

The Gasification Technology of Straw and Its Problems & Countermeasures

Zenggang Zhang^{1,2}, Jizhi Li¹, Yongan Li²

¹School of Mechanical and Electrical Engineering, China University of Petroleum, Dongying, P.R China

²School of Engineering Thermal Energy Engineering, Shandong University of Architecture and Engineering, Jinan, P.R China

Abstract: With the fast development of the gasification technology of the straw and general application, this paper systematically introduces the gasification mechanism of straw gasification technology, the procedure of the gas supply system and equipments in common use. According to the problems of present straw gasification project, such as small scale, scattered distribution, and secondary pollution, this paper analyzes them and the corresponding countermeasures have been proposed. Therefore, it would be worth with research on the gasification technology of the straw in the practical engineering of the renewable resource.

Keywords: gasification of the straw, gasification mechanism, systematic procedure, problems and countermeasure

1. INTRODUCTION

As our country is a large agricultural country, the crops straw produced every year is about 700 million tons, and the majority of it is wasted by the way of burning directly. This has already wasted resources, and polluted the environment again. To prohibit burning straw and comprehensive utilization is already a social and environmental problem that needs urgently solving in the near future, and it is also an important content of our country rural sustainable development. This resource of rational effective use, have certain social benefit and economic benefits. The gasification technology that makes the straw finish the transformation from solid state to gas using the crops straw as main raw materials, called the gasification of the straw. As straw is renewable, the energy that resource produce, called renewable energy. As the straw gasification gas burns stably, and has thermal efficiency, it is extensively suitable for cooking, warming, boiler, generating electricity, etc. But because the gasification project of the straw is in small scale, distribution is comparatively scattered, also is restricted by the investment and operating cost, so the large-scale gasification factory can not be totally adopted, neither the maturity technology of gasification and purifies, which makes straw gas very difficult to reach the quality requirement of the domestic gas.

2. THE GASIFICATION MECHANISM OF STRAW

Gasification is the heat chemical process which transforms solid or liquid fuel into gaseous fuel. When materials like straws are burning, a definite quantity of oxygen is needed. When the quantity of oxygen provided is equal to or greater than the definite value,

straws can burn adequately, so the final relicts are ashes. If little oxygen is provided, straws can't be burnt out. The less quantity of oxygen is provided, the more flammable components are not burnt out. These flammable components include charcoal, carbon monoxide, hydrogen, firedamp and so on.

The gasification course of straws shows in Fig. 1.

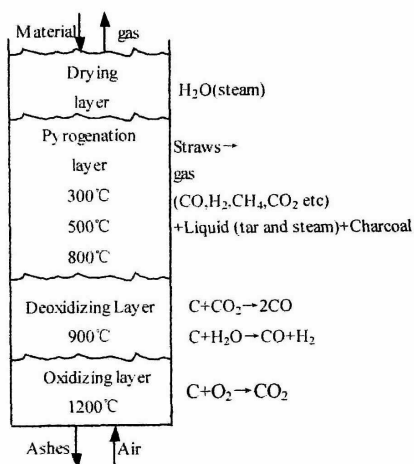
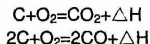


Figure 1: The gasification process principle of straws

2.1 Oxidation Reaction of Straws

The gasification pharmaceutical (air) is entered through the bottom of the gasification stove, and is heated while passing the grey dreg layer. The gas after heating enters the oxidizing area of the gasification stove bottom, burns with the blazing

charcoal, produces CO₂ and emits heat at the same time. Because of the limited oxygen combustion, the supply of O₂ is insufficient, imperfect combustion occurs, produces CO, and emits heat at the same time. In the oxidizing area, temperature can be up to 1000-1200 degrees Centigrade. The reaction formulas are:



Reactions in the oxidizing area are all combustion reaction, and emit heat, which offers the heat source for the deoxidizing reactions in the deoxidizing area, cracking and drying of materials. The hot gas CO and CO₂ produced in oxidizing area enters the deoxidizing area of the gasification stove, and the ashes enter the bottom ash room.

2.2 Deoxidization

There is no O₂ in the deoxidizing area. The CO₂ produced in the oxidation deoxidizes with charcoal and vapour, then becomes into CO and H₂. As the reaction is endothermic reaction, the temperature of the deoxidizing area decreases to 700-900 degrees Centigrade.

The staple in the deoxidizing area are CO, CO₂ and H₂, and these hot gases enter the top cracked district with some other hot gas produced in the oxidizing floor, while the charcoal not finishing reacting falls into the oxidizing area.

2.3 Decomposition

The hot gas produced both in oxidizing area and deoxidizing area, pass through the splitting decomposition layer in the upward course, heat the straw at the same time, and splitting decomposition occurs after the straw is heated. In the course of reaction, most volatile matter is separated out of solid in the straw. Because the splitting decomposition of the straw needs a large amount of heat, the cracked

district temperature drops to 400-600 degrees Centigrade.

The staple of the cracked district are charcoal, H₂, vapour, CO, CO₂, CH₄, tar and other hydrocarbon materials(C_mH_n), etc., and these hot gas continues rising, then enter into the dry district, while the charcoal enters the deoxidizing area below.

2.4 Dryness of Straw

The upper strata of gasification stove is dry district, and the supplies from above enter into this district directly. The wet supplies become hot at here with the hot gas produced from the under response of 3 pieces, which makes the moisture in raw materials evaporate, and the temperature of this layer 100-300 degrees Centigrade. The productions of the dry district are dry supplies and vapor. The vapor is drained out of the stove with the hot gas resulted from the under response of 3 pieces, while the supplies enter the cracked district.

Usually call the oxidizing area and reduction area altogether as the gasification area, and gasification mainly reacts here. The cracked district and dry district are referred to as the preparing for fuel area or the fuel pretreatment area, and reflect here that is carried on by a principle according to the dry distillation, hot carrier is hot gas from gasification area.

In the export of the gasification stove, the output gas composition are CO, CO₂, H₂, CH₄, tar and other small amount of hydrocarbon, vapor and ash. The gas after purifying be sent into the gas tank and store for residents use.

3. STRAW GASIFICATION GAS-SUPPLY SYSTEM TECHNICS

The technological process of straw gasification centralized gas-supply system is shown in Fig. 2.

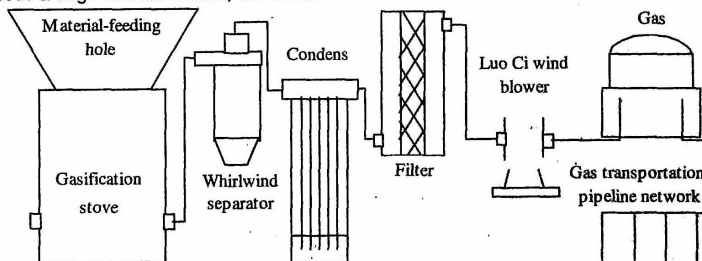


Figure 2: The technological process of straw gasification centralized air-supply system

The system mainly consists gasification stove, segregator, condenser, filter, air blower, gas tank, etc.

3.1 Gasification Stove

Gasification stove is the core equipment of the straw gasification centralized air-supply system. In the system, below-suck fixed bed gasification stove, made up of interior gallbladder, outer cavity and ash room, is mostly used. Its structure is as Fig.3 shows.

3.2 Whirlwind Separator

Whirlwind separator is the most widely applied and effective removing dust equipment. In the straw gasification centralized air-supply system, sheer-flow whirlwind separator is usually adopted. The straw gas needed purifying enters the cylinder of the separator along tangent direction through the linking pipe. Some particles of ash and charcoal granule suspending in the gas are thrown towards the inside wall of the separator by the centrifugal force. The particles become inactive in the effect of friction, then drop to the taper part of the separator' bottom as suffered gravitation, and finally discharged from the emission

hole in the separator' bottom at regular intervals. After purifying, the straw gas is discharged from the vent-pipe which is in the center line of the separator.

3.3 Spraying Tower

In the straw gasification centralized air-supply system, spraying tower can be used to cool and purify straw gas, and it can also remove dust and tar. Most spraying tower have a round section. The cooled gas is given from bottom, and spraying water from top, so the relative convection between water and gas. In the process of flowing from top to bottom, the gas consisting of impurity gets across lines of liquid spraying below, which can not only take the impurity, cool gas, but also remove dust, tar and finally cool the straw gas.

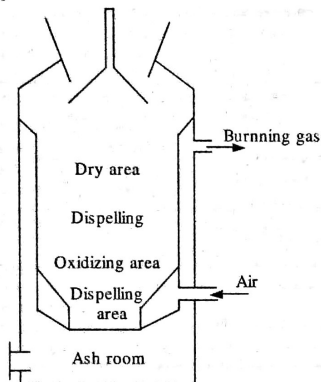


Figure 3: The structure of gasification stove

3.4 The Biomass Filter

The biomass filter, which is a more effective, more economical and more practical purification equipment in the straw gasification centralized gas-supply system, purifies the gas utilizing principles of filtering by particles layer. When the straw gas passes the filtering material, impurity, minute charcoal particle, water, tar, etc. in the gas are absorbed by the porous body surface of the filtering material. In the straw gasification centralized gas-supply system, saw-dust, corncob of different grain size as the filtering material are generally adopt, called the biomass filter. When saw-dust or the corncob absorb things and reach the saturated condition, they should be replaced with new saw-dust, corncob, and old conduct as gasification raw materials put into the gasification stove. It can reduce the secondary pollution.

3.5 Luo Ci Gas Blower

Luo Ci gas blower is the equipment most frequently used in the project of gas engineering. There is a couple of "8" shape rotor in the shell, one of which circumgyrating clockwise and another doing counterclockwisly while operating. This kind of rotation makes the volume of space between the rotor and cliff side change periodicity, thus compress the gas in the space and increase gas pressure.

3.6 Gas Tank

The gas tank is the key equipment of the system that sends and outfits the gas, and its function is: (1) It stores some gas when it is not the peak of using the gas, while release the gas in order to supplement the partial capacity of the gasification machinery crew can't supply with in time when it is the peak of using the gas. It is also used to compensate the change of the load of using the gas and guarantee the steady operation of the gas supplies system. (2) It can supply a steady pressure to gas pipe network, and ensure the inlet pressure in the scope of the allowable pressure of all the equipment using the gas in the pipe network.

The gas tank in common use has two types: low pressure waterhry type and low pressure dry type.

3.7 Gas Transportation Pipeline Network

The gas transportation pipeline network is divided into two parts: outward and indoor. The function of the outward network sending gas is to let the gas from gasification place to the outdoors of the users. The function of the indoor gas pipeline is to receive the gas from the outward net and sends it to the stove for burning equipment use.

4. PROBLEMS AND COUNTERMEASURES FOR STRAW GASIFICATION GAS-SUPPLY SYSTEM

4.1 Low Calorific Value and Bad Quality of Gas

As the gasification stove structure is below-suck type, air is used as gasify pharmaceutical, there are much ash in straw raw materials, the calorific value of gasification output gas of the straw is generally on the low side, generally only about 5000kJ/Nm³. So every part in the system needs to have a increase of the capacity and investment of the equipment. At the same time, because the selected type of the equipment is relatively simple, the impurity is not purified completely, so the gas which contains a large number of tar, dust and water enters pipe network and user, often cause the stopping up of pipe network, valve and gas apparatus.

Adopting double fire layer stove fuel gasification technology can make the content of carbon of dregs drop to 15% from 30%, the energy conversion ratio improves by 20%. The amount of tar, H₂S, suspended substance and volatility phenol in the gas can reduce. The amount of tar can reach 30 ± 10mg/m³, and calorific value can reach 9000kJ/Nm³. If can choose the daily spray of cleaning system of coal gasification to wash the tower, electricity and attack such equipment as the tar device, etc. in the cleaning system, can is it purify gas index after reach country makings in domestic gas require to make.

4.2 Severe Secondary Pollution

In the gasification and purifying of the straw, such harmful substances as tar, charcoal dust, etc. emerged and followed by a large number of sewages, which contain such harmful substances as the ash content, tar, H₂S, fragrant clan rings of phenol benzene, etc. If the pollutant excludes outdoors unprocessedly, it will cause the secondary pollution of the farmland or the river. This is another technological

difficult problem in the gasification of the straw. How to handle the pollutant well, and avoiding secondary pollution of the environment, is an important index to examine whether the operation technique is ripe and suitable. Have only understood these discharge composition of the harmful substance and corresponding content, and choose or redesign the purification device of the gas pointedly, and set up the storing facilities for sewage and dust, concentrate on dealing with the material emerging in each link that is produced and purified, can solve problem of secondary pollution, and can get product such as tar, which will give certain economic benefits.

4.3 Small Construction Scale, Great Unit Investment

As the straw gasification centralized gas-supply system mainly faces countryside and small town that has abundant resources, the station assigns scattered.

The buildings of users are mostly one-storey house, and the density of population is small, from hundreds to thousands. The construction scale of gasification is relatively small, as form 1 shows with the investment of the concentration air supply system of 100 and 200 households of scale.

Form Table 1 shows that a systematic user capital cost more than city gas and natural gas. Investment shows that it can be accepted only by rich peasant. Choosing towns and countryside that population relatively centralized, economic strength strong, and building large scale gasification supply system, can reduce unit investment amount. Following the growth of the rural economic strength and improvement of the living standard at the same time, the obstacle of the investment of technology popularization will be cut down thereupon too.

Table1: The investment of the concentration air supply system

Gas users (house)	Gasification station area (m ²)	Cupboard value (ten thousand yuan)	Unit value (ten thousand yuan)	Gasification station outfit value (ten thousand yuan)	Pipeline network building value (ten thousand yuan)	Overall investment value (ten thousand yuan)	Unit investment value (yuan/ house)
100	1200	16	9	1.4	7.3	33.7	3370
200	1200	24	13	2.0	14.6	53.6	2680

4.4 Difficult Operation and Maintenance, Plenty of Hidden Trouble

The fast popularization of the straws gasification air supply technology improves the peasants' living standard. Because of lack of the relevant country's norm, standard and rules directed against this kind of technology, make the engineering construction and operation management consult the relevant regulations of urban gas, leave a lot of hidden dangers and questions.

As the administrative staff and attendant of this kind of technology usually have relatively low quality in the countryside, it is very difficult for them to master the basic principle of the technology used, and they are unable to deal with the equipment fault. So it will cause the system not to run smoothly, if the trouble is frequent, the maintenance cost can not increase, invest the anticipated purpose, even the equipment is damaged, the whole system is unable to run. At the same time, the manager and the user generally lack the knowledge of gas defence, fire prevention, disaster relief and explosion-proof, so such accidents as poisoning, fire and explosion will occur in the course of operating and using.

As the straw is flammable, explosive and poisonous, and raw materials are also flammable, so the administrative staff should be strengthened trained. Engineering design and equipment installation must be in accordance with relevant State regulations. Operational procedure, rules and regulations in systematic production and operation, must be made to guarantee that there is no accident to happen.

5 CONCLUSION

The straw gasification and concentrated gas-supply is a system engineering, which includes gasification, purifying, storing, transporting and users. Only every part has modern techniques and rational economy, can the safe and steady production of the system be obtained, and can social and economical benefit be ensured.

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