Solar gasification of carbonaceous waste

Temperatures:
- *700 to 1600 °C*

Typical size of a gasifier:
- *50-100 ton$_{waste}$/day*

Industry field:
- *solid waste treatment,*
- *waste-to-energy,*
- *fuel synthesis*

Countries with high potential:
- *all regions with high DNI*

Character of process:
- *continuous*

Source: https://pxhere.com/en/photo/867288

What is the gasification process?

Gasification is the reaction of carbonaceous waste with a gasifying agent (oxygen and/or steam) at temperatures ranging from 700 °C to 1600 °C, in partially oxidizing conditions (below stoichiometric oxygen level) to produce a fuel gas called syngas, which is a mixture of CO and H_2. The syngas can be used directly as a fuel or converted into synthetic hydrocarbon fuels. The gasifying agent is generally preheated.

Where is this process used?

While incineration is the most widespread waste-to-energy technology used to dispose municipal and industrial solid waste, gasification has become attractive in recent years. This is due its potential benefits of producing a storable and clean energy carrier and significant waste volume reduction. However, industrial scale application is still limited.

What makes it suitable for solar integration?

The temperature range of gasification aligns well with that achievable by point-focus solar thermal technologies. By concentrating direct sunlight over a small area with the aid of mirrors, it is possible to obtain a dense beam of solar radiative energy that can heat up the carbonaceous waste to the high temperatures necessary for its gasification. The solar energy input saves part of the feedstock from being burned, so that the process has the potential to be free of combustion byproducts and yield a higher syngas output with respect to conventional gasification. Solar gasification has the potential to be operated also during off-sun periods (i.e. night-time or cloudy days) with the integration of a thermal energy storage unit that can accumulate high-temperature (>700°C) solar heat during the day and release it when required.

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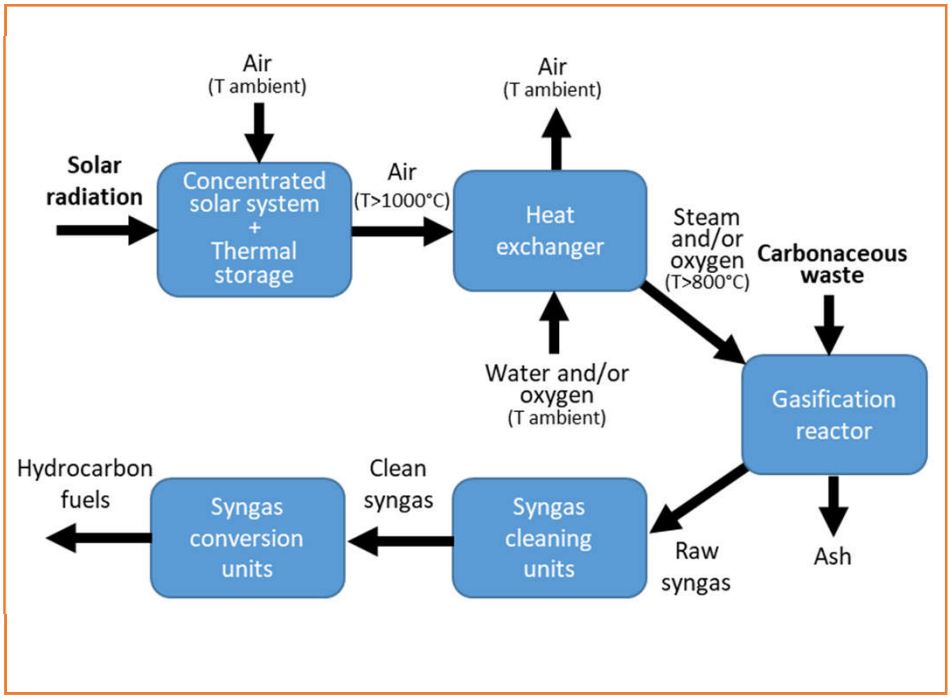

Summary of requirements for solar systems providing heat for this process

User side heat transfer fluid:

- *air, oxygen, steam*

Final temperature:

- *up to 1600 °C*

Return temperature:

- *n/a*

Power level required:

- *MW range*

Required continuity of heat supply:

- *High continuity favorable*

Available backup heat supplies:

- *fossil-fuel, electricity*

Heat storage options:

- *Favorable, integration strongly depends on the final concept*

Solar integration options

Solar gasifiers can be (i) directly irradiated, where the solid waste is directly exposed to the concentrated radiation, or (ii) indirectly irradiated, where the concentrated solar beam heats up the reactor wall or a heat transfer fluid. Directly irradiated reactors offer efficient heat transfer, but need a transparent window that has to be carefully designed to withstand pressure fluctuations and prevent deposition of particles or condensable compounds on it. Indirectly irradiated reactors eliminate the necessity for a window at the expense of a less efficient heat transfer. Indirect concepts are open to include high temperature thermal storage like regenerator storage to increase operating hours of the gasifier.

The possible reactor configurations can be: packed bed, fluidized bed, entrained flow and vortex flow, among others.

Status quo in solar integration

Solar gasifiers have been demonstrated as part of research projects, with operating temperatures above 1400 K e.g. in the SYNPET project. Industrial scale integration and demonstration of solar gasifiers has not yet been achieved.

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