SESSION 1: 9:40–10:00

ESTEP workshop

SecCarb4Steel

Preparation and use of biogenic and non-biogenic secondary carbon carriers (SCC) in processes for iron and steelmaking

Towards low-CO_2 cokemaking: Insights on the influence of alternative carbon materials on the coke quality

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Incorporation of alternative carbon materials to substitute classic coals blends

- Coal blends are tested in 400 kg moveable-wall pilot oven at CPM
- Different alternative carbon materials are testes at addition rate of 2.5 and 5%

Alternative carbon materials

2 to 5 % addition

Blending

400 kg moveable-wall pilot

metallurgical coke

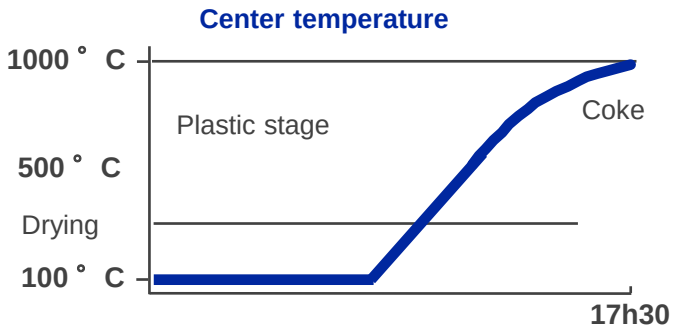
Crushing

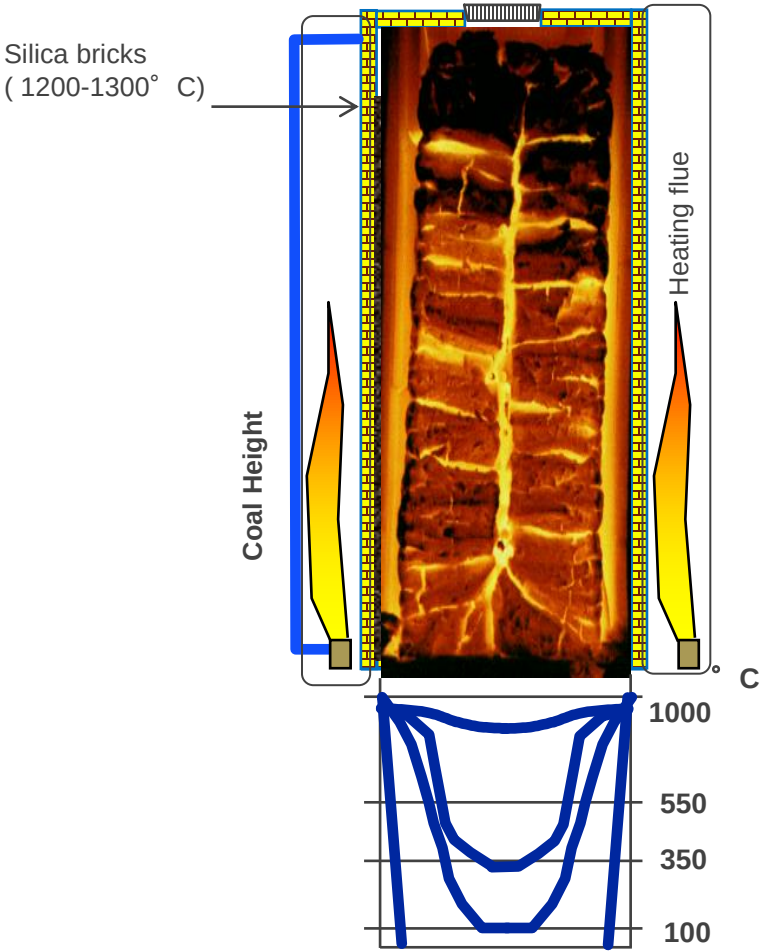
Coals

Impact of alternative carbon addition	Main KPIs followed:
Cokemaking process	Maximum Equivalent **Wall Pressure** (kPa)
Coke plant productivity	Coke **yield** (%)
Coke quality	Coke **grain size** and Resistance to fragmentation (**I40**) Coke reactivity index (**CRI**) and strength after reaction (**CSR**)

Carbonization in slot coke oven

Item	Gravity	Stamp
Bulk density (t/m3, db)	**0,75**	1,00
Moisture (%)	**7-9**	10-11
Volatile matter (%, db)	**23-25**	26-28
Coking time (h)	**17-19**	20-21





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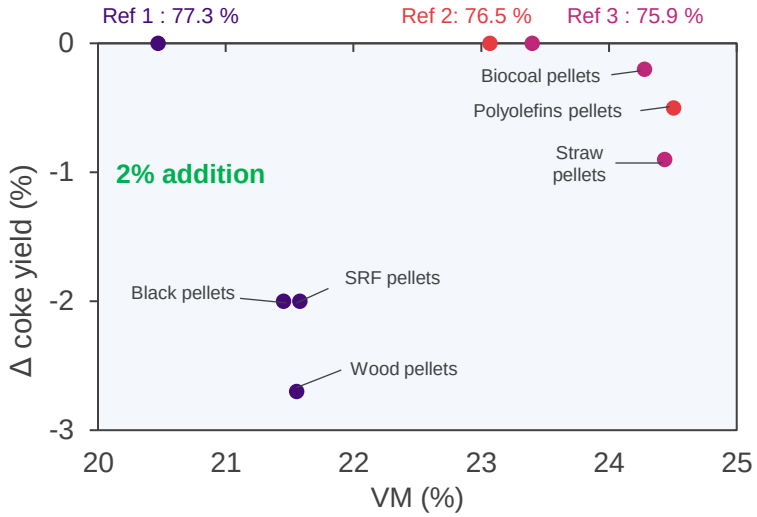
Incorporation of densified alternative carbon materials to partially substitute classic coals

	Polyolefins granules	Wood pellets	Straw pellets	SRF pellets	Black pellets	Biocoal pellets
Particle size	Φ = 3-5 mm	Φ = 8 mm	Φ = 8 mm	Φ = 16 mm	Φ = 9 mm	Φ = 5 mm
Ash (%, d.b.)	3.4	5.8	6.6	12.8	5.3	2.5
Volatile matter (%, d.b.)	95.0	75.8	73.1	77.1	70.5	65.5
Sulfur (%, d.b.)	0.04	0.3	0.1	0.3	<0.1	0.04
Basicity index $\frac{CaO + Mg + K_2O + Na_2O + Fe_2O_3}{SiO_2 + Al_2O_3}$	1.25	0.90	1.14	2.33	2.69	1.48
Water resistance (immersing in water)	No	No	No	No	No	Yes

- Densified no-coking materials
- Differences in origin and composition: high volatile matter and ash content; high alkali concentration



- Decrease in coke yield with the addition of alternative materials
- The decrease is proportional to the increase in volatile matter:

Biocoal < polyolefins <straw pellets< SRF < black pellets < wood pellets

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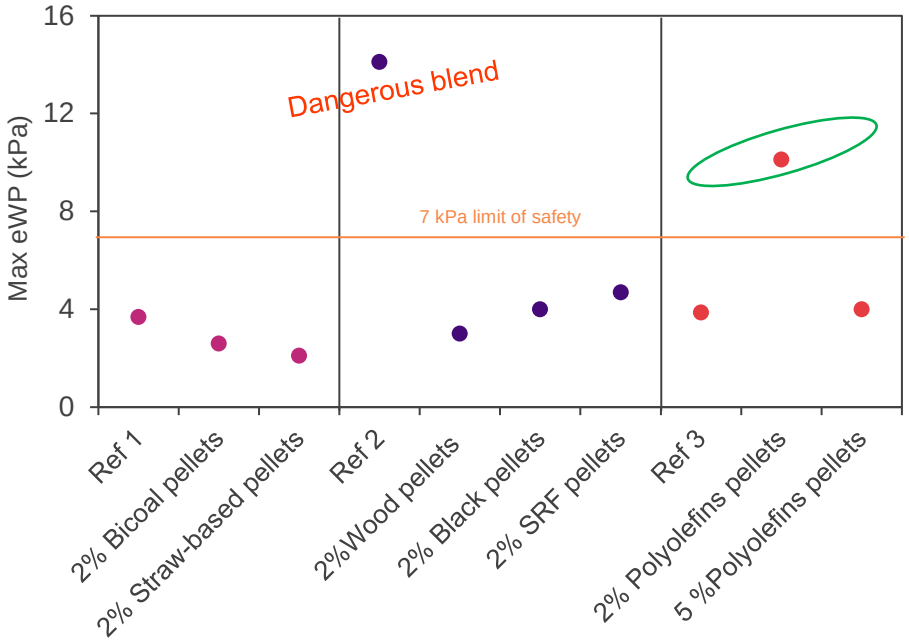
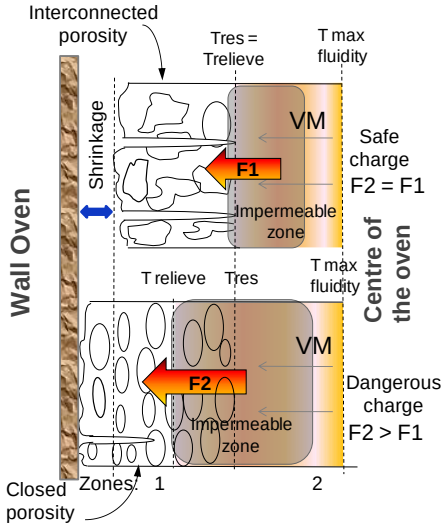
Effect on maximum wall pressure



- **Decrease** of wall pressure with the addition of alternative materials, except 2% addition of polyolefins



Mechanism of wall pressure generation. (from RFCS SPRITCO project)

- Typical of polyolefins
- At 2%, VM would be entrapped in the coal thermoplastic layer → developing significant internal gas pressure
- At 5%, VM would be able to leave the material due to lower bulk density (the coke with 5% addition is expected to have higher porosity)

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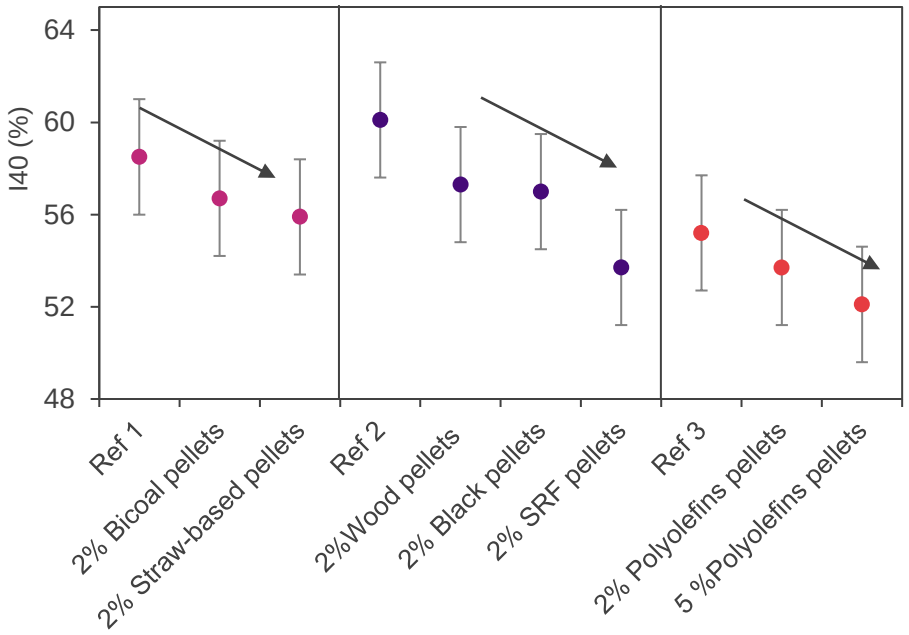
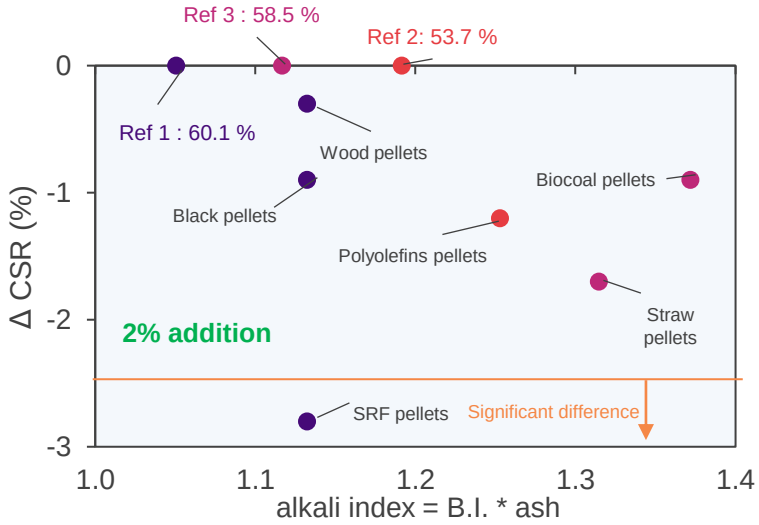
Effect coke mechanical strength (I40) and strength after reaction (CSR)



- I40 is directly impacted by inert carbon
- Slight deterioration of I40 due to non-coking nature of alternative carbon materials



- A marginal impact on CSR → inert carbon and ash composition of alternative materials (high B.I index)
- SRF <straw pellets < polyolefins < biocoal < black pellets< wood pellets.

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Conclusion

- **Alternative Carbon** Sources: Biomass, biocoal, SRF, black pellets, and polyolefins were tested as partial coal substitutes **in top charge mode** in cokemaking to reduce fossil CO_2 emissions
- **Key Findings:**
  - **Coke Yield**: **Decreased** with most alternative materials due to high volatile matter (VM).
  - **Wall Pressure**: Generally reduced, except with 2% **polyolefin** addition, which **exceeded safety limits due to high VM and low bulk density.**
  - **Coke Quality**: decrease of coke strength after reaction (CSR), and fragmentation resistance (I40)
- **Recommendations:**
  - **Bulk density** and **water resistance** should also be taken into consideration for handling and storage.
  - Tailor alternative material use based on **specific plant contexts** and characteristics:
    - Leveraging biogenic **coking gas with higher LHV** for other plant facilities if possible
    - **Reducing wall pressure** of dangerous coals
- **Perspectives:**
  - Test on **stamp charge** at pilot scale to reduce the impact of alternative materials on coke quality
  - Biocoal pellets to be tested at 5% addition rate at industrial scale, testing different particle size

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Thank you