SOLIDS
Gasification and Pyrolysis

EPOS TECHNOLOGY FOCUS
Technologies for industrial processes

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Within the scope of the EPOS project, extensive literature and market research reviews were performed in order to identify different technological, organisational, service and management solutions that could be applied to different industrial sites and clusters. The collected information will aid in establishing on-site and/or cross-sectorial industrial symbiosis opportunities; additionally, to enhance overall sustainability, performance and resource efficiency of different process industry sectors. Through the cooperation of project partners, a longlist of different technological options was created. Resource material for this list included: scientific articles, project reports, manufacturer’s documentation and datasheets.

**About the EPOS Technology Focus**

**SOLIDS**

Solid waste and other by-products can be utilised in many ways in order to achieve resource efficiency and industrial symbiosis. Two of the most common options for the utilisation of solid wastes are re-use and recycling. These are often used in the waste streams of plastics and metals.

Re-use and recycling of solid waste is, in some cases, not feasible, e.g. due to highly contaminated waste. In such cases, the solid waste can be used for energy production through incineration, producing heat, steam or electricity. Energy valorisation of the solid wastes is especially practical, as it can have caloric content.

In addition to basic waste incineration, other options for energy valorisation of solids are considered, namely pyrolysis and gasification. Using these two approaches, new resources can be obtained from the waste (gas and liquid fuels, etc.).

In addition to the energy valorisation, some emergent approaches for the recovery of minerals, metals and rare earths from cement kiln dust and fly ash are added, together with options for combustion improvement.

**GASIFICATION AND PYROLYSIS**

- Counter-current fixed bed (up draft) gasifier
- Co-current fixed bed (down-draft) gasifier
- Fluidised bed gasifier
- Entrained flow gasifier
- Rotary kiln gasifier
- Plasma gasifier
- Pyrolysis
In counter-current or updraft gasifiers, waste flows downwards, opposite to the upwards flowing air. The waste will go through several temperature levels. Unlike in other processes, the resulting gas will not typically interact with the biomass and char regions. This lack of interaction results in the retention of both tars and hydrocarbons.

**Technology 1: Counter-current fixed bed (updraft) gasifier**

**Applicability**
For the production of gases from organic substances. These gases can be used as a feedstock (through some reforming processes) or as a fuel.

**Maturity**
Commercial.

**Project/product reference**
Nexterra’s updraft gasifier.
Co-current or downdraft gasifiers introduce the air around the middle of the process, in a narrow section of the reactor. This type of gasification typically results in less tar in the final product than the updraft gasification process. This is due to an increase of breakdown to both hydrogen and lighter hydrocarbons as the tar and heavy hydrocarbons pass through the high-temperature oxidation zones.

**Applicability**
For the production of gases from organic substances. These gases can be used as a feedstock (through some reforming processes) or as a fuel.

**Maturity**
Commercial.

**Project/product reference**
PHG Energy’s downdraft gasifier used for waste gasification - case study.
In fluidised bed gasifiers the air flows directly through the feed, which results in the feed being suspended, thus creating a fluid-like substance. This direct contact makes the moisture content important for this process. The process can use either bubbling or circulating beds. The system is usually kept at a high temperature.

**Technology 3: Fluidised bed gasifier**

**Applicability**
For the production of gases from organic substances. These gases can be used as a feedstock (through some reforming processes) or as a fuel.

**Maturity**
Commercial.

**Project/product reference**
Kobelco Eco-Solutions’ fluidized bed gasifier.
Technology 4: Entrained flow gasifier

The waste feedstock (either solid or liquid) and air/steam enter the gasifier at the same time in the entrained flow gasification process. The suspension created is where the reactions occur. This gasification process takes place at high temperatures and typically has a short residence time.

Applicability
For the production of gases from organic substances. These gases can be used as a feedstock (through some reforming processes) or as a fuel.

Maturity
Commercial.

Project/product reference
Entrained flow gasifier for liquid and pasty waste in SVZ Schwarze Pumpe.
Rotary kiln gasifiers use a cylinder, lined with ceramic to gasify the waste. The cylinder is set on an incline and it rotates slowly; the waste moves downwards as it reacts with the input air. Of the gasification methods, the rotary kiln has one of the longest residence times.

Technology 5: Rotary kiln gasifier

**Applicability**
For the production of gases from organic substances. These gases can be used as a feedstock (through some reforming processes) or as a fuel.

**Maturity**
Commercial.

**Project/product reference**
Enviro Power Renewable Inc.’s rotary kiln system.
Plasma gasifiers use an electric arc-powered plasma torch in order to convert organic material into syngas. The process takes place at extremely high temperatures allowing for the ionisation of gas. Slag and other materials can be recovered.

**Technology 6: Plasma gasifier**

**Applicability**
For the treatment of waste, it has been tested for the gasification of biomass and solid hydrocarbons, such as coal, oil sands, and oil shale.

**Maturity**
Commercial.

**Project/product reference**
AlterNRG.
The pyrolysis process occurs in the absence of oxygen. The feedstock waste is degassed, leading to the formation of a solid coke and pyrolysis gas. The synthetic gas that is produced during the reaction is generally converted to a liquid hydrocarbon, such as biodiesel.

**Technology 7: Pyrolysis**

- **Applicability**: For the treatment of municipal waste.
- **Maturity**: Commercial.
- **Project/product reference**: GLES’ pyrolysis solution.
REFERENCES


