Energy-intensive industries: Innovative technologies toward climate neutrality

RETROFEED, Angela Nunes, Secil
Decarbonisation of energy-intensive industries

- **ENERGY-INTENSIVE INDUSTRIES ARE RESPONSIBLE FOR HIGH CO₂ EMISSIONS THAT CONTRIBUTE TO CLIMATE CHANGE**

- **IMPROVEMENTS IN ENERGY AND RESOURCE EFFICIENCY ARE KEY TO TRANSITION TO A CARBON-NEUTRAL INDUSTRY**

- **EXISTING INDUSTRIAL PLANTS NEED TO BE TRANSFORMED TO ADDRESS THE ENVIRONMENTAL CHALLENGES AND REMAIN COMPETITIVE**
  
  - Increasing the resource and energy efficiency
  - Decreasing GHG emissions
  - Decreasing the utilisation of fossil resources
  - Reducing operational costs and/or increasing productivity

  of the industrial processes
Implementation of a smart RETROfitting framework in the process industry towards its operation with variable, biobased and circular FEEDstock

5 energy-intensive sectors

AGROCHEMICAL  ALUMINIUM  CEMENT  CERAMIC  STEEL

TOTAL COST 15,468,861.25 €
EU FUNDING 9,912,915 €
PROJECT MAIN GOALS FOR HARD-TO-ABATE INDUSTRIES

• Energy efficiency
• Circularity and use of Bio-based materials as alternative feedstock (as secondary raw materials or alternative fuels)
• CO₂ emissions reduction
• Process digitalization;
  • new monitoring infrastructures;
  • advanced modelling techniques;
  • smart control systems of retrofitted processes;
  • develop a process Decision Support System;
• Develop a retrofitting methodology for industry replication
Main environmental and economic impacts on cement production

- **Energy intensive**
  - Thermal energy for clinker production (high temperatures needed 1450°C)
  - High electrical power consumption (grinding and transportation)

- **CO₂ emissions**
  - Fossil fuels combustion (petcoke)
  - Limestone Decarbonation (530kg CO₂/t Clinker)
The cement production process

Replacement of fossil fuels

Petroleum coke

RDF (Refuse Derived Fuel)

Cement kiln
Cement Demo Site

Our project goals/Why?

✓ Improve plant environmental performance by replacing fossil fuel for alternative fuels, decreasing CO₂ emissions.

✓ Increase knowledge on operations conditions and feedstock for improved monitoring improved energy efficiency, reduced operational costs and improved process yield.
Why use of Alternative Fuels (AF)?

✓ Fuel emissions account for 35% to 40% of total CO₂ emissions from cement manufacturing.

✓ Alternative fuels are derived from non-primary materials (waste or by-products) and can be biomass, fossil or mixed alternative fuels. SECIL uses RDF (Refuse Derived Fuel) avoiding landfilling disposal or incineration.

✓ The extremely high temperatures and residence times of a cement kiln ensure these are managed in a safe and environmentally sound way.

✓ CO₂ is saved by replacing fossil fuels with the alternative waste streams, avoiding those emissions of being released by incineration or landfilling.

RDF Characteristics

✓ High heterogeneity material (size, composition),

✓ High variation of calorific value,

✓ High variation of moisture content,

✓ High feedstock variability

✓ High Chlorine content.

RDF Challenges

✓ Flame control, blockages and process instability,

✓ Product quality maybe affected

✓ Overall lost of energy efficiency and productivity (>15%)
Retrofitting actions

✓ Kiln digital model (digital twin)
✓ Multi-fuel burner design (allowing H₂ as main fuel)
✓ New sensors and control system:
  • Image based combustion diagnosis tool
  • Alternative fuels properties determination
  • Real time clinker optical characterization
✓ DSS implementation
Cement Demo Site

RESULTS

✓ Alternative fuels rate increases by: +13% to +34%
✓ Thermal energy consumption decreases by: -5%
✓ CO₂ emissions reduction of: -7% to -11%

Other atmospheric emissions continuously monitored during the trials (dust, NOₓ, SO₂, CO, NH₃, HCl, HF, TOC) comply with emission limit values.

Clinker quality: not affected by the retrofitting changes during tests. Expected improvement as well an increase in productivity due to a better burnability and combustion control system.
Optimization:

- Clinker carbon footprint reduction (CO$_2$ emissions reduction by 7 to 11%)
- Energy consumption reduction (by 5%)
- Productivity improvement (less 15% blockages stops)
- Product Quality Improvement (standard deviation reduction)
- Adaptation to a future hydrogen combustion use at industrial scale.
- Advanced control and monitoring systems.
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