NEWSLETTER NO. 4

Information about new products of the H2GEO project

In June 2025, we published a new Deliverable of the project: D4.1 delivered by VSB.

Deliverable 4.1 "Evaluation of Data from Operational Tests of the Plasma Gasifier"

The aim of the experimental activities was to investigate the plasma gasification of a sorted coal fraction using a high-temperature plasma reactor located at CEETe, VSB–Technical University of Ostrava. The tests focused on evaluating the effect of key process parameters, particularly the steam-to-fuel ratio and fuel feed rate, on the composition and yield of the produced syngas.
Gasification was conducted at a constant temperature of 1600 °C, with varying steam/fuel ratios (0.6, 1.0, 1.3) and fuel feed rates (15 and 20 kg/h). Each test ran for one hour using a fixed amount of feedstock.
In parallel, current-voltage characteristics of the plasma torches were measured under three nitrogen flow rates (148, 195, and 250 L/min) to assess the electrical behavior of the plasma arc under different gas conditions.

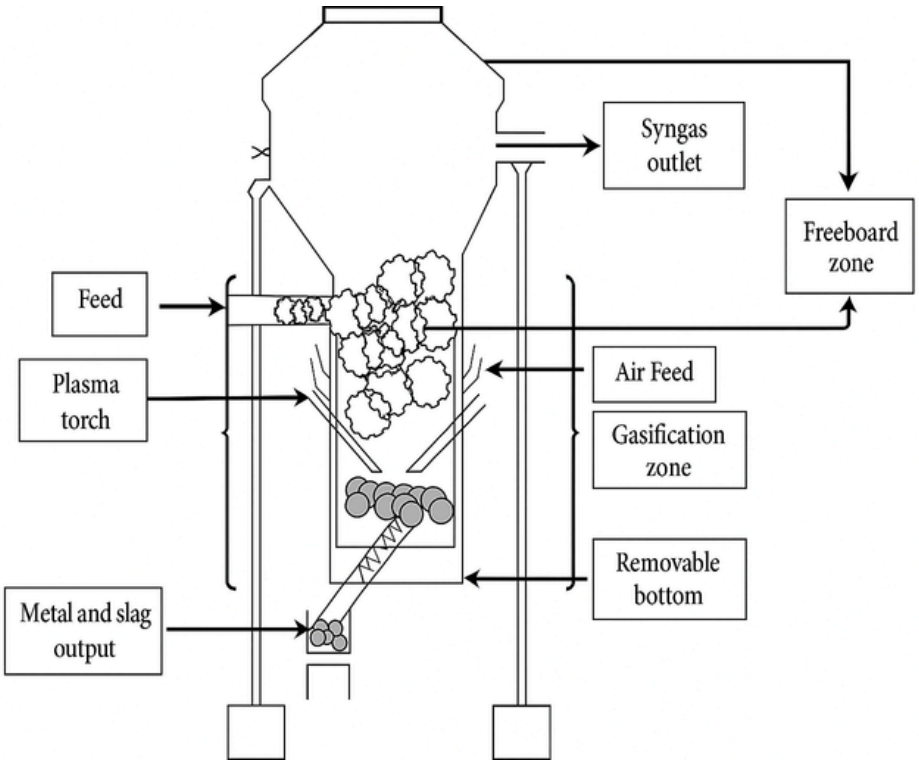

Fig. 1 Scheme of Plasma Gasifiler

Co-funded by the European Union

Research Fund for Coal & Steel

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

The plasma gasification unit at CEET converts organic and alternative fuels into energy gas using high-temperature plasma without air. This gas mainly contains hydrogen (H_2) and carbon monoxide (CO), along with water vapour, CO_2, and trace amounts of other gases. The process also produces slag from inorganic materials in the feedstock, which traps contaminants and shows very low leachability—lower than glass—making it suitable for use as a building material. The technology is emission-free, modular, and intended for research use.

Fig. 2 Picture of Plasma Gasifier in CEETe

The mass balance showed a high syngas yield – up to 92% by volume. As the steam-to-fuel ratio increased (from 0.6 to 1.3), the content of H_2 and CO_2 increased, while the CO content decreased. A lower fuel feed rate (15 kg/h) led to higher N_2 content in the gas due to dilution by the ionizing gas.

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

The optimal gasification conditions were identified as a temperature of 1600 °C, a fuel feed rate of 20 kg/h, and a steam-to-fuel ratio of 1.3. A higher steam content increased the syngas volume but also the water vapor content. However, at high temperatures, steam reacts with raw fuel, so the heating value of the produced gas is not significantly reduced.

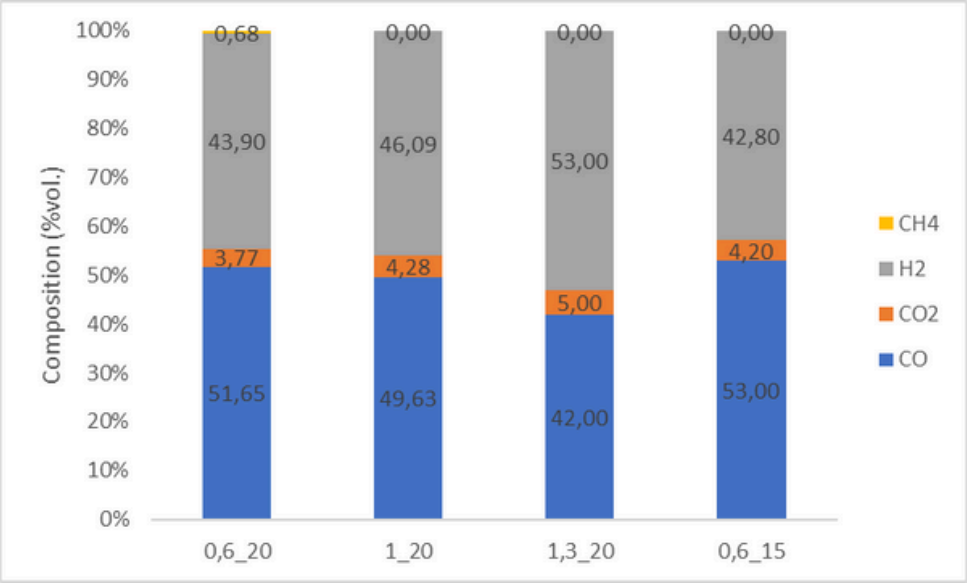

Fig. 3 Composition of Syngas without N_2

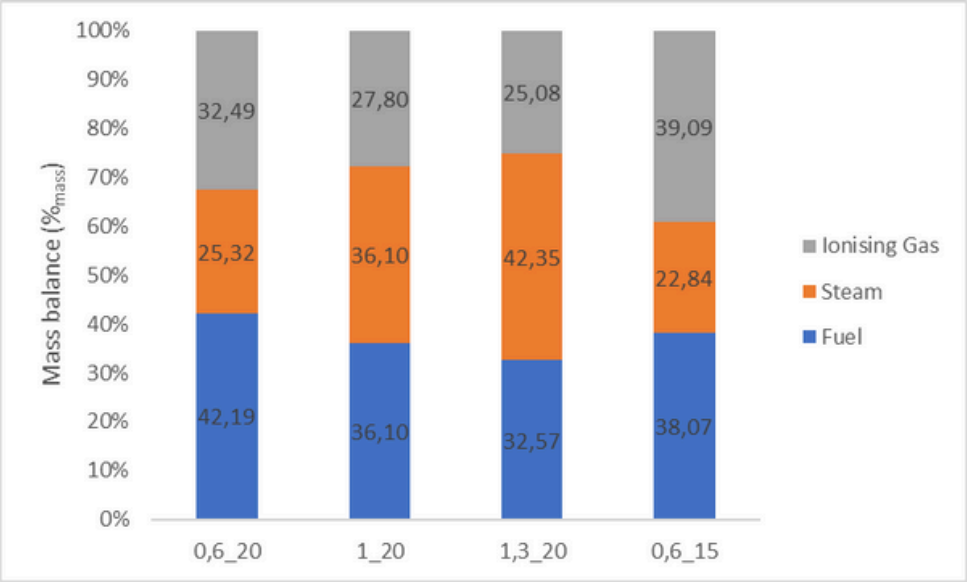

Fig. 4 Mass Balance Feedstock of Gasification

The current–voltage characteristics of the plasma torches were measured at three nitrogen flow rates (148, 195, and 250 L/min). The results showed that with increasing nitrogen flow, the voltage rises at a constant current. This effect is due to the higher volumetric density of ions and atoms in the arc, which requires a higher voltage to maintain arc stability.

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

Two more milestones planned in the H2GEO project were achieved: Milestone no. 3, developed by KOMAG, and Milestone no. 4, developed by VSB.

Milestone no 3 "Technical documentation of the prototype of mobile system for separation of mine wastes"

The KOMAG Institute has developed the technical documentation for the prototype of the mobile system for the separation of mining waste, model S-100. The developed documentation has been archived in the KOMAG Institute's archive. An integral part of the documentation is the user manual, which includes all elements required by applicable standards.

The newly developed pulsating jig features a single working chamber measuring 2 × 2 meters, divided into two independent pulsation zones with separate air and bottom water supplies.
The separator includes a control and discharge system with a heavy (mineral) product receiver, an overflow for the light (coal-bearing) product, a float-based sensor, and components that generate pulsation and loosen the material bed—such as a pulsation valve, compressed air manifold, and automated water system.

The device separates materials by density in a pulsating water medium. The mineral-rich product is discharged via a rotary receiver, while the coal-rich product exits over the overflow weir.
An integral SES control unit manages the pulsation valve and mineral product receiver, allowing adjustments to key parameters like pulsation cycle and scraper speed. This ensures consistent, high-quality separation products for further processing into hydrogen and geopolymers.

Fig. 5 Prototype of the mobile system for separation of mining waste S-100, developed in the H2GEO project

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

Based on laboratory tests results, a disc pulsation valve was selected for the new jig. It allows for easy curve shaping and frequency adjustment during operation, without physical interference, unlike rotary valves. Settings can be modified via the control panel or remotely if a wireless module is installed. The new jig will include an advanced version of this valve, with four discs and two chambers supplying air separately to the front and rear of the deck, enabling more precise pulsation control.

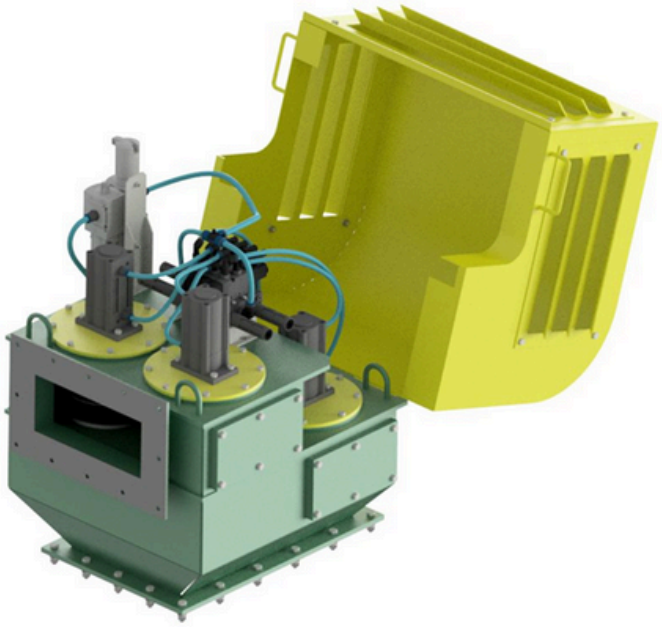

Fig. 6 The ZP-4 disc pulsation valve

In the designed enrichment device, a rotary cell receiver was chosen due to its precise throughput control and minimal process water outflow—advantages unmatched by other solutions. The scraping rotor will be modified with flexible polyurethane-lined blades mounted on adjustable sliding fittings, reducing grain jamming and allowing material collection in the 30–3 mm range (with some up to 40 mm). These changes are expected to improve rotor and body durability. Additionally, a clean water sealing and flushing system will prevent material buildup and reduce wear around the rotor's seals.

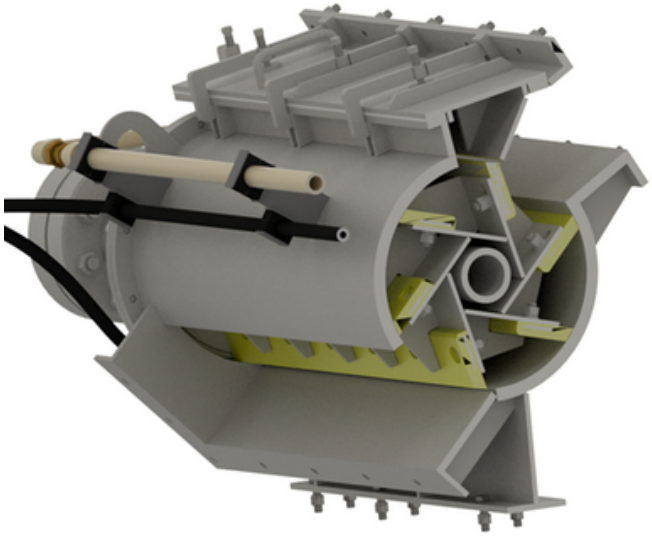

Fig. 7 Mineral fraction receiver – cross-section

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

The new pulsatory jig will feature a 2000 × 2000 mm screen deck, inclined at 5.8°, selected based on lab tests as optimal for 100 Mg/h throughput. It uses modular screens with a steel frame and polyurethane surface, with 2.5 mm slots—proven more effective than 1.5 mm in tests—offering better pulsation and density separation while limiting fines below the 3 mm feed size. Screens are mounted with clamping strips and wooden wedges, ensuring a secure yet easily replaceable setup under heavy-duty conditions.

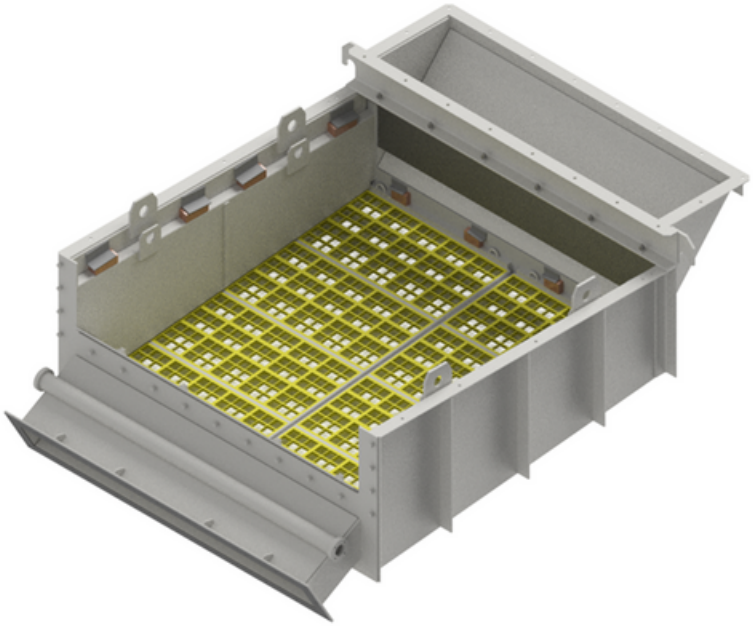

Fig. 8 Working trough with polyurethane screen deck

Milestone no. 4 "Design of plasma gasifier operating parameters and their subsequent validation"

This Milestone was directly related to D4.1 and included complete set of validated experimentally process data.

Based on the measured data, the optimal conditions for the plasma gasification process were determined. A total of four experiments were conducted, each with different steam-to-fuel ratios and varying mass flow rates of fuel at the reactor inlet. The results indicated the conditions under which the highest relative yield of hydrogen from the fuel was achieved. The most favorable operating parameters were: a steam/fuel ratio of 1.3 kg/kg and a fuel mass flow rate of 20 kg/h. The composition of the synthesis gas in this experimental setup was: 53 % H_2; 42 % CO; 5 % CO_2.

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.