WP1

A novel multi-stage steam gasification and syngas purification demonstration plant for waste to hydrogen conversión (“HYIELD”)

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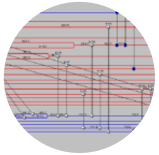
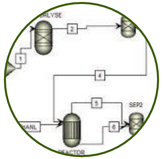
T1.1 

Process specification

T1.2 

Waste heat recovery

T1.3 

Process design

T1.4 

Feedstock specs

T1.5 

Basic engineering

T1.6 

Gasification (TRL5-6)

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T1.1 – Process specs

Scope:

- ✓ Collect data and main KPIs for:
  - Block Flow Diagram development
  - Identification of main sections and process unit
  - Definition of scope and role of each unit and section
  - Heat integration strategy
  - Model assumption and model strategy

- ✓ Align modelling and assessment with activities related to process development (especially pilot)

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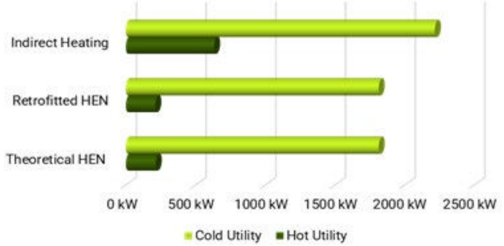
T1.2 – Waste heat recovery via heat integration

Scope:

- ✓ Heat integration of the **HYIELD** pilot facility to determine the energy targets and possible utility savings in the heat exchanger network.
- ✓ Two cases investigated: (a) waste heat from pilot plant and (b) waste heat from pilot plant + kiln in CMX plant.
- ✓ Theoretical Heat Exchanger Networks (HENs) designed i) for the ideal cases and ii) retrofitted considering practical constraints and process limitations.
- ✓ CAPEX estimation for all scenarios.



Indirect heating: heat recovery via a thermal oil as an intermediate heat-transfer fluid

Retrofitted HEN: optimized design considering process constraints

Theoretical HEN: ideal scenario based on Pinch Analysis

Key takeaways:

Up to **86%** reduction in external heating utility demand

Up to **98%** reduction in external cooling utility demand

Lowest CAPEX: Theoretical HEN: **1.5 M€**
Highest CAPEX: Indirect heating scenario: **2.4 M€**

T1.3 – Process design

Scope:

- ✓ Process simulated in COCO-COFE, CAPE-OPEN license-free simulation environment
- ✓ Semi-rigorous approach used for the gasification process
- ✓ Unit operations designed based on KPIs assigned from industrial partners
- ✓ Results compared with existing published data show good agreement

T1.4 – Feedstocks specs

Scope:

- ✓ Development of a matrix for characterisation of the main potential feedstock
- ✓ Classification of the most promising materials
- ✓ Selection of the most suitable "wastes" to be tested at the CSIC's Pilot unit
- ✓ Preparation samples for running validation at TRL-5 pilot unit

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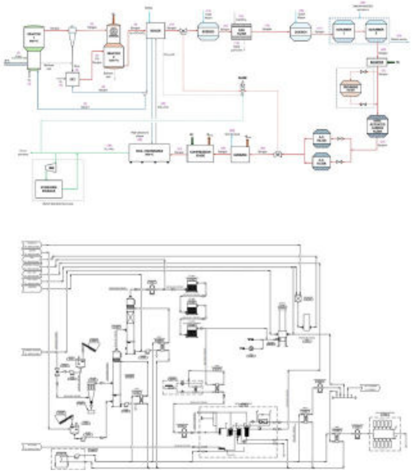
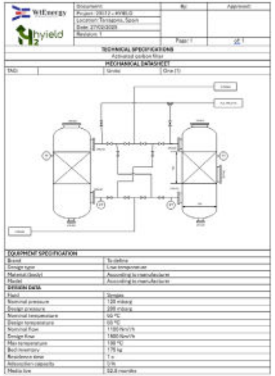
T1.5 – Basic engineering

The basic engineering is the basis of the detailed engineering for the acquisition and construction that defines the technical requirements for the design, manufacture, construction, operation and common maintenance of equipment and facilities in WP4.

Process concept

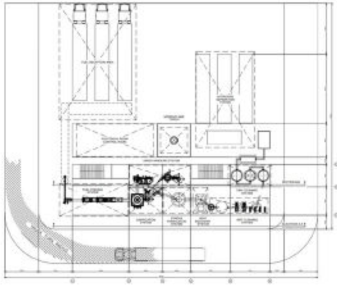


Technical specifications and standardization

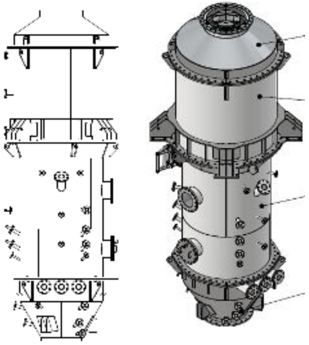


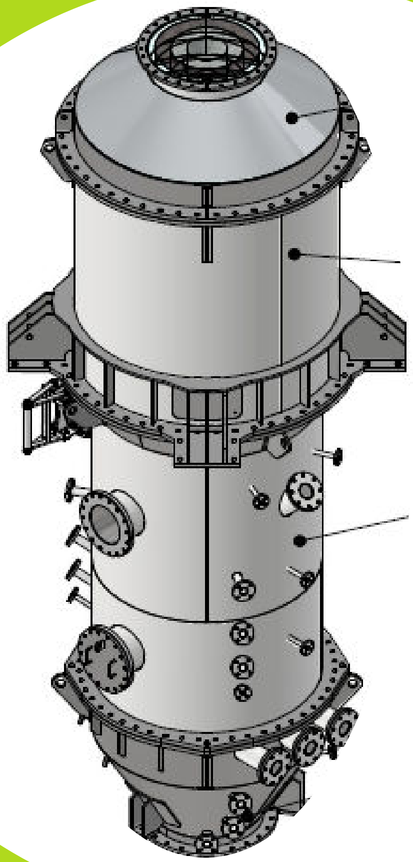
ATEX

Plant distribution



Design of the main equipment





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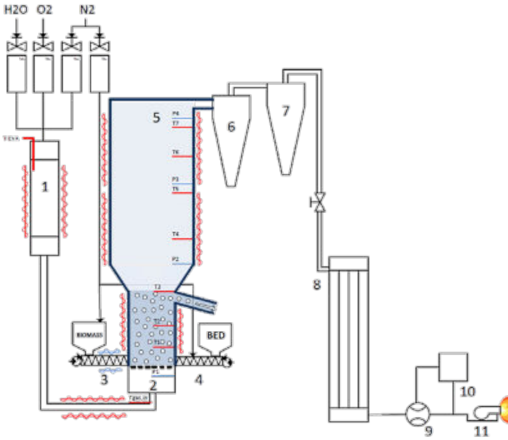
T1.6 – Testing gasification at TRL5

- Ran an experimental campaign on a real 10 kWth pilot-scale fluidised-bed gasifier (the key step between lab-scale concept and industrial design)
- Carried out 15 controlled test runs, exploring temperatures from 650 to 850 °C and different steam-to-carbon ratios
- Compared several bed materials (olivine, magnesite, limestone) and a reactive CaO bed for potential integration with cement-plant CO_2 capture
- Tested six real waste-derived feedstocks, from agricultural residues to sewage sludge, to see how each behaves during gasification
- Combined continuous gas monitoring with chromatography and mass spectrometry to fully characterise the syngas, tars, and sulfur species produced



1.Evaporator, 2.Distributor plate, 3. y 4.Feed screw, 5.Gasifier, 6. y 7.Cyclone, 8.Condenser, 9.Flowmeter, 10. Analyzer 11.Burner

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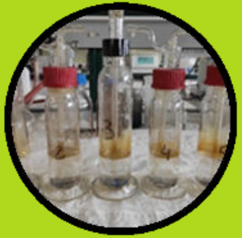
T1.6 – Testing gasification at TRL5

- Temperature proved decisive: moving from 650 to 850 °C sharply increased hydrogen yield and gas production while cutting tar content
- The steam-to-carbon ratio shows a threshold effect — real gains in gas quality only appear once a certain steam level is reached
- Bed material choice strongly shapes performance: magnesite gave the best combination of high H_2 and low tar among the materials tested
- Feedstock composition (ash, moisture, mineral content) clearly influences gas quality and tar formation, confirming the need to tailor operating conditions to each waste stream
- Overall, the campaign provides a solid, validated basis for the industrial-scale design of the HYIELD process

Gravimetric tar sample

Rotary evaporator



Gas sampling impingers

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Thank you for your time!

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