## Biomass gasification plants

# Gasification of wood chips

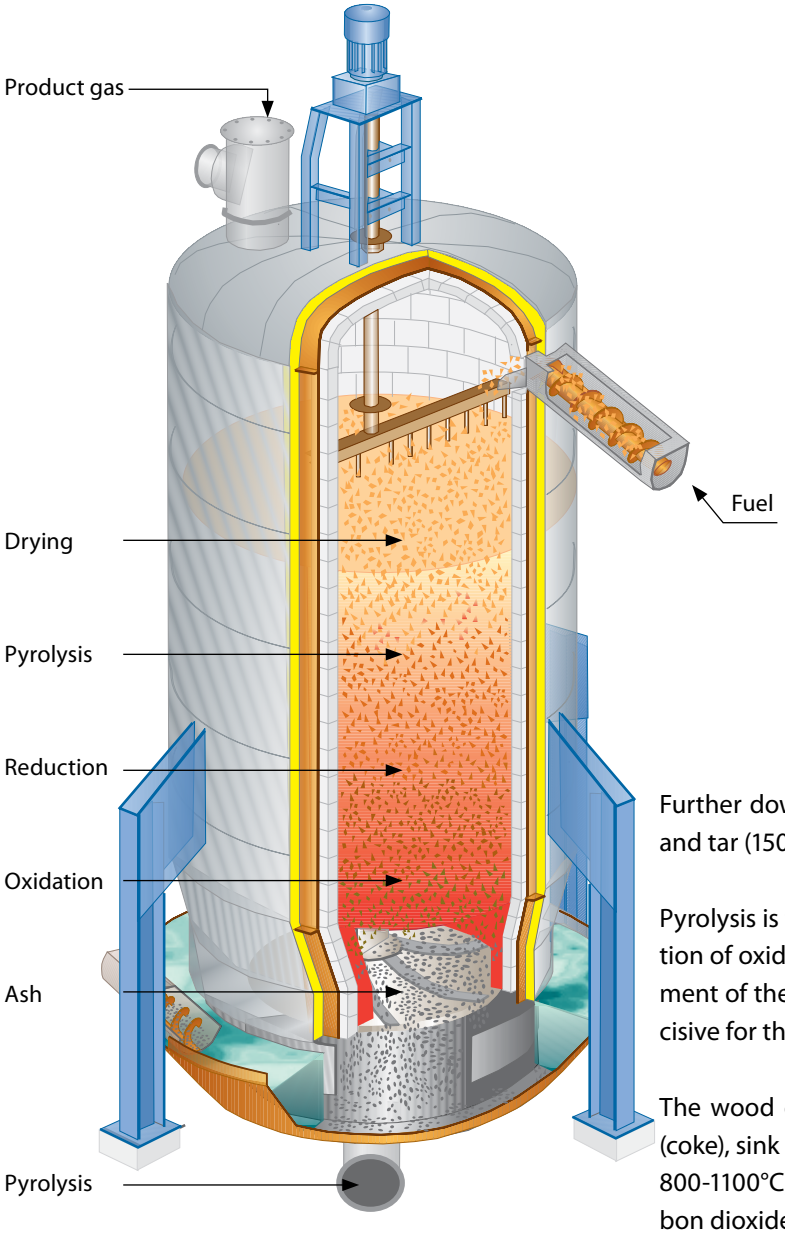
*2 MWe plant in Yamagata, Japan*

Today gasification of biomass is an alternative to traditional combustion plants as it is possible with this technology to generate more electricity than with the existing solutions based on steam in small district heating and industrial plants.

Already in 1988 Vølund decided to take an active part in the development of this technology in order to create a gasification principle with the possibility of

- achieving a stable and continuous gas production
- gasifying fuel with a moisture content of up to 50%.
- producing gas for use in a gas motor achieving a high degree of automation for the total plant

As forest wood chips usually have a high moisture content, the updraft gasification principle was chosen because of the built-in drying zone which makes possible to use fuel with a high moisture content without prior drying of the fuel. The generated gas has a temperature of 75°C.




*Principle sketch of updraft gasifier*

## The updraft gasifier

The gasifier is designed as a vertical, cylindrical furnace with internal ceramic insulation and a specially designed revolving grate at the bottom through which moistened combustion air is supplied and participates in the chemical reaction.

The wood chips are fed continuously from one side at the top of the gasifier. A levelling device is installed here to keep the surface of the fuel smooth. Furthermore, the levelling device acts as a mechanical level control which controls the fuel supply.

Up through the gasifier a thermal conversion of the biomass into a combustible mixed gas takes place.

At the top the moisture in the biomass is evaporated by means of the hot upward gas flow.

Further down a pyrolysis takes place, releasing volatiles and tar (150-800°C).

Pyrolysis is the heating of organic material without addition of oxidizing gases (air, oxygen, steam). The development of the pyrolysis and the process conditions are decisive for the formation of chemical combinations.

The wood chips, which have now turned into charcoal (coke), sink into the reactor, and a reduction (gasification 800-1100°C) with the gasification agents (vapour and carbon dioxide) takes place.

Subsequently the oxidation - the actual combustion takes place (1100-1300°C) with the rest of the charcoal which is burnt into carbon dioxide.

The combustion takes place under development of heat. This heat is used further up the reactor. The gas composition depends, among other things, on temperature, pressure, heating rate and residence time in the different zones.

## District Heating Plant Harboøre

After several years of development work the first gasification plant was put into commercial operation in 1993 at the district heating plant Harboøre which today supplies heat to approx. 560 heat consumers and to the municipal buildings of the town.

The gas is produced in a modern updraft gasifier de-


*District Heating Plant Harboøre, Denmark*

signed as a vertical, cylindrical furnace with ceramic insulation. The plant is controlled 100% on the basis of the heat requirement. The gasifier has an output of 4 MWth, and the gas is burnt in a Low-NOx gas burner built onto a 4 MW hot water boiler.

After the boiler the flue gas is carried through a condensing flue gas scrubber with heat recovery, as the fuel used often has a moisture content between 40 and 50%.

In the course of 2001 the district heating plant was converted in to CHP and was taken into commercial operation. In this connection, the following main components were installed:

- Gas cleaning plant
- Electrostatic precipitator
- 2 (two) motors with generators, 650 and 740 kW e
- 800 $m^3$ heat accumulator tank
- Tar and water cleaning system (TarWatC)

Our experience shows that the gas is easily cleaned of particles and tar for use in a motor. The motor operation at the plant has proven very satisfactory. With over 50000 hours of experience with the operation of the motor plant we can conclude that the performance i up to our expectations. The combustion leaves the motors even less fouled than N-gas.

A water treatment plant for cleaning the surplus water before discharge into the municipal sewers has been installed.

The primary fuel is wood chips, but successful tests have been made at the plant with other types of fuel, e.g. chunk-wood, bark and waste wood.

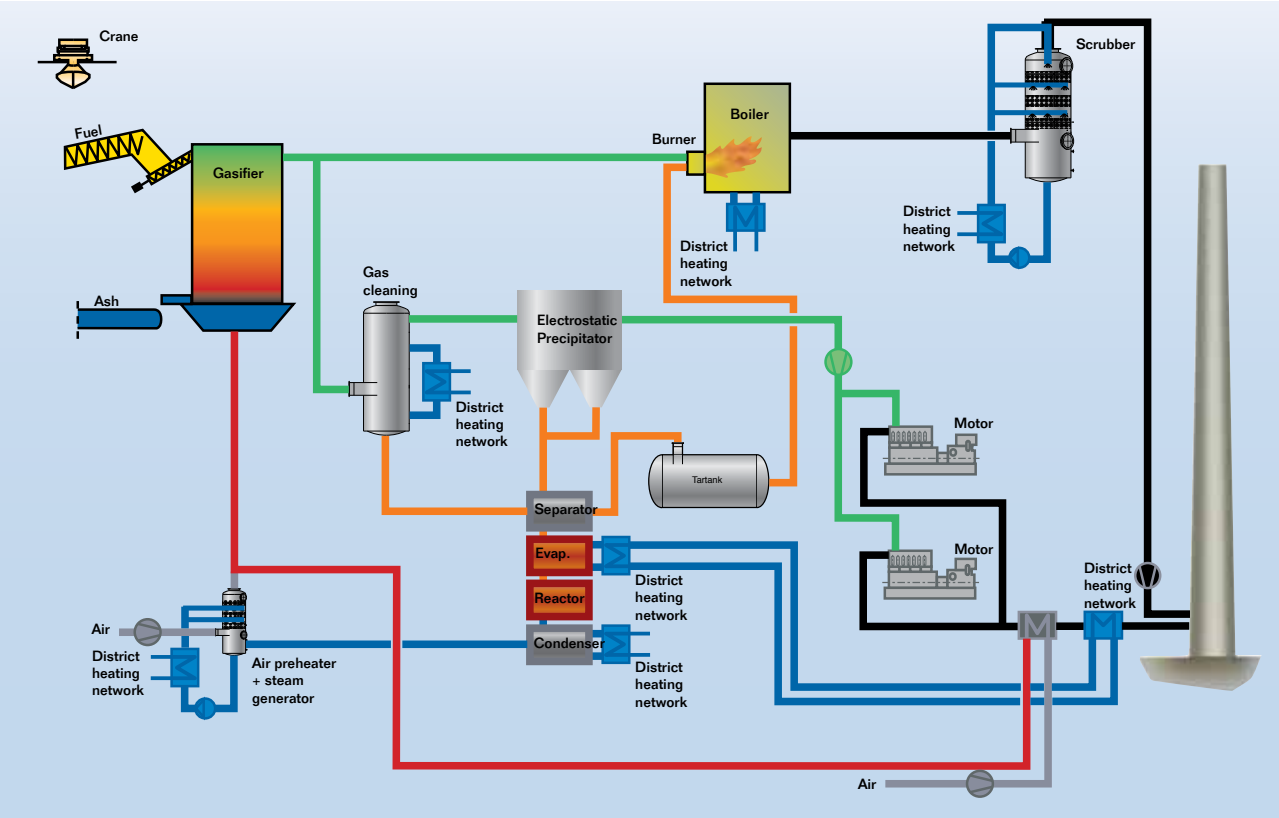
Today the gasifier is in fully automatic, unattended operation and produces more than 95% of the district heating requirement of the town of Harboøre.

## State of the art of upstream gasification

Gasification technology for generation of heat, as it is applied at the district heating plant Harboøre, can today be considered as commercial, as so much knowledge and operational experience have been gathered that it is possible to keep a gasification plant in continuous operation without supervision. The gasifier reactor has now been in operation for more than 100,000 hours.

In 2008 BWV were awarded the order for a combined heat and power plant for the generation of 4 MWe. The plant will be built in southern Italy The plant is based on gas motors followed by a steam cycle with a gas turbine.

The plant will have an electric efficiency of 40%.




*Flow diagram, District Heating Plant Harboøre*

*Bottom of the gasifier at the Yamagata plant, Japan*

## Technical data

In addition to the generated electricity and heat there is a fraction of tar, corresponding to approx. 13% of the generated energy, which can be utilized for the generation of heat during peak load periods.

| Plant data | | |
|---|---|---|
| **Technical parameters** | **Values** | **Units** |
| Fuel energy input | 3500 | kW |
| Fuel | 25 | Wood chips |
| Electrical output | 1000 | kW |
| Thermal output | 1900 | kW |
| Electrical efficiency | 28 | % |
| Thermal efficiency | 53 | % |
| Total efficiency | 94 | % |

**Babcock & Wilcox Vølund A/S**
Falkevej 2 • DK-6705 Esbjerg Ø • Denmark • Tel: +45 76 14 34 00 • Fax: +45 76 14 36 00
We have branch offices in Aarhus and Glostrup/Copenhagen, Denmark.