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CONFERENCE PROCEEDINGS

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SESSION 2: BIOMASS TECHNOLOGY AND MARKET

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A New Type of Straw Gasification-Heating Set

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1. Disadvantage of traditional biomass gasification-heating sets

As a method to utilize all kinds of biomass energy on a large scale, biomass gasification technology is today experiencing worldwide research activities and current applications include heating, electricity generation, centres for the supply of cooking gas as well as synthesizing chemical products.

'Biomass gasification-heating' denotes that biomass is converted into combustible gas through a gasifier and the produced gas is burned in order to provide heat energy.

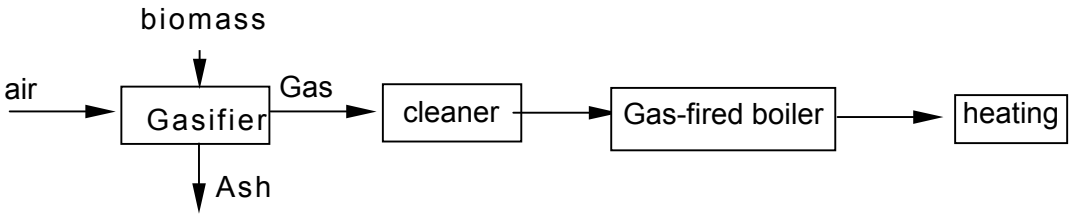

Figure 1: Technological process of biomass gasification-heating system

A number of studies on biomass gasification-heating have been performed during the past years in China. New practical biomass gasification-heating sets were developed for district heating or industry boilers and brought certain economical and social benefits. Figure 2 is a schematic diagram of a wood drying system by means of waste chip gasification. Figure 3 is a schematic diagram of a grain drying system by means of corncob gasification.

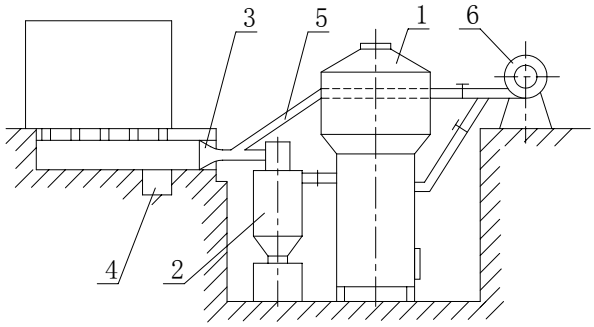

Figure2 Schematic diagram of wood drying system by means of biomass gasification
1.gasifier 2.cleaner 3.burner 4.dust drop chamber 5.duct of supplemental air 6.blower

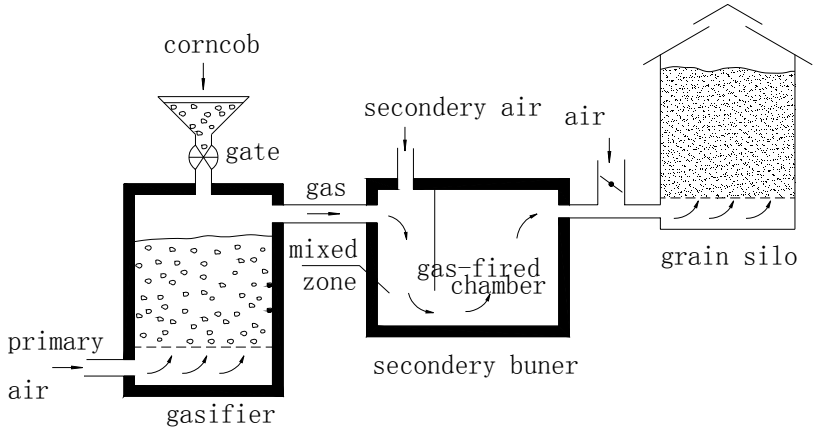

Figure3 Schematic diagram of grain drying system by means of biomass gasification

As shown in figure 2 and figure 3, every existent set of biomass gasification-heating is operated under positive pressure conditions. The raw material should have large stack density and low ash content such as wood, corncob etc. But these technologies are not suitable for straw gasification-heating systems, in which case benefits could be taken from the large yield and wide distribution of straw in China. The reason is that the gasifiers are always operated always under positive pressure and the raw material feeding is discontinuous, when straw is used as raw material. Thereby, the gasifier's status will rapidly undulate, leading to great operational difficulties and even failure of the gasifier.

The new straw gasification-heating set is realised as down-draft fixed bed gasifier with a rectangular gasifier cross-section. Under continuous feeding of the raw material and continuous removal of ashes, the system is operated under negative pressure conditions. Not only can this technology be applied for wood and corncob, but also for various straws. In addition, it also has such advantages as simple structure, easy operation, high heat efficiency and unpolluted exhaust.

2. Principle and work process of new type straw gasification-heating set

The new straw gasification-heating set mainly consists of a gasifier and a gas-fired boiler.

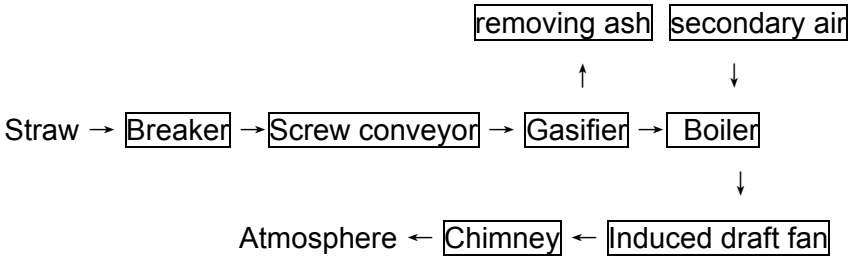

Figure 4 Principle diagram of new straw gasified-heating set

The broken straw is fed from top into the gasifier by a screw conveyer In the gasifier the oxidation and reduction reactions take place producing gas at high temperature. A screw remover is used to get rid of the ashes from gasifier during operation. The gasifier is isolated from the outside by a rotating valve, therefore the equipment can operate continuously for a long time, both for raw material with high ash content (such as rice husk and peanut shells) and for raw material with lower ash content such as wood and corncob.

The temperature of the gas is about 400°C and the gas contains impurities such as dust and tar. After dust removal, the gas is transferred to the combustion device, a boiler, in which the gas is mixed with secondary air and burns perfectly in a special designed burner.

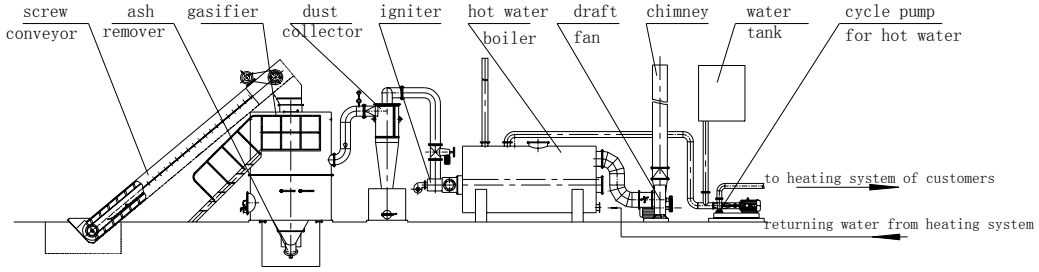

Figure 6 Technological process of heating system of hot water through straw gasification

As the gas is not cooled, the heat of the gas and the heat content of the tar leads to a higher heat efficiency of the system. The tar is cracked and combusted completely continuously by burning at a high temperature, so that the environment is not polluted by tar.

The flue gas generated in the combustion process at high temperatures is transferred to a heat exchanger inside the boiler, or is mixed directly with cool air for drying purposes. Then the flue gas is vented to the atmosphere via a chimney by induced draft ventilation.

3. Main characteristics

3.1 Working under negative pressure

The reason for operation under negative pressure is primarily to realise flexibility to various biomass sources, especially to all sorts of straw. Since the gasifier is designed as down-draft fixed bed which is working under negative pressure, the gasifier can be fed, observed and operated conveniently.

3.2 Rectangular cross-section of the gasifier

When used for biomass gasification-heating, a larger production capacity for the gasifier is required in order to meet the demand of technological heating. In traditional round-section-gasifiers, the air required for the gasification process will have difficulties to enter the centre of the gasifier, when its gas yield exceeds 600 m^3/h. This leads to an uneven flow and an uneven gasification process, reducing the efficiency of gasification and even causing failures of the system. The new design uses a rectangular cross-section of the gasifier, with holes for the circulation of air for the gasification process on the narrow sides of the gasifier. By restricting the width of the gasifier, air can enter into the centre of the gasifier, ensuring a stable biomass gasification.

3.3 Reliable gas burning equipment

The burner is another key part of the new system. The combustible gas and flue gas is introduced by a draft fan located behind the boiler. Therefore, the combustion of gas and the secondary air occurs under negative pressure. The burner is required to run steadily in a certain load range and at a variety of operation conditions affected by the heat value and the yield of the gas. After many test, we have designed a burning device (shown as figure 5) which has good burning characteristics and load adaptability.

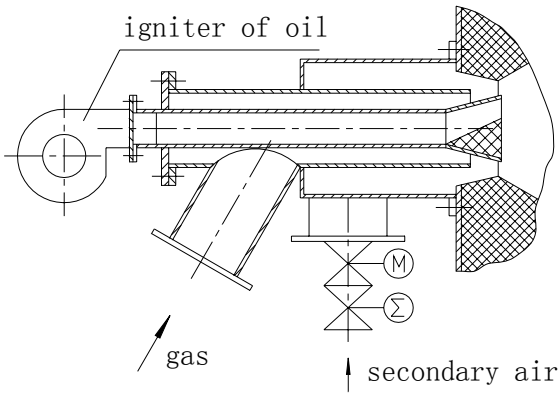

Figure5 Schematic diagram pof gas burner

3.4 Simple start process

This set is easy to start. If it has not been running for a longer time (cold condition), it can begin from a simple ignition of the gasifier and it will reach normal operation state in less than 15 minutes. If the set had run the day before (hot condition), it can directly enter into the starting program and reach normal operating conditions in 5 minutes.

3.5 Reliable method of automatic control

The set adopts a reliable method of automatic control, so that its adjustment of operational conditions is easy and simple. Automatic control includes:

- Definition of the thickness of ashes according to the flow resistance of the gasifier
- Adjustment of the rotary speed of the grid
- Control of the opening angle of the adjustable door of the draft fan (adjustment of the set load) according to the temperature signal of the heated medium (or steam pressure)
- Adjustment of secondary air according to the dynamic signal of flue gas composition detectors and gas burning temperature
- Ensuring optimal state of gas combustion and higher system heat efficiency
- Flameout alarm and pressure evacuation.

4. Testing result and practical operation

4.1 Testing result

Early in 2002, a gasification-heating set with 1.4 MW output was tested, with respect to thermal engineering and environmental protection. The result are as follows:

items	Heat output	Heat efficiency	Expenditure of rice hull	Expenditure of electricity	Dust contain of tail gas	Exhaust of SO2	Exhaust of NO2
results	1.4MW	75.5%	490kg/h	7.7kw/h	52mg/Nm3	36mg/Nm3	294mg/Nm3

As indicated in the table, the exhaust dust fully complies with the standard I category of China and the exhaust SO_2 is far lower than the standard I category.

4.2 Practical operation

In 2002, a 1.4MW straw gasification-heating set started practical operation. It was built in a modern agriculture demonstration development zone, using multiform raw material including rice husk, peanut shell, peel of sunflower, corncob, straw of corn etc. The total running time was 6 months. Compared with coal-firing, the running cost only corresponds to 55% of that for coal-fired boilers. Moreover, it did not lead to any environmental pollution or damage.

Photo of 1.4MW straw gasification-heating set

5. Conclusion

This technique provides a new way for the utilization of biomass by gasification. It belongs to pioneer technologies developed in China and it has obvious benefits with respect to environment, economy and substitution for energy. New straw gasification-heating sets with downdraft fixed bed operate under negative pressure and are adaptable to many kinds of raw material. It provides an effective, economic and environmentally-friendly method to utilize straw as energy source on a large scale. Particularly in northern areas of China it has obvious practical significance to use straw in great quantities and to reduce cost of heating in winter. This technology converts waste straw into useful commercial energy and increases the income of farmers. It plays an important role in raising the level of living in the countryside, improving the living environment and accelerating the development of small towns. Thus, this new technology is in accordance with the demands of country development in China.

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