International Conference on Bioenergy Utilization and Environment Protection
6th LAMNET Workshop – Dalian, China 2003

Introduction of Small-scale Biomass Gasification – Electricity Generation Systems

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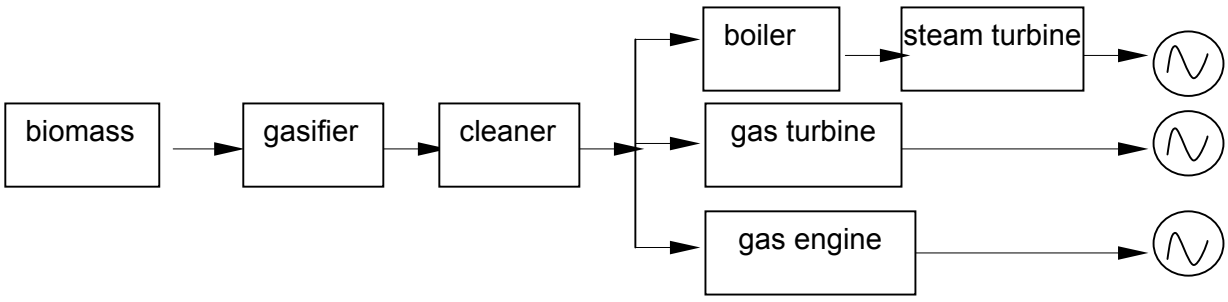
1. General

The 'Biomass Gasification – Electricity Generation' system is a technology which converts any kind of biomass energy with low heat value (such as waste from agriculture and forest and organic waste) into combustible gas and then feeds this gas to a generator for electricity generation.

Discovering the method of biomass gasification for electricity generation, can solve both problems of effective use of renewable energy and environmental pollution from organic waste. For this reason, the technology of biomass gasification for electricity generation attracts more and more research as well as applications. Thereby, this technology is being continuously optimised.

The model of biomass gasification for electricity generation can be realised as follows :



As shown, biomass gasification for electricity generation can be realized in 3 ways:

- Fuel gas produced in a biomass gasifier enters directly into a boiler to produce steam, which then drives a steam turbine to generate electricity
- the clean gas drives a gas turbine to generate electricity
- the clean gas drives a gas engine to generate electricity

Above pathways correspond to large-scale, medium-scale and small-scale electricity generation, respectively .

Today, commercially successful technologies for biomass gasification for electricity generation using gas engines get wide application because of their small system capacity, nimble arrangement, low investment, compact structure, reliable technique, low running cost, simple operation and maintenance and their low demand for gas quality.

2. Main Composition of Biomass Gasification – Electricity Generation Systems equipped with a Gas Engine

The system is mainly composed of gasifier, gas cleaner and gas engine:

biomass → gasifier → gas cleaner → gas engine

A Gasifier is a system which converts solid biomass energy into combustible gas. Biomass is combusted im-perfectly by way of controlling the flow of air into the gasifier to convert solid state into gas state, generating a combustible gas which mainly consists of H_2 , CO , CH_4 and C_nH_m.

The gas temperature in the outlet of the gasifier is in the range 350°C ~ 650°C, depending on the type of gasifier. The gas contains impurities such as dust and uncracked tar. In order to meet the demand of reliable gas engine operation over a long period of time, it is necessary to clean the gas at temperatures below 40°C as well as to reduce the content of dust plus tar below 50 mg/Nm^3. After cleaning, the gas is fed into the gas engine to generate electricity.

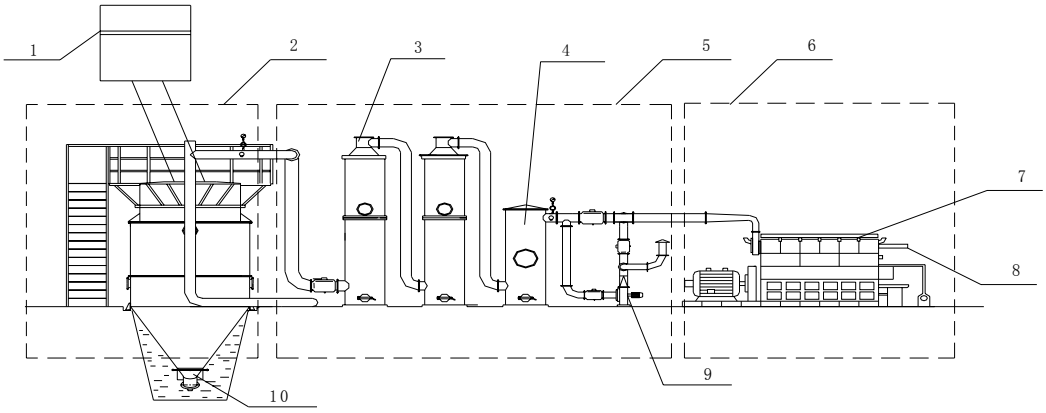
In the gas engine, the gas is mixed with air, burns and drives the main shaft to rotate at a high speed. The latter then drives the generator to generate electricity.

Through above procedure, any waste can be converted into electrical energy, thereby solving pollution problems from wastes.

3. Biomass Gasification – Electricity Generation Systems equipped with a Gas Engine

Specifications of the set contain power outputs of 60 kW, 160 kW, 200 kW, 400 kW, 600 kW, 800 kW and 1000 kW with the largest power output of about 1.4 MW.

For power outputs below 200 kW, down-draft fixed bed gasifier are commonly used. A typical down-draft fixed bed gasification set for the generation of electricity is shown in the following figure:



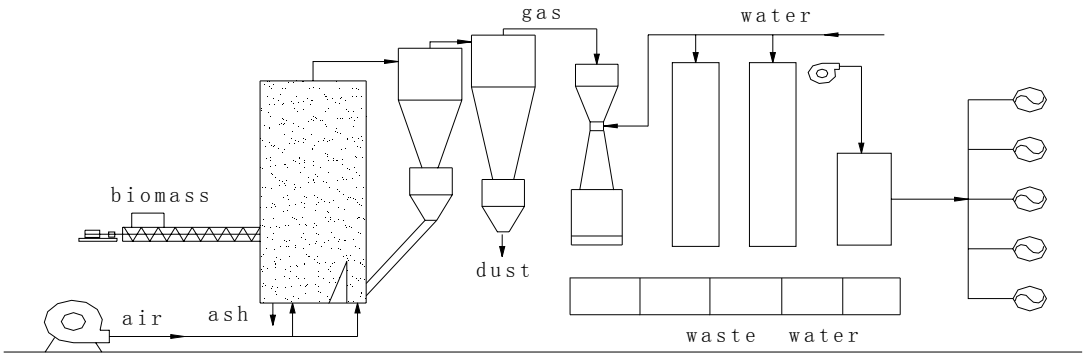
(1 — silo of raw material in high position, 2 —gasifier section, 3 — washing tower, 4 — gas storage tank, 5 — gas cleaning system, 6 — gas engine generator, 7 — gas engine, 8 — exhaust pipe, 9 — blower, 10 — ash remover)

This down-draft fixed bed gasifier (‘kai-xin type’), can feed in raw material continually. The inlet of raw material is located at the top of the gasifier, raw material falls into the gasifier from the silo or it is transferred to the gasifier by a screw conveyer. In the lower part, the gasifer is equipped with a rotatory grid driven by a gearcase. The grid rotates continuously to extract ashes, the latter then being removed from the gasifier.

Fixed Bed Gasification - Electricity Generation Set Equipped with a Gas Engine

For cooling and cleaning of the gas use, a multistep water-washing is used. It is a reliable and cheap system meeting the demand of the engine. The gas engine is designed on the basis of the ‘6250 diesel engine’ so that it meets the low pressure ratio required by the produced bio-gas. In addition, a mixer structure outside of the machine and a simple reliable electric ignition system is used.

In case of electricity generation with larger capacity, fluidized bed gasifiers are used. As the greatest power output of a single gas engine is up to 200 kW, a fluidized bed gasifier is used to drive several gas engines at the same time. A diagram of a fluidized bed gasification - electricity generation system is shown below .



The gasifier uses a cyclical fluidized bed and it has high gasification efficiency and a powerful output. Raw material is formed grain or broken biomass and impurities such as ash or particles are removed from above by a cyclone. The temperature at the outlet of the gasifier is about 600°C ~ 650°C. Removal of dust from the gas and gas cooling is realised by means of multistep water-washing. Several gas engines with an output of 200 kW generate electricity in parallel.

(a)

(b)

(c)

Fluidized Bed Gasification – Electricity Generation Set Equipped with a Gas Engine

(a)power plant, (b)gasification and cleaning system, (c)outline

4. Main Technical and Economic Data

The following table presents main technical and economic data of a 200 kW fixed bed down-draft biomass gasification – electricity generation system equipped with a gas engine.

variety of raw material	all kinds of waste from agriculture and forest	heat value of raw material	14000 kJ/kg
type of gasifier	down-draft fixed bed	power output	200 kW
heat value of gas	≈ 4800 kJ/m^3	expenditure of gas	≈780 m^3/h
raw material input	≈ 360 kg/h	total efficiency of electricity generation	15%
System investment	3000 yuan/kWh	cost of electricity generation	0.25 yuan/kWh

The following table presents main technical and economic data of 1000 kW fluidized bed biomass gasification – electricity generation system equipped with a gas engine.

variety of raw material	all kinds of waste from agriculture and forest (grain or broken material)	heat value of raw material	14000 kJ/kg
type of gasifier	cyclical fluidized bed	power output	1000 kW
heat value of gas	≈ 4800 kJ/m^3	expenditure of gas	≈3700 m^3/h
raw material input	≈ 1700 kg/h	total efficiency of electricity generation	16%
System investment	2800yuan/kWh	cost of electricity generation	0.24 yuan/kWh

5. Introduction to Hefei Tianyan Green Energy Development CO.Ltd

Hefei Tianyan Green Energy Development CO.Ltd is an enterprise engaged in the development of green energy and the manufacturing of products in the field of new technologies. It is also the research base of the Department of Heat Science and Energy Resource Engineering of the University of Science and Technology of China. The 'Anhui Province Biomass Energy Research Center' is located here. Today, the total number of staff is 110 including 40 engineers. The company occupies area of 2100 m^2 and it has first acquired the certification of the ISO 9001 Quality System.

The company insists on cooperation with universities and experts at home and abroad and it has acquired many development and research results in the area of biomass gasification. It owns 2 inventive patents and 9 news practical patents, and the company has achieved awards such as 'National Emphasizing New Product in 2002 Year', 'High-New Technical Product in Anhui Province' and 'High-New technical Enterprise of Anhui Province'. The technology of biomass gasification has acquired wide application in China, generated huge benefits for society and environment and wins appreciations from society. In bidding procedures issued by the Department of Agriculture of China and local governments, biomass gasification supply system of the company's TY series won many times. The company also won the first bidding on straw gasification supply and electricity generation in China, which was aided financially by UNDP. Now, biomass gasification - electricity generation electricity systems also have been sold abroad.

At present, biomass gasification sets equipped with gas engines, made by the company, uses down-draft fixed bed gasifiers (when the power output is 200 kW), or fluidized bed gasifiers (when the power output is above 400 kW). The fluidized bed gasification set is a technology developed in co-operation with Nanjing Institute of Chemical Industry of Forest Product. Experts and professors of the University of Science and Technology of China also take part in this work. The set absorbed advanced techniques and experiences on fluidized bed in China and abroad and it is constantly being optimised.

The motto of the company is to 'use advanced techniques to insure superior quality of products'. Not only can we offer mature products to customers, but also design specific systems according to the demand of customers. The company will wholeheartedly offer superior service to customers and concentrate on both, improvement of human life and environment as well as continuous development of society.