Upgrading of low-quality iron ores and mill scale with low carbon technologies

TransZeroWaste - Horizon Europe project



ESTEP 2024 Annual Event

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European Steel Technology Platform

20 years together

voestalpine





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- •Transformation to low-carbon steel industry, from coal to H₂ as reduction agent up to 2030 according to green steel roadmap ESTEP
- •Change of production units necessary
 - <u>Current:</u> Sinter plant \rightarrow Blast furnace \rightarrow Basic oxygen furnace
 - <u>After transformation</u>: Pelletizing \rightarrow Direct oxygen Iron (DR) process \rightarrow Electric arc furnace
- •Existing recycling ways will be cut off e.g., for coarse mill, casting scale or fine iron ore fraction from sieving when replacing sinter plants and blast furnaces by DR process
- Up to now no recycling ways for e.g. oily fine mill scale
- •Requirements for metallurgical reuse of residues and by products after transformation not or only partly known
- Composition of new occurring residues as from DR top gas wet washing not known



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Materials before and after transformation

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Waste shortfall

•Blast furnace dust / sludge

•Basic oxygen furnace dust / sludge

•Shortfall of recycling ways for:

- Coarse mill scale casting
- Coarse mill scale hot rolling

New wastes with unknown composition/amounts

•DR process gas cleaning dust / sludge

•No / only partly used Fe rich wastes

• Fine mill scale (oily) casting

• Fine mill scale (oily) hot rolling

Contaminated scrap



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- Upgrading low-grade iron ore by combining with iron-rich by-products
- Development of innovative techniques to produce high quality pre-material for decarbonised future production routes;
- •Separation of disturbing components from byproducts to replace scrap
- Development of the technological basis and digital tools supporting the transition towards zero waste in the European steel industry.

Typical material samples



Fraction from iron sieving

Coarse mill scale

Oily fine mill scale (oily contents up to 10 wt.-%)







Technical Approaches

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•Use of microwaves for hot agglomeration of upgraded iron ore as well as for separation of interfering components such as oil or zinc.

 Process development for cold pelletisation, briquetting and material preparation for use in direct reduction processes (shaft furnace, fluidized bed)













Produced tablets/briquettes (10 mm)







- •Hydrometallurgical pre-treatment of due to impurities currently disposed or thermal treated materials with high iron contents from e.g. as oily sludges
- Transfer of results to treatment of oily scrap
- •Approach: Combination of magnetic separation and deoiling followed by cleaning agent recovery by filtration with ceramic flat sheet membranes





- Upgrading and utilization of low-grade iron ore in combination with iron-rich materials for use in future DR-EAF process routes
- •Demonstration of the developed processes to produce upgraded iron ores in operational tests
- Decision support tool based on life cycle assessment (LCA), life cycle costing (LCC) and circularity indicators to identify most sustainable processing routes
- Digital mapping of material flows before / during and after the transition to identify locations and timing of necessary investments in technologies for upgrading low-grade iron ore
- Contribution to climate-neutral & circular industrial value chains supporting transition towards low-CO₂ -DR and EAF production routes
 - TZW technologies aim to provide solutions on TRL 8 to fill the gaps for recycling & upgrading for ore- and scrap-based green steel production









Thank You!



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