EUROSLAG - Core activities and implications for the slag value chain

Thomas Reiche, EUROSLAG / FEhS-Institute

ESTEP 2024
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European Steel Technology Platform
20 years together

H2 FOR GREEN STEEL
3rd INTERNATIONAL CONFERENCE
meets
A CIRCULAR ECONOMY DRIVEN BY THE EUROPEAN STEEL

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PRIMETALS TECHNOLOGIES

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EUROSLAG - The European association representing the producers and processors of metallurgical slag

(26 members from 17 European countries)

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More than 95 % of the total slag production in Europe (2023: 37,6 million tons) have been used in various applications.

→

Blast furnace slag:

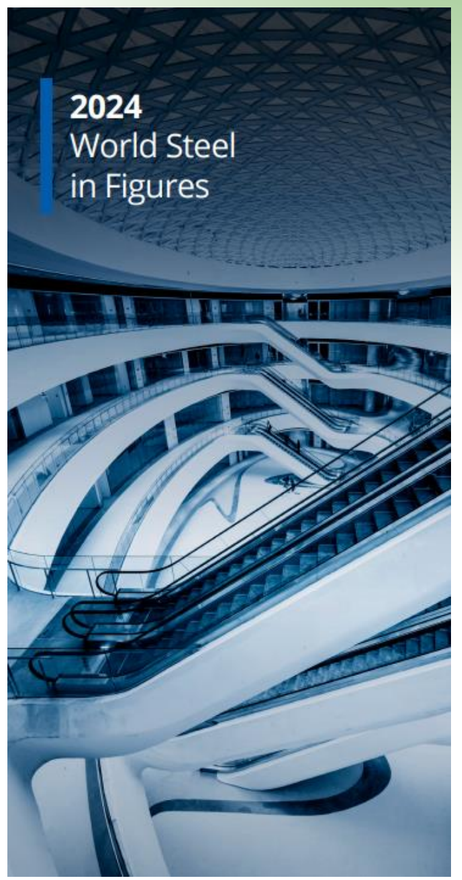
- Hot metal production in EU 27 + UK:
  68.6 Mt
- Hot metal production in reporting countries:
  45.2 Mt = 65.9 %

⇒ **Estimated BFS production:**
20.7 Mt

Steel furnace slag:

- Crude steel production in EU 27 + UK:
  131.9 Mt
- Crude steel production in reporting countries:
  66.3 Mt = 50.2 %

⇒ **Estimated SFS production:**
16.9 Mt



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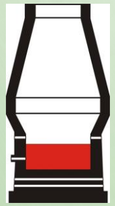
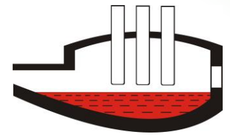
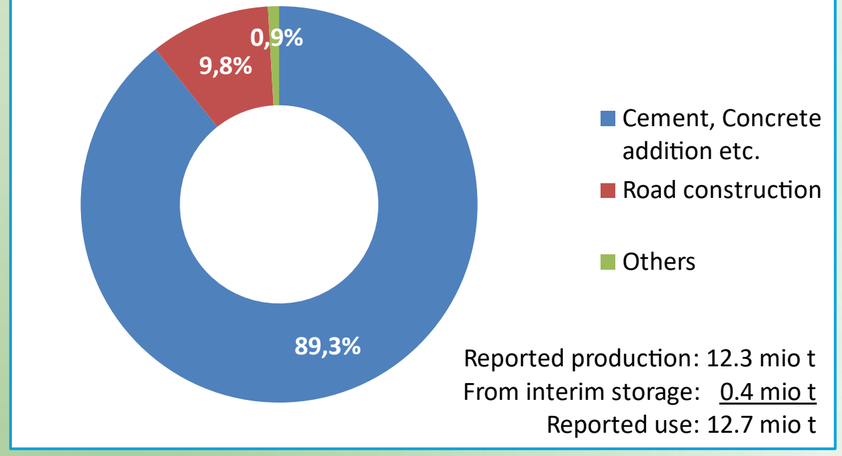
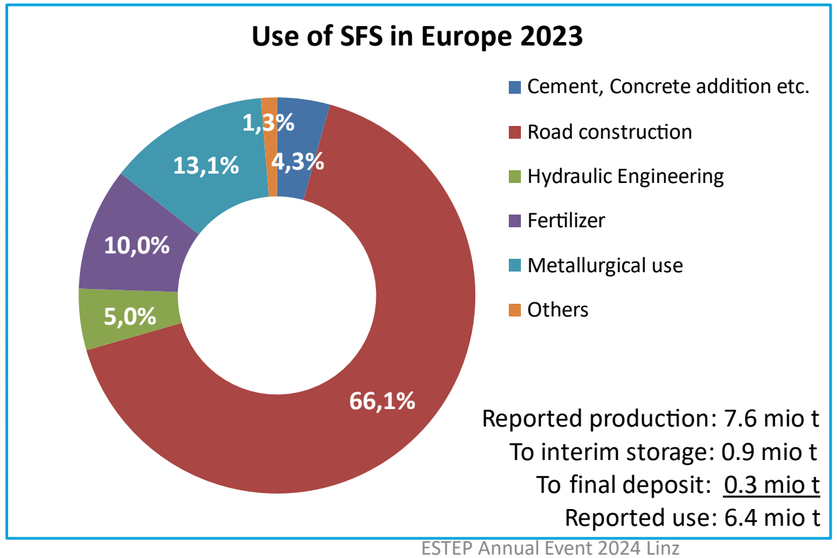
While 90 % of the Blast Furnace Slags are used as GBS in Cement, about 2/3 of the Steelmaking Slags are utilized as aggregates for road construction.









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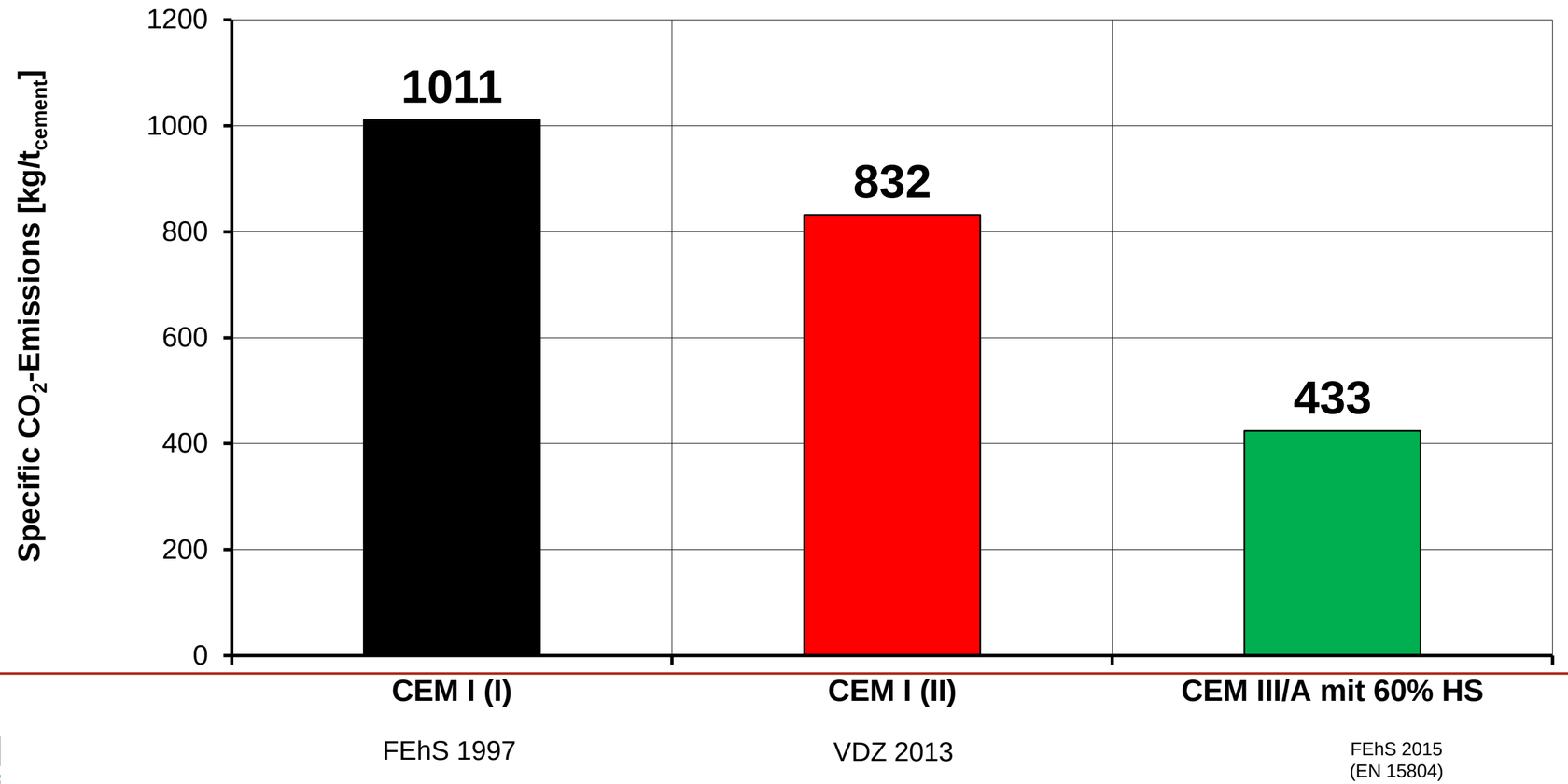
More than 1,170 million tons of natural stone have been substituted by slag-based products in Europe (2000 – 2023)!

- Substitution of 406 Mt natural stones by use of aggregate products made by slag for construction purposes
- Substitution of 754 Mt limestone, clay and sand (Portland cement clinker) by use of slag for binder manufacturing
- Substitution of 12 Mt natural lime fertiliser by use of slag fertiliser

About 420 million tons of CO_2 emissions were avoided in Europe (2000-2023).



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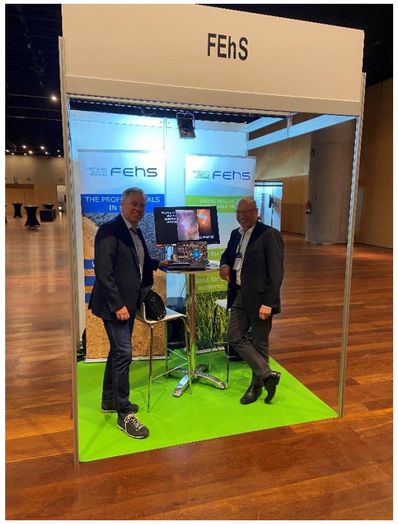
The challenge is to keep the role of slag-based products as best practice examples for climate protection and the conservation of natural resources in a transformed (steel) industry!

The 12th EUROSLAG Conference in Bilbao most recently gave a comprehensive overview on research, best practices and legal framework.



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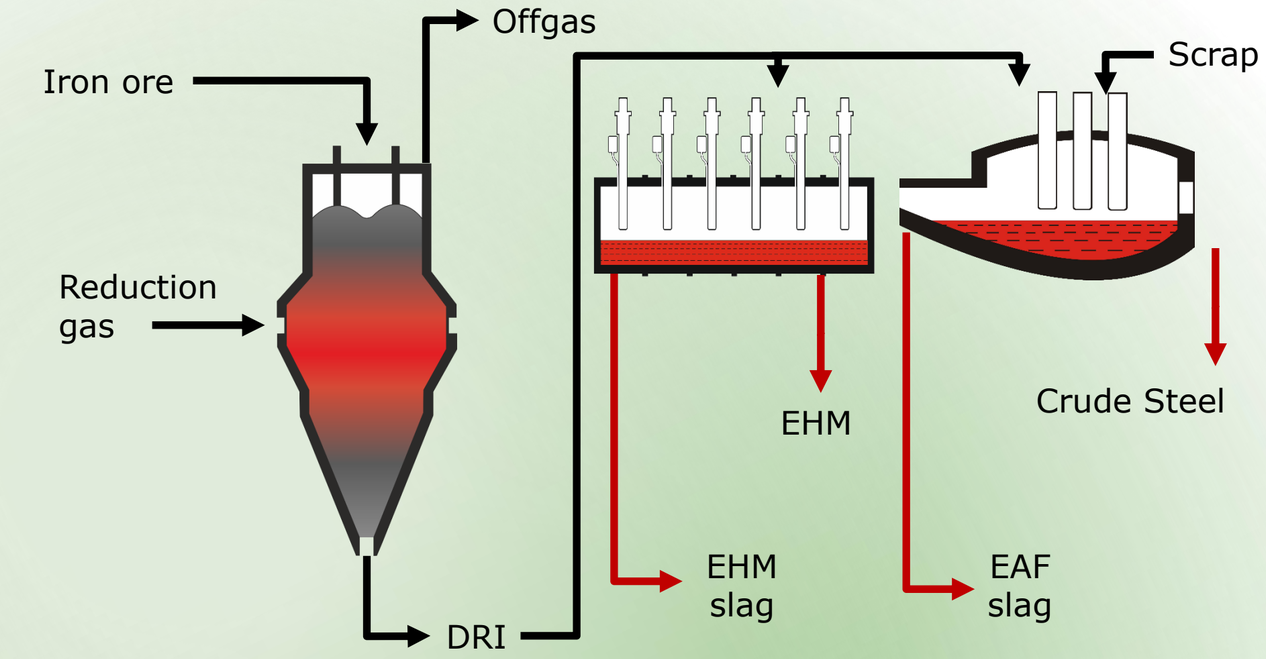
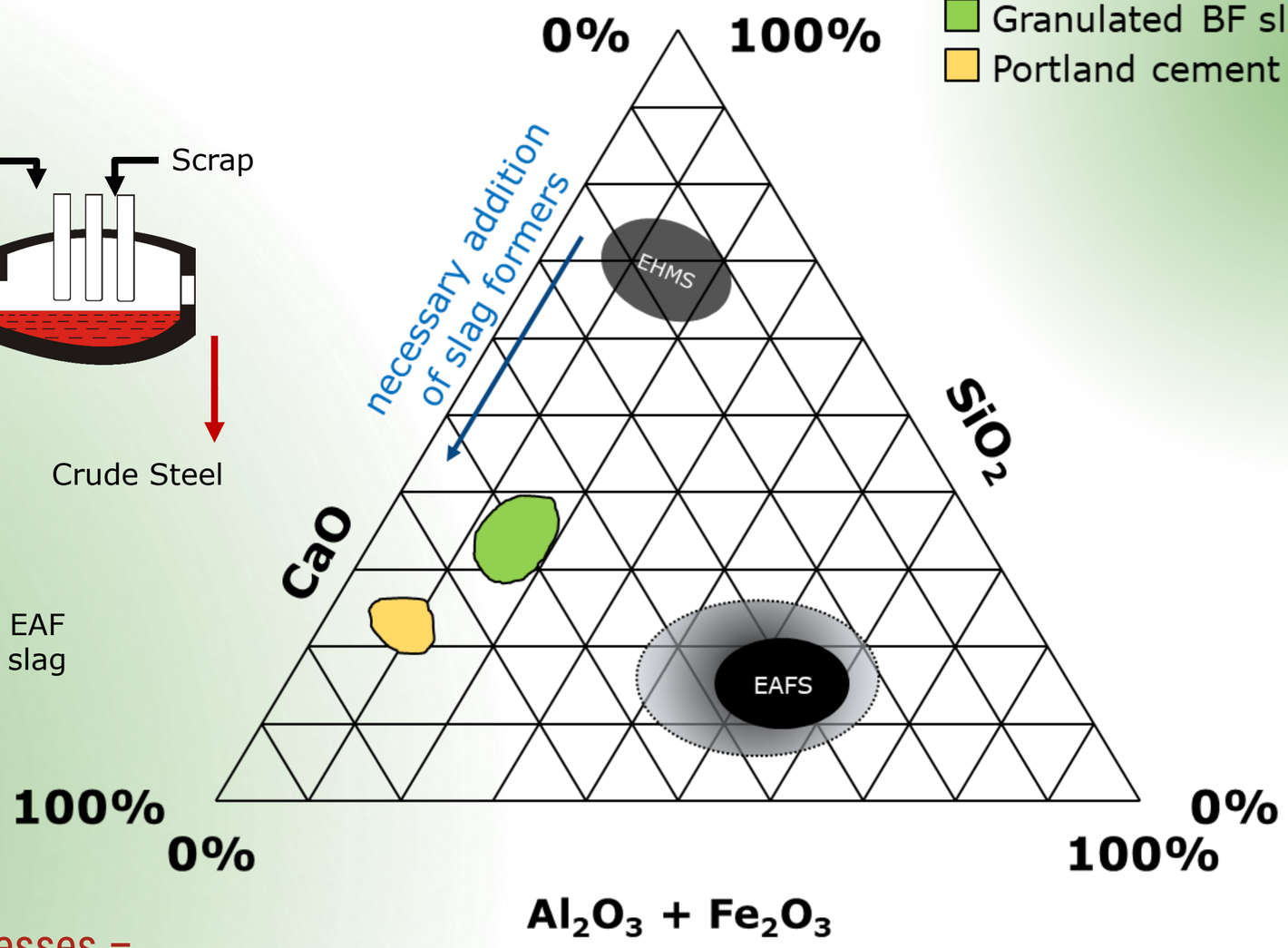
InSGeP
Investigations of Slags from Next Generation Steel Making Processes

The research leading to these results has received funding from the European Union's Research Fund for Coal and Steel research programme under grant agreement number: 101112665



EHM = Electric Hot Metal



David Algermissen

“Slags from Next Generation Steel Making Processes – Suitable for established Applications?”

The main challenge of the steel industry for the next decade is the transformation of the steel production to fossil free processes and the new types of resulting slags.

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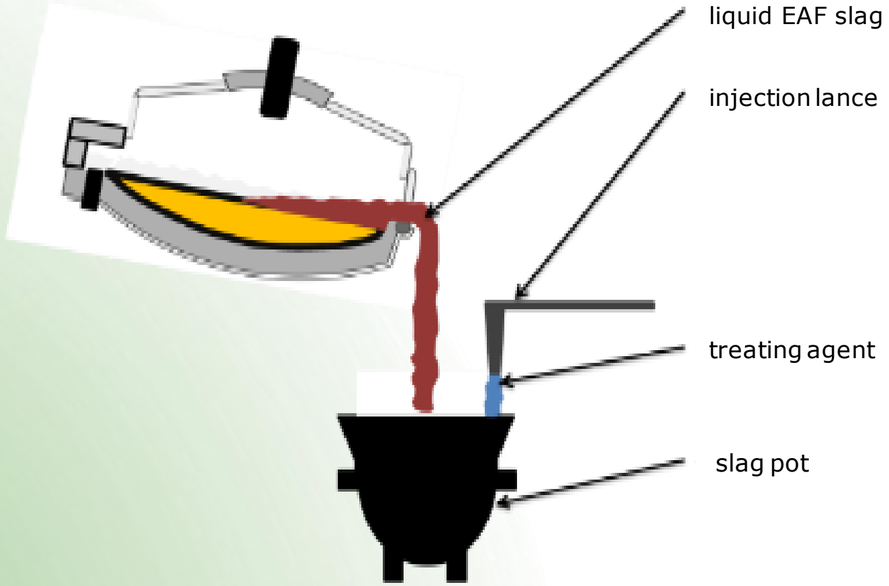
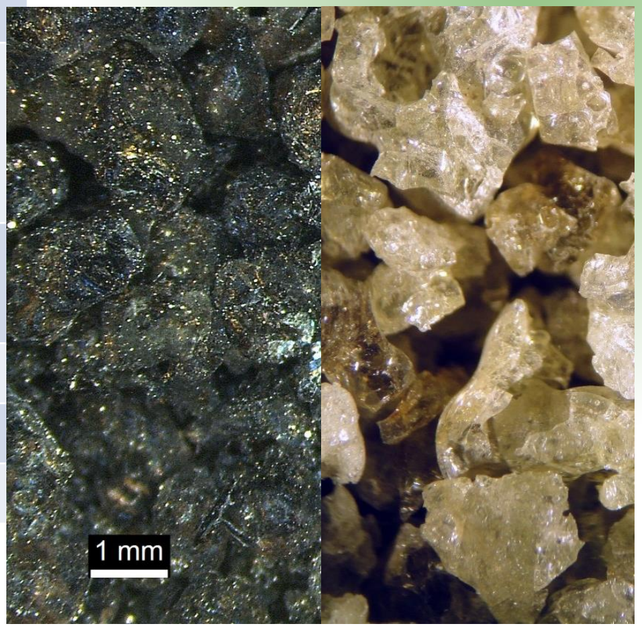


Treating during tapping

From DRI based steel making to a slag, suitable material for cement industry!

Process route	DRI/Smelter	DRI/EAF
Slag/metal ratio (after unavoidable slag processing)	160-285 kg/$t_{electric\ pig\ iron}$ < GBS (≈ 300 kg/$t_{pig\ iron}$)	150-200 kg/$t_{crude\ steel}$ > scrap based EAF slag (≈ 130 kg/$t_{crude\ steel}$) << GBS
Original basicity CaO/SiO_2	< GBS (∅ 1.1) ➔ increase necessary (viscosity)	1.8-2.2 >> GBS ➔ decrease necessary (glass formation)
Heavy metals, in particular Cr-III	≈ GBS (very low)	< scrap based EAF slag >> GBS
Fe oxides	≈ GBS (very low)	>> GBS
Glass content (if quenched)	≈ GBS (very high)	≈ GBS
Original color	≈ GBS (bright)	dark

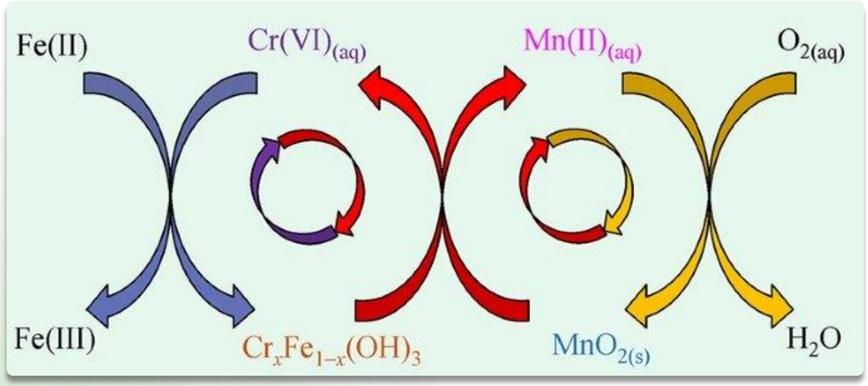


Andreas Ehrenberg
"EAF slag and its potential to substitute granulated blast furnace slag"

The decreasing availability of GBS traditionally being used as a cementitious material with a high clinker and CO2 reduction potential is a big challenge for the cement and concrete industry. Therefore, there is a high interest to transform as well the new slags as scrap based EAF slags into GBS like materials.

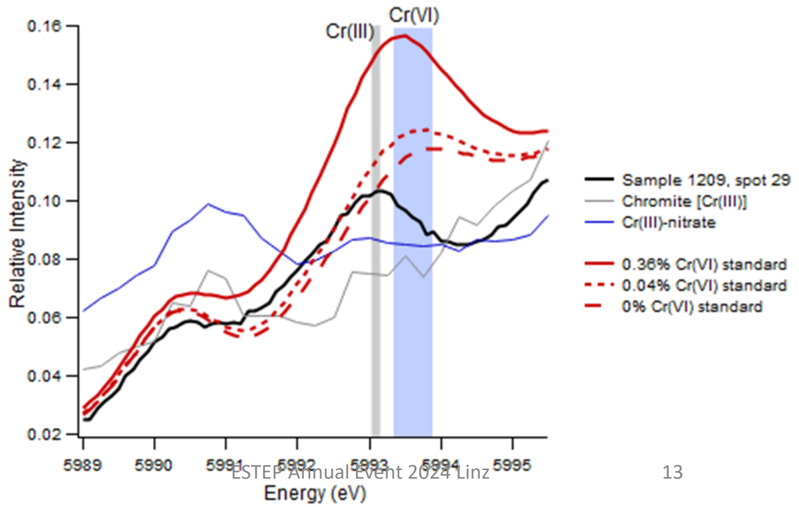
- Amounts will decrease
- Color of EAF based granulated slag will be dark
- Slags from Smelter will be comparable to GBFS

- Cr(III) limited solubility, but studies have shown oxidation of Cr(III) – Cr(VI) via MnO2 reduction [Mn(IV) – Mn(II)]
  - Rate of reaction greatest at lower pH
  - Some indication oxygen enhances Cr(VI) oxidation when in combination with Mn



⇒ XANES measurements indicate that no Cr(VI) is present in steel slags

Location of Cr species and standard ratios



Kelly Cook

"Review of a Novel Non-Destructive Technique utilizing XANES to detect Hexachrome in Steel Slag"

Overview of the original study, highlighting the inconsistencies between test data and controls, as well available data from an ongoing study utilizing the XANES non-destructive methodology to accurately quantify the amount of Cr(VI) present in steel slag.

Besides of research, the regulatory framework has to be adapted to use steel slags from transformed production processes in cement and concrete.

Problem:

- In Germany, the use of steel slag as a constituent in concrete or cement is restricted due to regulatory barriers.
- MVV TB/ABuG* defines limit values for the pure aggregates + limit values for the concretes produced from them + limit values for solid contents
- Solely due to the limit value for total Chromium (Cr_{total} = 600 ppm), steel slags are excluded as their chromium content always significantly exceeds the limit value

→ Paradoxical situation in Germany: Steel slag is allowed in road construction (bound and unbound) **but not** bound in concrete.

Need for regulatory adaption:

- The transformation of the steel industry will eliminate blast furnace slag and significantly increase "new" slags (DRI/SAF, DRI/EAF), with need for utilization pathways
- The disappearance of granulated blast furnace slag (GBS) as raw material challenges the cement industry, the use of steel slag (current EAF and DRI/EAF) would help to compensate for the supply gap in the cement industry
- Political pressure to conserve resources, boost circular economy, and reduce CO_2 → concrete producers are increasingly forced to explore alternative aggregates, leading to increased interest in steel slags
- The assessment of the environmental behavior should focus on the release of potentially harmful substances (ideally from the final product - concrete -) that is done by elution tests → urgent revisions are required → **solid limit values should be disregarded**
- The FEhS Institute is actively supporting efforts to bring about necessary regulatory changes

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* Muster-Verwaltungsvorschrift Technische Baubestimmungen 2024/1. Anhang 10: Anforderungen an bauliche Anlagen bzgl. der Auswirkungen auf Boden und Gewässer (ABuG), Model Administrative Provisions – Technical Building Rules

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New limit values for industrial by-products introduced into the EU fertilizing Products Regulation (FPR) exclude ferrous slags from participating in the single market.

We filed a claim against the Commission, as the introduction of limit values is a worst case scenario of circular economy.

- New limit values for industrial by-products had been introduced into the EU fertilizing products regulation by a delegated act.
- These new limit values (400 mg/kg Cr, 600 mg/kg V) exclude ferrous slag-based fertiliser from participating in the single market.
- The scientific reasoning of the limit values and the legal basis for their introduction into the fertilizing products regulation were most questionable:
  - COM was not entitled to regulate health and environmental protection issues (only agronomic efficacy and safety)
  - A realistic risk assessment was not carried out
- The overriding effect on national legislation is problematic. Meanwhile limits are being taken over into national law, e.g. Finland.
- It can be expected that these limit values are adopted to other areas of law.
- Thus, Fachverband Eisenhüttenschlacken e.V. filed a complaint against delegated act EU No. 2022/973 supported by FEhS-Institute and EUROSLAG.

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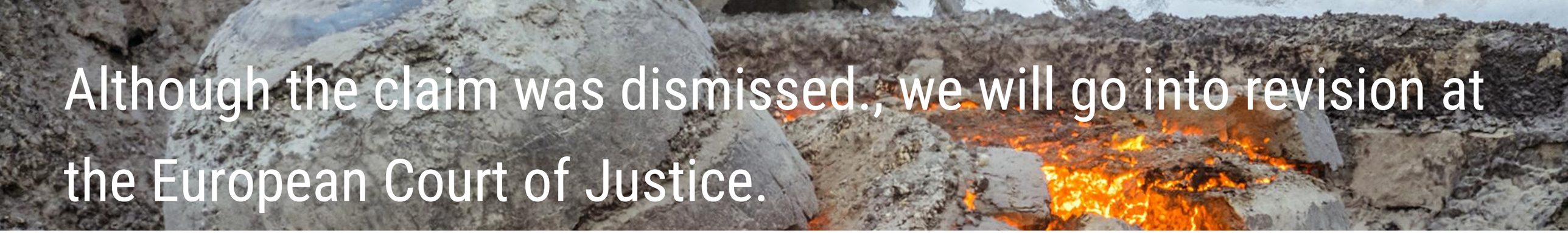

Although the claim was dismissed., we will go into revision at the European Court of Justice.

Reasoning for the dismissal of action:

- Application of the precautionary principle in the absence of clear evidence is possible.
- ‘Agronomic safety’ includes the protection of the environment and health.
- Beyond a REACH registration, additional measures can be taken in specialised legislation.
- The Commission should be given broad discretion in its assessment.
- Fertilisers may be marketed without CE-marking according to national law.

Outlook for the future:

The decision allows the Commission to introduce new regulations by means of a delegated act which, due to the application of the precautionary principle and the broad scope for discretion, hardly require any technically sound justification. This means that any by-product or recycled product can be denied access to market.

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The CO_2-Allocation between main (steel) and co-product (slag) must be in line with existing standards (EN 15804) and should avoid to distort existing markets for slag-based products.

CO_2 - Allocation

Framework

- For comparing different individual materials or complete constructions **Environmental Product Declarations** are helpful tools to avoid "to compare apples with oranges"
- EPDs for building materials, like cement, concrete, GGBS, …, are based on different standards (Product Category Rules)
- Basis for all is **EN 15804** "Sustainability of construction works – Environmental product declarations – core rules for the product category of construction products"
- Based on EN 15804, in France (2022) and in Germany (2024) **steel industry and authorities agreed on "economic allocation"** for unground GBS
- Regarding CO_2 emission: **France: 83 kg/t, Germany 100 kg/t**

Controversial discussions

- Despite the framework is clear, since many years some steel producers aim to green-wash their main product
- For example, for **prEN 17662** "Product category rules complementary to EN 15804 for Steel, Iron and Aluminium structural products for use in construction works" CEN/TC 135 tries to establish **"Process partitioning"** instead of **"economic allocation"** resulting in a very high CO_2 load for GBS (c. **484 kg/t**)

Resulting problems

- The sum of **484 kg/t** CO_2 emission from the main process + GBS specific emission (granulation, de-watering, internal transports, storing, drying) of c. **51 kg/t** would account to c. **535 kg/t** which significantly jeopardize the ecological advantage of GBS compared to Portland cement clinker (c. **800 kg/t**)
- A difference 800-535 kg/t still sounds relevant; however, **CEM III/A (**60% GBS + 40% clinker) would account to **682 kg/t** (instead of **450 kg/t**) compared to PC (**832 kg/t**)
- Any additional load for **crystalline slags** discriminates them compared to the competitive natural aggregates / fertilizers without any theoretical backpack

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CO_2 - Allocation

CEN discussion

- CEN/BT * stresses the consideration of the horizontal rules of EN 15804 (as considered in PCRs for glass and for plastic piping systems)
- CEN/BT refers to EC consultation to members states (09/2023): Most states (also Germany/DIN) preferred economic allocation
- prEN 17662 is already included in the draft SReq for Structural Metallic Products → Allocation method is important (new essential characteristic "envir. sustainability")
- **Options** for CEN/BT decision 28/05/2024:
  Option 1: Formal Vote for prEN 17662 without further modification (→ physical allocation)
  Option 2: prEN 17662 needs to be modified in order to consider TC 350 comments (→ economic allocation)
  Option 3: prEN 17662 will be abandoned; TC 135 has to start a new Preliminary Work Item; CCMC informs EC that CEN cannot support the SReq for Structural Metallic Products (new CPR)
  Option 4: Any other new proposal presented by CEN/BT delegates so far sent until 23/05/2024
- **CEN/BT decision:**
  - Option 1: 1 vote, option 2: 16 votes, option 3: 1 vote, no national consensus: 3 (DK, FIN, S), no position: 10
  - CEN/BT decided that prEN 17662 needs to be modified to be aligned with EN 15804 and CEN/TC 350 comments (= option 2)
  - Decision is applicable as from 30/05/2024
- **TC 51 meeting:** - It seems that TC 135 intends to go to FV without reference to EN 15804
  - Mr Nieto mentions high level discussion in DG Grow on how to solve the problem of varying prices → proposal of "the steel industry"?

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* Technical Board (CEN/BT) controls the full standards programme and promotes its speedy execution by the Technical Committees, the CEN-CENELEC Management Centre, and other bodies

We support the circular economy action points of the European Commission’s policy guidelines 2024 – 2029.

- Both, the creation of law on secondary raw materials law and the optimization of public procurement are highly appreciated
- Legal opinion commissioned by law firm Kopp Assenmacher Nusser on the use of EU public procurement law as an instrument to promote the circular economy was already discussed with EC and MEPs in 2019
- Objective: Amendment of the EU Public Procurement Directive analogous to the amendment of the German Circular Economy Act (§ 45 KrWG)
- Conditional preference for secondary raw materials in public procurement procedures

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We will manage the challenge with good results on research and the necessary adaptation of the regulatory framework.

Finally…

Thank you very much !
Please contact us for any questions.

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