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Experimental Study on the Transformation of Biomass and Coal Under Different Atmospheric Conditions

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The exploitation of fossil fuels and greenhouse gas emissions have brought great attention to the utilization of biomass fuel resources. The scholars researcher Were studied with thermo gravimetric mass spectrometry instrument in this paper, four kinds of biomass paralysis gas product characteristics, the small fixed bed is used for rice husk, straw paralysis experiment, the analysis of the microstructure of carob coal, element composition and phase composition of biomass and coal in fluidized bed gasification experiment. The different mixing ratio, air equivalence ratio, the influence law of water vapour in the fuel quality in the gasification process, the analysis of biomass and coal gasification mechanism are studied to explore the synergistic effect of the gasification process. The average gasification reaction rate of RH coal, DWG coal coke and YX coal coke is very different. The average gasification reaction rate of RH coal, DWG coal coke and Yx coal coke in the 0.1mpa paralysis was 1.04s^{-1}, 0.58s^{-1}, and 0.95 s^{-1}. The average gasification reaction rate of the RH was 1.8 times that of DWG coal coke gasification reaction rate. Therefore, we can conclude that RH coal gasification reactivity is the best, YX coal is the second, and DWG coal is the worst. In addition, we can also compare the influence of paralysis pressure on coal coke gasification reactivity. No matter RH, DWG coal or Yx coal, the paralysis pressure increases, the average gasification reaction rate decreases and the gasification reactivity deteriorates. Especially 0.1 MPa paralysis pressure average Yx char gasification reaction rate significantly greater than 0.5 MPa, and 3. The average MPa paralysis pressure Yx char gasification reaction rate is shown in figure 2. Gasification reaction rate and the total carbon conversion rate trend is consistent.

1. Introduction

Biomass energy has always been an important energy source for human beings to survive, accounting for part of the world's total energy consumption. It is predicted that by the end of the year, biomass energy consumption will replace global fuel consumption, which will generate the total amount of electricity in the world. Policies and regulations of many countries in Europe and America not only encourage the research and development of biomass energy, but also provide financial support to stimulate its development. In Austria, Denmark, Finland, France, Norway, Sweden and the United States, the proportion of biomass energy in total energy consumption is increasing rapidly. Austria successfully introduced the power station which burns wood waste to generate power. A Swedish project uses biomass cogeneration and biomass in the transformation for high grade of power to meet the needs of heat supply and improve the conversion efficiency (Song et al., 2014; Tursun et al., 2015; Li et al., 2015; Sonobe et al., 2008). The United States is leading the world in using biomass energy, which is widely applied in the country. Germany is conducting a biomass demonstration project to generate electricity from waste generated by farms and factories to provide electricity to households, a type of biomass project that can be used annually for waste tons. Denmark has introduced diversified policies to actively develop biomass resources, and the Danish company has pioneered the technology of direct combustion of straw (Yoon et al., 2012).
There is a wide variety of biomass resources. Biomass with similar properties can be classified into one class, and the transformation behaviour of biomass can be predicted by discriminating the species. Of the classification method is based on the basic components, including the biomass composition of cellulose,

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hemicelluloses, lignin content and conversion characteristics, which enables the classification method to successfully predict biomass paralysis behaviour (Chang et al., 2003; Zheng et al., 2010).
Wood and wood fuel hardwood and cork based on the classification of biomass sources and attributes; Herbs straw, grass and stem leaves; Organic waste sludge, solid waste, etc. Waste from other waste paper and food industry; Aquatic plant algae; Energy plants. In the standard of the European Union solid biomass fuel, biomass can be divided into wood chips, branches, logs and sawdust based on biomass.
The transformation methods of biomass mainly include thermalization method, biochemistry method and extraction method. Paralysis is the conversion of biomass into other forms of energy in high temperature, including paralysis, gasification and direct combustion. Biochemical method refers to the production of energy products such as biogas and alcohol under the fermentation of microorganisms. The extraction method is to use biomass to extract bio-oil. Paralysis, in which there is no oxidizing medium under the situation of participation, such as oxygen, air or water vapour, uses heat to make biomass through thermal decomposition of organic material, for example, the removal of volatile substances, under normal temperature for liquid or gaseous state, and in the process of forming solid carbocoal or coke. The operating parameters affecting the paralysis of biomass are terminal temperature, heating rate, pressure and retention time. The composition, structure and composition of biomass have influence on paralysis. Paralysis is an important stage of gasification and combustion, and can also be used to make gas and liquid fuel through biomass paralysis technology. Biomass gasification technology is carried out under the high-temperature thermal chemical reaction, in which biomass can be converted to gas fuel, which will be the carrier of chemical energy in the technology of on verting solid into gas. Biomass thermal conversion technology is one of the most practical technologies. In the process of gasification, the gasification medium usually adopts air, and the heat value of the gas is low, which is usually 4-6mj/m3. At present, the industrialized application is widely used for biomass gasification. Because of the different reactor design and the gasification medium provides a variety of different schemes for evaporator design. The most common form of commercial operation of biomass gasification are convection and downstream fixed bed, as well as bubbling and circulating fluidized bed. The commonly used oxygen reaction media are air and water vapour.

2. Experimental procedure

At home and abroad, many studies focus on biomass gasification. They mainly concentrated in the optimization of parameters of gasification, because when the type of gratifier was determined, gasification operation parameters such as the types of raw material, temperature, gasification agent and catalyst on the component content of gas, tar formation and its content have very important influence.
Temperature is the main parameter affecting the gasification performance. Temperature has an important influence on yield, gas component content and thermal value. The increase of temperature and increase of gas yield are due to the following reasons: during the initial lyses of biomass, the higher the temperature, the faster the cracking speed; Because the reaction of solid carbon and water vapour is endothermic reaction, the higher the temperature, the faster the reaction rate; The higher the temperature is, the higher the thermal cracking and the water vapour reforming of heavy hydrocarbon and tar. The effect of temperature on gas heat value is as follows: As the temperature increases, the volume fraction of H increases, and the content of CO and hydrocarbons decreases, lowering the gas calorific value.
The selection and distribution of gratifier is one of the important influencing factors in gasification process. The gasification agent directly affects the flow rate of the reactor and the stop time of the gas, thus affecting the gas quality and yield. The gratifier used in biomass gasification is air, water vapour, air vapour, carbon dioxide, hydrogen, etc. To air as gasification agent, air equivalent than ER is not independent It is interconnected with operating temperature, and its influence on the result of the experiment are two-sided. High ER corresponds to high gasification temperature. Under certain conditions, the gasification temperature increases the reaction rate, and improve gas quality.
In the raw material properties, biomass plant components (cellulose, hemicelluloses, and lignin), humidity, particle size, etc. have great influence on the gasification process. The content of biomass is different, and the content of gasification gas in similar conditions is different. In a self-heated fluidized bed gratifier, the increase of humidity in biomass will lower the temperature at the bottom of the bed, resulting in an increase in the tar content. In an externally heated gratifier, humidity has little effect on the temperature of the bed. When the temperature of bed varies from 600~ 8000C, the particle size of biomass has little influence on gas production. At low temperature, the gas production rate decreases with the increase of particle size. The reason is that the interior of the particle size affects biomass granule thermal group. The design of the carburettor factors is crucial for gasification, directly affecting the efficiency of gasification, gas calorific value, and parameters such as tar content. The design considerations mainly include secondary air setting, two-stage gasification technology and so on.

Due to low ash content and sulphur content, high volatile content and high fixed carbon responsiveness, biomass's synergistic effect with coal gasification can increase the value of products. Coal and biomass gasification not only can maintain the sustainable use of coal, but can reduce the emission of sulphur oxides and nitrogen oxides, which is very promising. Philomena uses dolomite, olivine and nickel and magnesium oxide, zinc oxide, drill base, key oxide as a catalyst, coal and waste material (pine sawdust, petroleum coke and PE C catalytic gasification of polyethylene powder. In gasification products, H: increased content, hydrocarbon and tar content decreased, NiO, MgO catalytic cracking works best. Rue conducted the experiment of gasification of coal and biogases in the fluidized bed gratifier. The results showed that when the gasification temperature rose to 8900C, H: the content increased by 45% and the content of gas hydrocarbon increased by 550%.

Using dolomite as catalyst, the content of tar decreased, and the content of H2 increased. The gasification temperature of Kazuhiro is 9000C in the lower suction fixed bed gratifier, and the biomass and coal gasification experiments are carried out. The conversion rate of tar and coke is reduced; H: the content decreases and CO: the content increases, the CO content is basically unchanged. In the process of gasification of lignocelluloses biomass and coal, the synergistic effect of h20-co: conversion reaction degree. In the fluidized bed, the gasification experiment of birch and UK Daw Marl coal and polish coal were carried out in the fluidized bed. In the gasification conditions (temperature is 700 ˚C and 9000 c, pressure is 0.4 MPa, fuel heat transfer is studied when possible synergies, formed in the process of gasification of coke, tar, N elements of the compound was analyzed. The results showed that the speed of gasification reaction increased, coke content decreased and gas production increased. Tar and NH: production is also lower than expectation due to synergy. Snowstorm, Los, USES thermo gravimetric analyzer were used to study the catalytic gasification of coal from biological potassium salts. The results show that when the temperature is 895 ˚C, coal and ashes are mixed in a proportion of 1:9.Under the condition of the ashes that are rich in potassium, catalytic effect is more obvious. The co-gasification characteristics of biomass and coal are studied in the fluidized bed experiment device. Compared the single product of coal gasification, and the mixture of rice straw and coal gasification, the results showed that the mixture in the gasification of carbon conversion, and the gas volume fraction of combustible components were higher than those of single coal gasification, the volume fraction of CO in the gas under the volume fraction of single coal gasification CO. In fluidized bed gasification reactor design and operation of research field, coal gasification reactor model study of biomass gasification reactor mature many,. Most of the biomass gasification fluidized bed reactor is the combination of biomass gasification reaction characteristics of coal gasification reactor model. The main factors influencing the reaction process are gasification agent flow rate, fluidization velocity, etc.

The bubbling fluidized bed reactor can be divided into three regions including the high direction, namely the combustion zone, the gasification zone and the upper free space region. The combustion reaction occurs in the dense phase, which ends in the lower concentration of oxygen concentration. In the upper part of the fluidized bed, the ability of the airflow to carry the material particles decreases. The gasification area is mainly between combustion zone and water vapour conversion zone. Denotes the temperature of the combustion zone, the mean of the temperature measured by the three thermocouple at the 200mm, 100mm, 150 mm, and 200mm. T: the temperature of the gasification zone, T: 300mm, 400mm, 500mn: the average temperature measured by the three thermocouples. T: the mean value of the temperature measured 1000mm and 1300mm. These temperatures vary due to the flow of air and water vapour, the mix of biomass and coal, and the amount of fuel.

3. Results and discussion

Biomass and coal cannot completely react in paralysis process, and coke gasification can improve their utilization efficiency. There are a lot of literatures about the carbon and coke gasification of the graduate students. Tang made researches on yucca coal tar and sundial char steam gasification experiment. He first proposed the active point/intermediate model, the results of which show that the active point/intermediate model is suitable for coal tar and catalytic gasification and catalytic gasification in all the carbon conversion rate within the scope of the dynamics of change. It also successfully predicted the intermediates in the process of carbon formation, growth, and the trend of decline. Hong investigated the paralysis pressure, atmosphere, and time on ZhunDong coal tar and yucca coal tar CO: the influence of gasification reaction. The results show that Hz improves ZhunDong atmosphere pressure paralysis char gasification reactivity. N2 atmosphere paralysis char gasification reactivity is slightly worse than H2 atmosphere paralysis char gasification reactivity, since it extends the paralysis time and decreases yucca char gasification reactivity. Guiana examined the gasification agent, for example, biomass char gasification reaction. The results show that the diffusion in H2 atmosphere and our fleet basic same, but the biomass carbon H20 gasification reactivity is 2 times of CO2 gasification reactivity. Bay et al., in the C02 mixing atmosphere, basified Yunnan coal coke, and the results showed that adding C to the H20 atmosphere can increase the reactivity of coal coke. Wang wait for coal tar in CO atmosphere non-isothermal mild gasification experiment, in which the experimental data is in accordance with that of the random pore model, and the apparent activation energy, is 212.6kJ/mol and 212.6kJ/mol respectively.

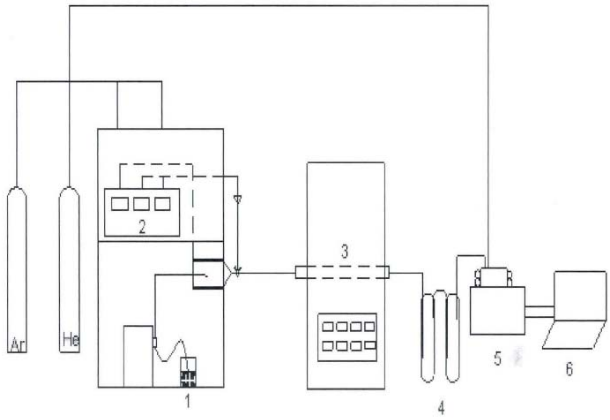

Figure 1: Schematic diagram of the horizontal tubular fixed-bed reactor

In this experiment, the coke gasification characteristics were studied in terms of the average gasification reaction rate, coke activity point, graphitization degree and mineral composition. This experiment mainly studies the synergistic effect of the biomass carbon and coal coke gasification characteristics W and the co-paralysis of coal gasification. This experiment device is horizontal type fixed bed reactor. The structure of the reaction device is shown in figure 1.

1, steam generator 2, mass flaw meters; 3，reactor; 4, water condenser; 5, gas chromatography; 6, computer

In order to compare biomass carbon and coal coke gasification reactivity, we put forward the concept of "average gasification reaction rate V" to characterize gasification reactivity. The definition of V is:

$$v = \frac{\Delta x}{\Delta t} = \frac{x_1 - x_0}{t_1 - t_0} \quad (1)$$

In formula 1, axe and of are the changes in the total carbon conversion rate x and the change in t, x0 and x1, respectively, are the total carbon conversion rates for time to and t1. Note: total carbon conversion rate; the ratio of total carbon in COQ r COC Ha to total carbon in coke.

In this experiment, the relationship between temperature T and time T is non-isothermal vaporization.

$$T_1 - T_0 = \beta \times (t_1 - t_0) \quad (2)$$

Type 2, time T0 and T1 respectively correspond to the temperature, the beta for the heating rate, and beta = 5 ˚C / min in this experiment.

The formula (2) can be taken into equation:

$$v = \frac{\Delta x}{\Delta t} = \frac{(x_1 - x_0) \times \beta}{t_1 - t_0} \quad (3)$$

From equation 3, it can be seen that the larger the U is in the same temperature change interval, the greater the change in total carbon conversion and the greater the gasification reaction.

Figure 2 shows the rate of RH coal, DWG coal coke and YX coal coke gasification reaction rate and total carbon conversion in different pyrolysis pressures, and the total carbon conversion rate is between 0.94-1.00. As you can see from figure 2, whichever pyrolysis pressure, RH carbon and YX char gasification reaction rate rise rapidly to 700 ℃, DWG and char gasification reaction rate slowly rise within the range of 700-750 ℃. RH carbon, DWG YX coal tar and char gasification reaction rate of maximum temperature, are 920 C, 1000 ℃ and 960 0 C C 0.1 MPa pyrolysis pressure YX char gasification reaction rate peaked at 910 ℃). From the point of the total carbon conversion, RH carbon and YX coal tar the total carbon conversion rate after the start of the 700 ℃ reaction rapidly rising, and reach maximum at 980 ℃ and 1000 ℃, respectively, and then stays the same. The increase of DWG coal tar in 700-750 ℃ within the scope of the total carbon conversion is small. It increases rapidly after 750 ℃. When the total carbon conversion rate reached the maximum value 1060 ℃, it remains the same. From this we can conclude that the difference between RH coal, YX coal coke and DWG coal coke gasification reactivity is very large.

Fig. 2 compares the effects of pyrolysis pressure on RH coal, YX coal coke and DWG coal coke gasification reaction. For RH carbon, during 700-900 ˚C, the smaller the pyrolysis pressure, the larger the RH char gasification reaction rate is; After 900 ˚C, due to the low pressure pyrolysis under RH carbon reaction conversion, the gasification rate is less than RH carbon under high-pressure pyrolysis gasification rate. The total carbon conversion of RH carbon can be seen from the chart, the higher the pyrolysis pressure is at the same temperature, the smaller the total carbon conversion rate of RH is, which shows that the pyrolysis pressure inhibits the H coal gasification reaction. As shown in figure 5.2, before 900 0C, 0.1mpa pyrolysis pressure of YX coking gasification reaction rate was significantly greater than that of the o.s. MPa and 3.OMPa pyrolysis pressure under pressure of YX coal coke gasification reaction rate. From the point of the total carbon conversion rate, the same temperature and pressure 0.1 MPa pyrolysis YX coal prices are always significantly higher than carbon conversion J - grown MPa and 3 OMPa YX coal pyrolysis pressure but the total carbon conversion rate, suggesting that increasing pyrolysis pressure inhibits YX char gasification reaction. For a J flying DWG coal coke, no matter from the "V reaction rate" or the total carbon conversion rate, the pyrolysis pressure has no obvious influence on the coal gasification reaction.

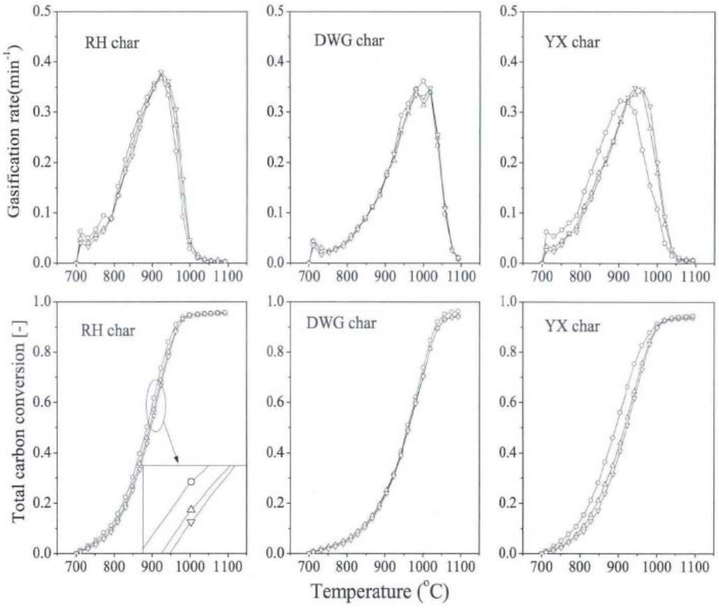

Figure 2: Gasification rate and total carbon conversion of RH char, YX char and DWG char prepared from pyrolysis at different pressures. O, 0.1 MPa; 0.5 MPa; 3.0 MPa

Table 1: CO_2 adsorption capacity of RH char, YX char and DWG char

Sample	T0=700℃, T1=960℃, x0=0=5℃/min	
	x1	V(s-1)
RH-0.1	0.9	1.04
RH-0.5	0.88	1.02
RH-3.0	0.87	1
DWG-0.1	0.5	0.58
DWG-0.5	0.48	0.56
DWG-3.0	0.47	0.55
YX-0.1	0.82	0.95
YX-0.5	0.75	0.86
YX-3.0	0.72	0.83

It can be seen from table 1 that the average gasification reaction rate of RH coal, DWG coal coke and YX coal coke is very different. The average gasification reaction rate of RH coal, DWG coal coke and Yx coal coke in the 0.1mpa pyrolysis is 1.04 s-1, 0.58 s-1, and 0.95 s-1. The average gasification reaction rate of the RH is 1.8

times of DWG coal coke gasification reaction rate. Therefore, we can conclude that RH coal gasification reactivity is the best, YX coal is the second, and DWG coal ranks the last. In addition, we can also compare the influence of pyrolysis pressure on coal coke gasification reactivity. No matter RH, DWG coal or Yx coal, the pyrolysis pressure increases, the average gasification reaction rate decreases and the gasification reactivity deteriorates. Especially 0.1 MPa pyrolysis pressure average Yx char gasification reaction rate isgreater than 0.5 MPa, and 3. The average OMPa pyrolysis pressure Yx char gasification reaction rate, and this is shown in figure 2 gasification reaction rate, and the total carbon conversion rate trend is consistent.

4. Conclusion

Shows the rate of RH coal, DWG coal coke and YX coal coke gasification reaction rate and total carbon conversion in different pyrolysis pressures, and the total carbon conversion rate is between 0.94-1.00. As you can see from figure 2, whatever the pyrolysis pressure is, RH carbon and YX char gasification reaction rate rise rapidly form 700 ˚C. DWG and char gasification reaction rate rise slowly within the range 700-750 ˚C, and rise fast after 750 ˚Ct. The maximum values of RH carbon, DWG YX coal tar and char gasification reaction rate of maximum temperature are 920 C, 1000 ˚C and 960 0 C C 0.1 MPa pyrolysis pressure YX char gasification reaction rate peaked at 910 ˚C). From the point of the total carbon conversion, the total carbon conversion rate of RH carbon and YX coal tar rise rapidly after 700 ˚C, and reach maximum at 980 ˚C and 1000 ˚C, respectively, and then stay the same. The scope of the total carbon conversion rate increase of DWG coal tar in 700-750 ˚C is small. However, it increases rapidly after 750 ˚C. When the total carbon conversion rate reached the maximum value of 1060 ˚C , it remains unchanged. From this we can conclude that the difference between RH coal, YX coal coke and DWG coal coke gasification reactivity is very large.

The effects of pyrolysis pressure on RH coal, YX coal coke and DWG coal coke gasification reaction. For RH carbon, during 700-900 ˚C, the smaller the pyrolysis pressure is, the larger the RH char gasification reaction rate is; After 900 ˚C, due to the low pressure pyrolysis under RH carbon reaction conversion is more, the gasification rate started less than RH carbon under high-pressure pyrolysis gasification rate. It can be seen from the chart of total carbon conversion of RH carbon that the higher the pyrolysis pressure is at the same temperature, the smaller the total carbon conversion rate of RH is. It shows that the pyrolysis pressure inhibits the} H coal gasification reaction. As shown in figure 5.2, before 900 0C, 0.1mpa pyrolysis pressure of YX coking gasification reaction rate was significantly greater than that of the o.s. MPa and 3.OMPa pyrolysis pressure under pressure of YX coal coke gasification reaction rate. From the point of the total carbon conversion rate, the same temperature and pressure 0.1 MPa pyrolysis YX coal prices always significantly higher carbon conversion J - grown MPa and 3 OMPa YX coal pyrolysis pressure but the total carbon conversion rate, suggesting that increasing pyrolysis pressure inhibits YX char gasification reaction. For a J flying DWG coal coke, no matter from the "V reaction rate" or the total carbon conversion rate, the pyrolysis pressure has no obvious influence on the coal gasification reaction.

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