf, LOI Thermprocess GmbH, Essen ■ Ashton Hertrich G., Danieli & C. Officine Meccaniche, Italy ■ Dr.-Ing. (INPL) Klaus Peter Kinzel / Dipl.-Ing. Miriam Valerius, Paul Wurth S.A. Luxembourg ■ Dr.-Ing. Hans Bodo Lüngen, Steel Institute VDEh, Düsseldorf ■ Prof. Dr.-Ing. Johannes Schenk, Montanuniversität Leoben ■ Prof. Dr.-Ing. Peter Schmöle, schmoele Consulting, Dortmund ■ Jens Sperber, Steuler KCH-GmbH, Höhr-Grenzhausen ■ Prof. Dr.-Ing. Karl-Hermann Tacke, Technical University of Berlin ■ Michael Zarl, K1-MET GmbH, Linz ■ Organisation: Peter Schmieding, Steel Academy, Steel Institute VDEh