



**DRY GRANULATION OF STEELMAKING SLAGS :  
PRODUCTION, CHARACTERIZATION AND  
INDUSTRIAL APPLICATIONS**

M. Messuti, M. Guzzon, E. Malfa,  
E. Chiarullo, S. Oliverio



25.06.2025

# Dry Slag Granulation

Dry slag granulation process is a patented technology to rapidly solidify molten slag from Electric Arc Furnaces (EAF) and Ladle Furnaces (LF) mixed with residual steel by forced air stream.



## Goals

- ✓ Obtain a glassy/amorphous material.
- ✓ Avoid dust production.
- ✓ Reduce slag handling costs for metal separation.
- ✓ Stabilize elements to prevent leaching.



## Environmental Benefits

- ✓ Avoids water usage.
- ✓ Prevents emissions of sulfur compounds
- ✓ Reduces greenhouse gas (GHG) emissions.
- ✓ Preserves landscapes by reducing raw material extraction (e.g.,  $\text{CaCO}_3$ ).
- ✓ Minimizes soil consumption for landfilling.



## Valorization

- ✓ Slag can be used as a construction material, contributing to sustainability and resource efficiency.

# Methodology

In recent years, we have established a clear methodology, detailed as follows:

1- Definition of the chemical and physical properties of the slag

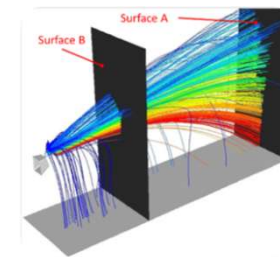
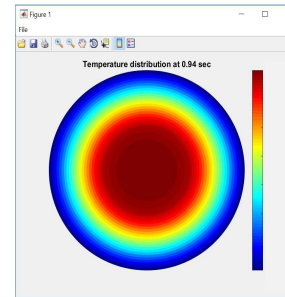
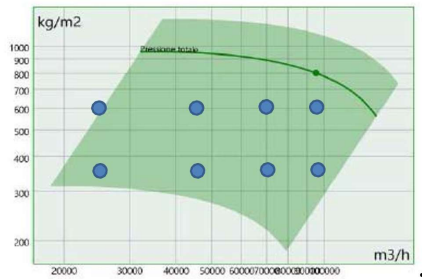
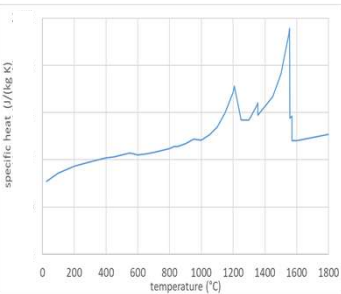
2- Design of the fan size and the definition of the working points

3- CFD study of the primary break up

4- Particles cooling model

5- Computation Fluid Dynamic modelling

6- Pilot test

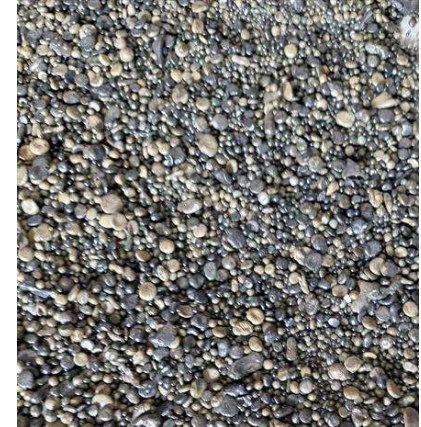
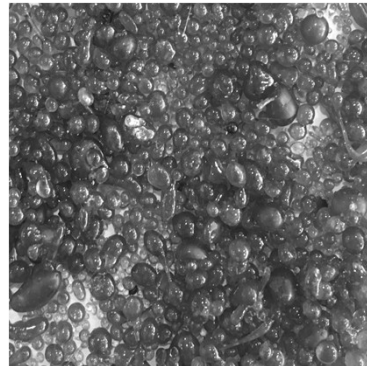


# Tested slags

Since 2017 Tenova started-up several industrial testing facilities and applications for industrialization of dry slag granulation which allows to deliver materials to possible further users.

## Granulated slag

- *LF slag*
- *EAF carbon steel slag*
- *EAF stainless steel slag*
- *Blast furnace slag*
- *Ferrosilicon slag*
- *100% DRI slag*

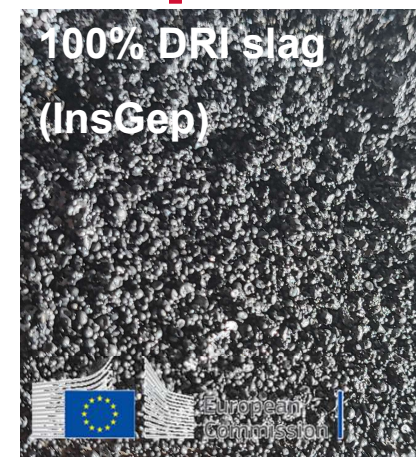
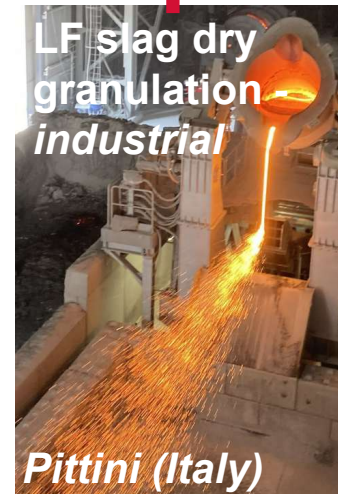


# Tested slags



Blast furnace slag

Ferrosilicon slag



Slag2Build



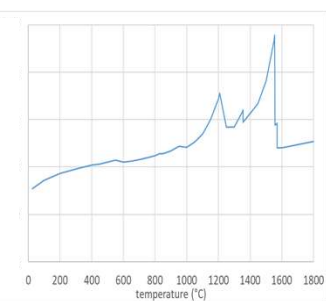
# InsGep Project – 100% DRI Slag



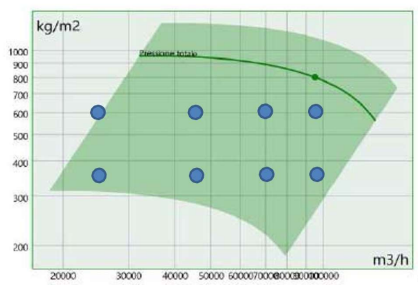
The European project InSGeP (Investigations of Slags from Next Generation Steel Making Processes) is an initiative funded by the European Commission through the Research Fund for Coal and Steel (RFCS) program, active from July 1, 2023, to June 30, 2027.

Its main objective is to study the slags produced by next-generation steelmaking processes in order to understand their characteristics and identify sustainable ways for their reuse.

1- Definition of the chemical and physical properties of the slag



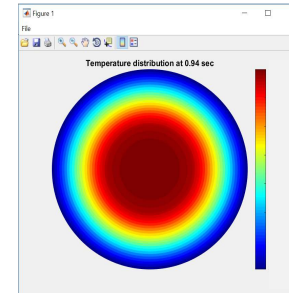
2- Design of the fan size and the definition of the working points



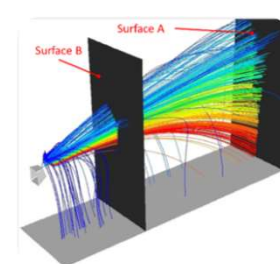
3- CFD study of the primary break up



4- Particles cooling model



5- Computation Fluid Dynamic modelling



6- Pilot test



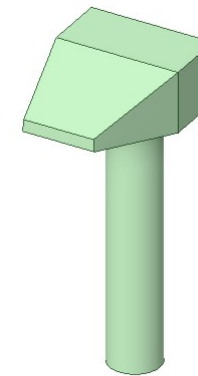
# InsGep Project – 100% DRI Slag



1- Definition of the chemical and physical properties of the slag

2- Design of the fan size and the definition of the working points

Temperature	1550	°C
Density @T	3081	Kg/m3
Surface tension @T	0.539	N/m
Viscosity @T	0.0261	Pa*s
Thermal conductivity @T	0.08	W/m/K
Specific heat @T	1401	J/kg/K



- ✓ Design of the fan
- ✓ Range of air velocity selected

# InsGep Project – 100% DRI Slag



The system is described in a transient way by means of a multiphase model called VOF-to-DPM

## VOF (Volume Of Fluid) – to – DPM (Discrete Phase Model)

3- CFD study of  
the primary  
break up



- Jet initial description (tracking liquid-gas interface)
- Capture instabilities and large structures formation (primary breakup)
- Explicit spray description from atomization to dispersion with a computationally intensive approach (*long* computation time)
- The inputs are based on the process conditions (such as the slag mass flow rate)
- The dispersion phase (DPM) consists in the spherical droplets formed during primary breakup
- The output is the granulometry, temperature and properties of the individual particles



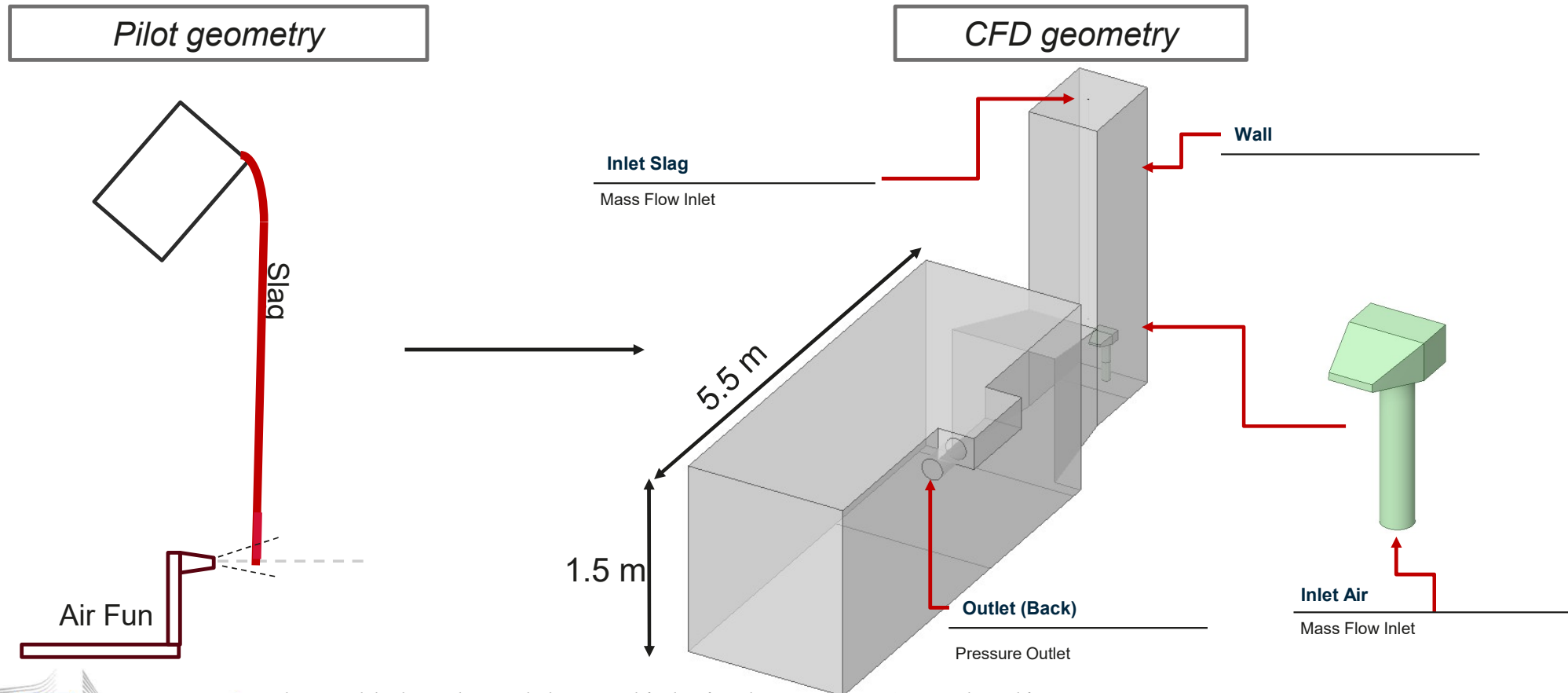
### Goal

- Check the fan design
- Check the behaviour of the 100% DRI slag
- Define granulometry

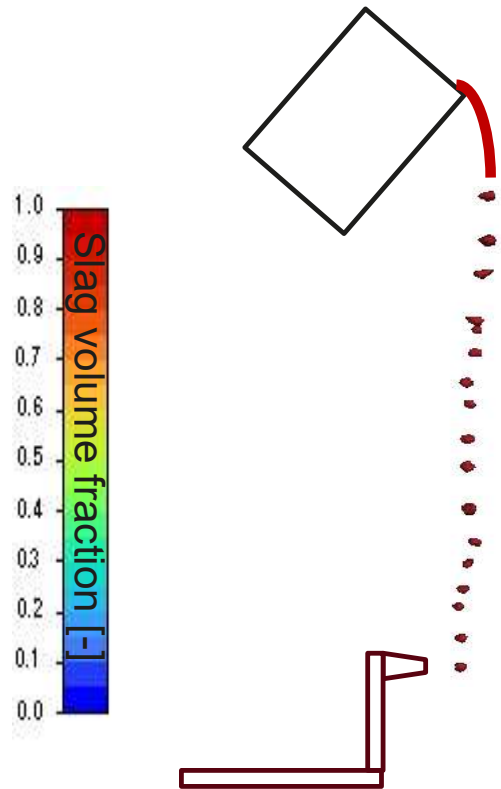
# InsGep Project – 100% DRI Slag



The pilot geometry has been converted in a geometry suitable for CFD purposes.



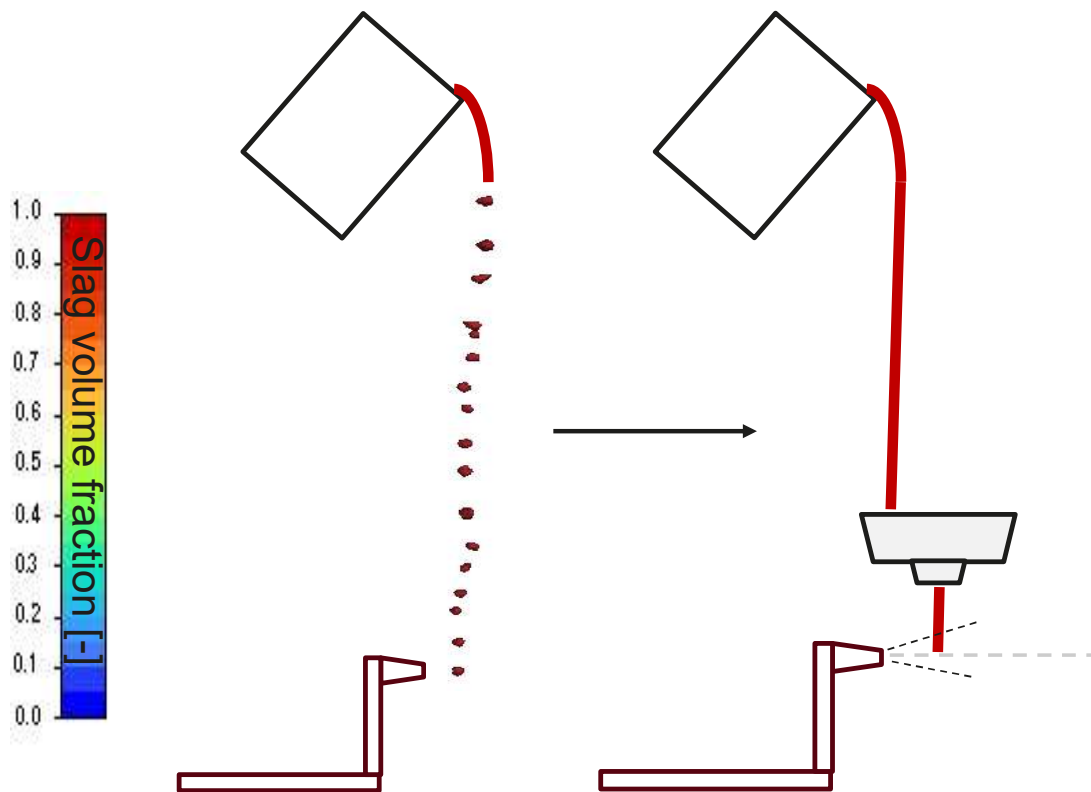
# InsGep Project – 100% DRI Slag



The jet is not coherence during its trajectory, so the breakup is due to the instability of the jet and not due to the impact with air.

- Empirical correlation from literature
- CFD test to validate the correlation
- New configuration developed

# InsGep Project – 100% DRI Slag

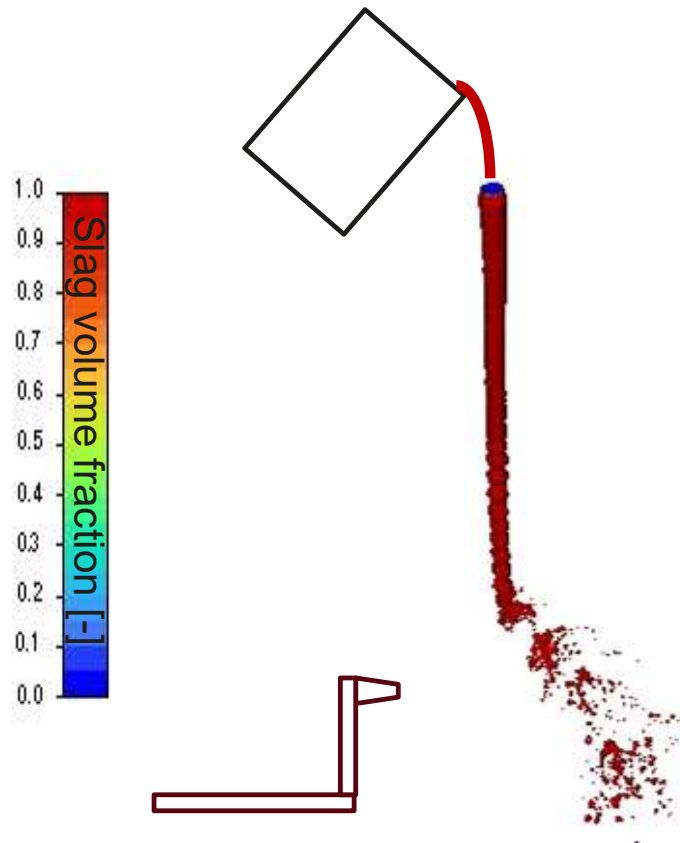


The main difference is the introduction of a 'slag tundish' that allows to obtain a more stable and continuous jet.

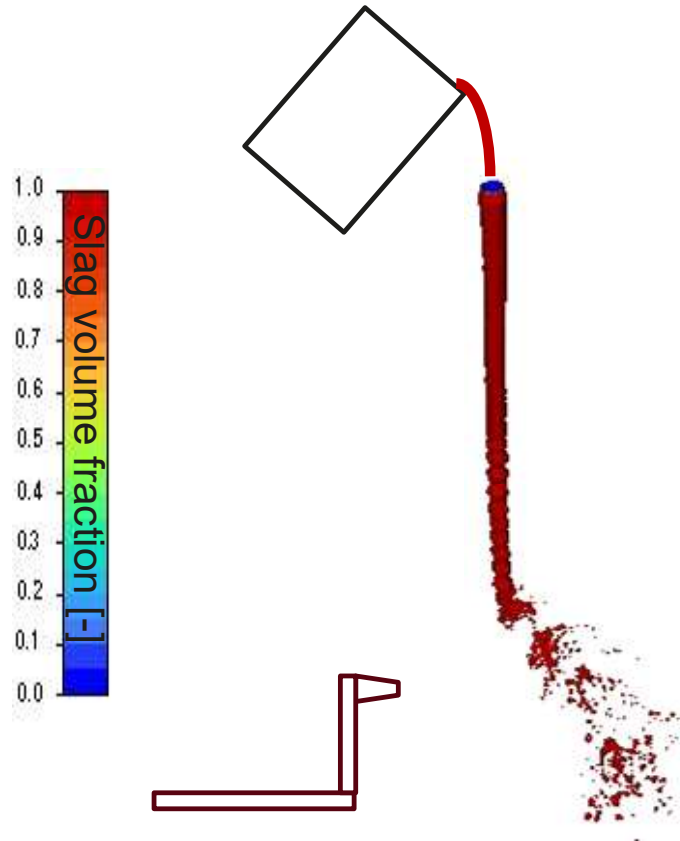
The CFD geometry is different by means:

- Position of the slag inlet
- Diameter of the slag inlet

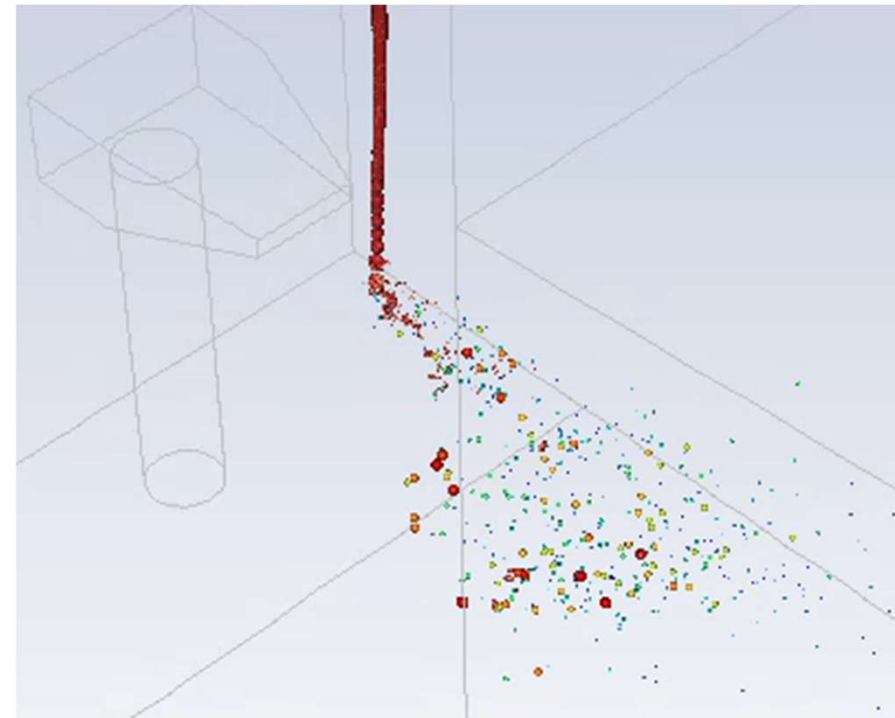
# InsGep Project – 100% DRI Slag



# InsGep Project – 100% DRI Slag



Primary breakup



Diameter [mm]  
Small Big

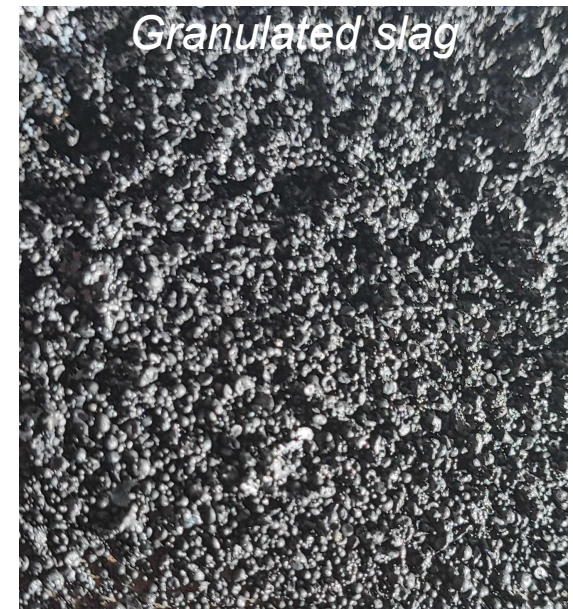
# InsGep Project – 100% DRI Slag



# InsGep Project – 100% DRI Slag



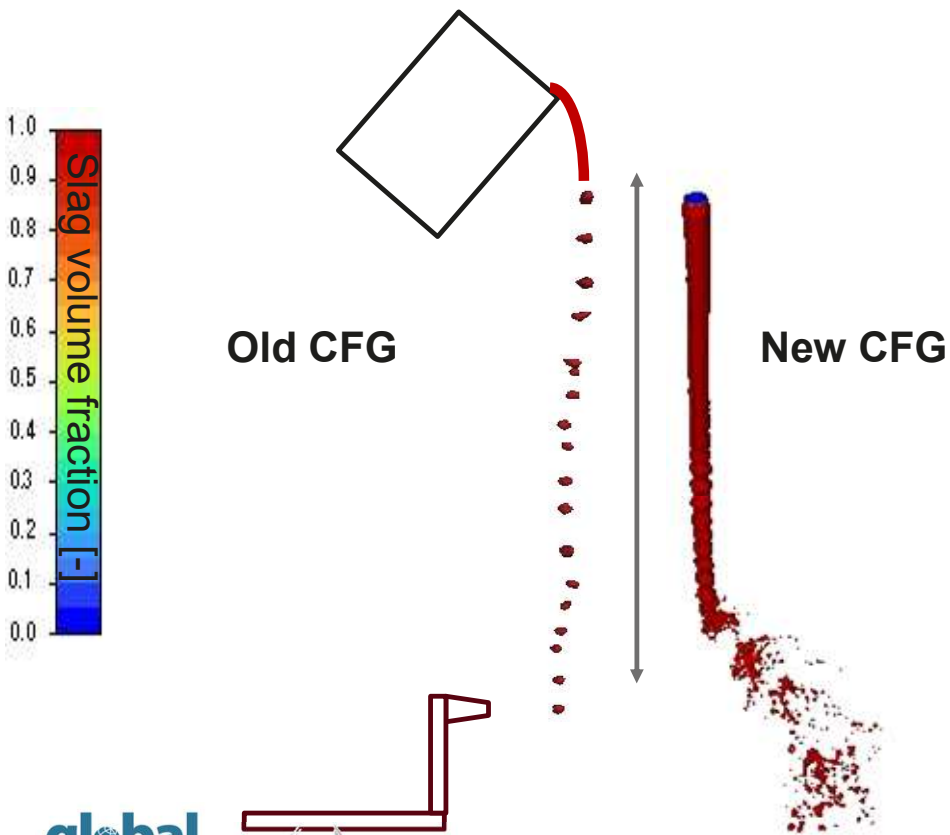
# InsGep Project – 100% DRI Slag



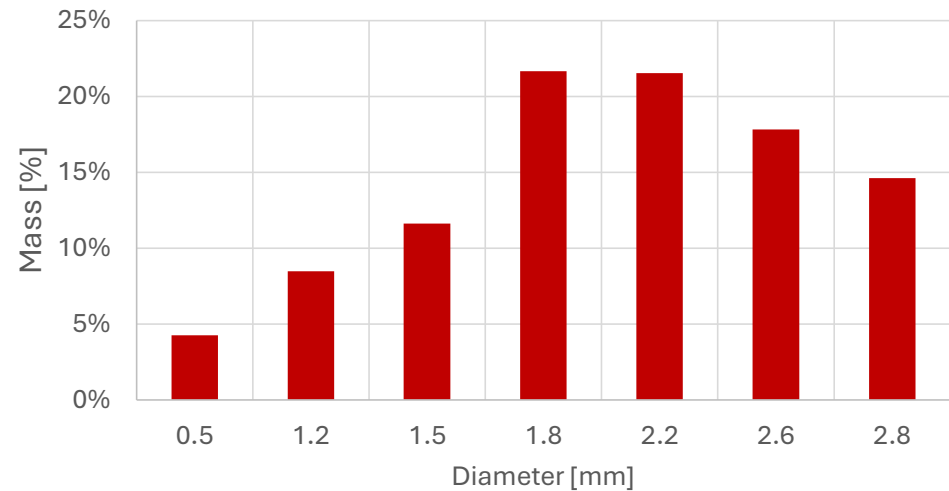
# InsGep Project – 100% DRI Slag



1. New configuration allows to obtain a coherent jet



2. The granulation results in a gaussian granulometry curve



3. The average diameter coming from experimental and CFD are very close

D Exp	1.86 mm
D CFD	2.03 mm

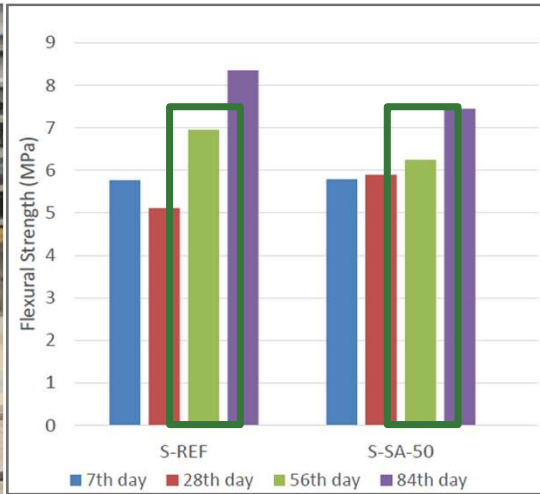
# EAF slag 100% scrap applications

The granulated slag replaced sand in the mortar sample:

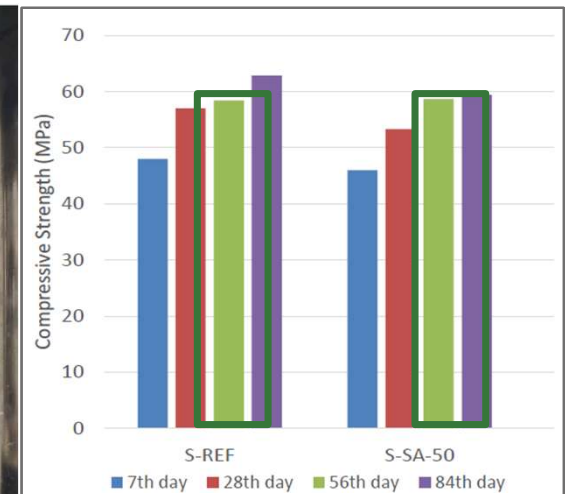
Air granulated slag was used as a 50% volume replacement for sand in the mortar specimens.



## Bending Test



## Compression Test



# LF slag - industrialization

## Update

Recent industrialization of the granulation plant applied on LF slag.



Gruppo Pittini

30.349 follower  
2s • Modificato •

Presso lo stabilimento di Ferriere Nord sono ufficialmente iniziati i test operativi del nuovo impianto di granulazione a secco della scoria bianca, il primo al mondo di questo tipo.

Questa nuova soluzione trasforma i residui siderurgici in risorsa per l'industria del cemento, favorendo sostenibilità ed economia circolare. Un nuovo traguardo concreto nell'ambito della politica **#ZeroWaste** del **Gruppo Pittini**.

Leggi l'articolo completo:

<https://bit.ly/3SRmPGR>

At the Ferriere Nord plant, operational tests have officially begun on the new dry slag granulation plant for white slag - the first of its kind in the world.

This new solution turns steelmaking residues into a resource for the cement industry, supporting sustainability and the circular economy. A new concrete result of the **#PittiniGroup #ZeroWaste** policy.

Read the full article:

<https://bit.ly/43qyXUj>

[#steelahead](#)



**tenova**<sup>®</sup>

**global**  
**slag**

Tenova SpA

[martina.messuti@tenova.com](mailto:martina.messuti@tenova.com)

[www.tenova.com](http://www.tenova.com)

TECHINT GROUP

**THANK  
YOU**