What do we mean by Gasification?

Wood biomass can either be used directly as a fuel to heat a conventional type of boiler and produce steam for power production or a completely separate process can be supported where the wood is used to produce a gas. Gasifier technology has undergone many improvements in the last 50 years because of increased fuel prices and environmental concerns. Gasification has become more modern and is now a quite sophisticated technology. The advantage of this technology is the operation of a decentralized energy conversion system which can prove to be economic on a small scale.

The main component of this conversion process is the "Gasifier", in essence a simple device consisting of a cylindrical container, which is made out of stainless steel. The simplest process – downdraft gasification, can be used to produce electricity on a small scale. In such a process, the gasifier is called a "Downdraft Gasifier" and the process that occurs inside the gasifier is explained below. The process of gasification can be considered as a thermo chemical process, which converts biomass materials into gaseous components, which is referred to as "Producer Gas", containing carbon monoxide, hydrogen, methane and some other inert gases. A simple system mixes the producer gas with air and the resulting mix can be used to run a diesel engine with only relatively minor modifications. The diesel engine can be coupled with a generator in the normal way to produce electricity as the final out put.

Downdraft Gasifier

Downdraft gasification generally produces a low particulate and low tar gas so it is suited for power generation in small scale applications.
The gasifier must have a chemical reactor where the above process is taken place. The fuel wood gets dried, heated, pyrolysed, partially oxidized and reduced inside this reactor. The four basic processes of gasification are noted below.

1. Drying of the fuel
2. Pyrolysis
3. Oxidation (Combustion)
4. Reduction

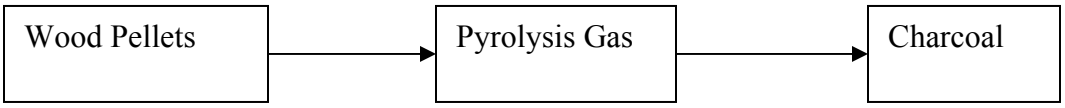
- **Drying of Fuel**

The fuel wood pellets are heated and dried at the top of the gasifier unit. Moisture contained in the wood pellets is removed in this region to a level below 20%.

- **Pyrolysis**

The dried wood pellets enter the second zone called the "Pyrolysis" zone. The gaseous products from devolatilization are partially burnt with the existing air. This process is termed "*Pyrolysis"*.

Both Pyrolysis and gasification turn waste into an energy rich fuel by heating the waste under controlled conditions. In contrast to incineration, which fully converts the input waste into energy and ash, these processes deliberately limit the conversion so that combustion does not take place directly. Instead, the waste is converted into valuable intermediates that can be further processed for materials recycling or energy recovery i.e. its convert to Pyrolysis gas and charcoal.



Pyrolysis Process

- **Combustion**

In the combustion zone the outputs from the above zone, react with the remaining char in the absence of oxygen at a temperature of around 800-900 °C.

Basic Reactions

$C + O_2 \longrightarrow CO_2$

$4\,H + O2 \longrightarrow 2\,H_2O$

$C_nH_m + (n/2+m/4)\,O_2 \longrightarrow n\,CO_2 + m/4\;H_2O$

- **Reduction**

In this region the hot gases formed in the above process is converted in to "*Producer Gas"* by the following two endothermic reactions.

Boudouard reaction:

$C + CO_2 \longrightarrow 2CO$ HR = + 160.9 kJ/mol

Water gas reaction:

$C + H_2O \longrightarrow H_2 + CO$ HR = + 118.4 kJ/mol

As these reactions proceed the temperature sinks progressively until it becomes so low (700 °C) that the reaction rates are insignificant. This means that the extent of the char reduction zone is dependent on the amount of energy entering the reduction zone and consequently also on the heat losses from the reactor. Although there is a considerable overlap, each process can be considered to be occupying a separate zone, in which fundamentally different chemical and thermal reactions take place. The fuel must pass through all of these zones to be completely converted.

Composition of Producer Gas

	Constituent of wood gas at 650^{o}C					
Composition	**H_2**	**CO**	**CH_4**	**CO_2**	**N_2**	**H_20**
(% by weight**)**	18.0	18.0	1.8	10.8	41.4	10.0

Composition of producer gas of fuelwood with 10% moisture level Source: VIT Research Notes 1648-Feasibility of Electricity Production from Biomass by Gasification Systems

Overall efficiency of plant

Unit	**Efficiency (%)**
Gasifier unit	75
Engine	33
Generator	92
Overall	**22.5%**

Overall efficiency (Source: VIT Research Notes 1648-Feasibility of Electricity

Production from Biomass by Gasification Systems)

Basically this efficiency will vary around 16% to 24% in present systems. This will be the overall efficiency in production of electricity, but using flue gas to dry the fuel wood we can increase the usage of energy in fuel wood.