Researches on Behaviors of Low-rank Coal Pyrolysis

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Abstract

The matching of chemical construction, thermal reactivity and the characteristics of raw materials is vital to determine the reaction and energy efficiency during pyrolysis of low rank coal. The behaviors of coal are the most important theoretical basis on the pyrolysis processing. And the research was focused on the difference product distribution of gas and liquid yields during the pyrolysis. The development of clean fuels derived from co-pyrolysis of coal is beneficial to lower the emission of greenhouse gas and volatile organic chemicals. The literature review revealed the most advanced researches of coal pyrolysis. At last, the pyrolytic condition effected the product distribution is further discussed.

Keywords

Coal; Clean conversion; Pyrolysis; Fuel.

1. Introduction

Energy is a vital input for social and economic development of any nation. There has been an enormous increase in the demand for energy since the middle of the last century as a result of industrial development and population growth. Energy considerations are of paramount importance to key global concerns such as sustainable development, poverty reduction and economic growth. With the advent of industrialization and globalization, the demand for energy has increased exponentially. Apart from the phenomenal growth in population, the marvels of modern technology have enhanced the aspirations of the people for an improved quality of life. One of the indices of improved quality of life is the per capita energy consumption, which has been rising steadily for the last few decades. Fossil fuels in the form of coal, oil and natural gas comprise 80% of the world's energy use. It is predicted that if the current global energy consumption pattern continues, the world energy consumption will increase by over 50% before 2030. General agreement exists that an effective energy efficiency policy requires a combination of measures including regulatory instruments, financial incentives, information provision, and that the mix of measures needs to be adapted to the situations of each particular country. Limited growth in petroleum supply and uneven petroleum market has being brought a significant gap between supply and demand of the liquid fuel. Moreover, most air pollution results from coal combustion and coal are the source of 90% of the SO2 emissions, 70% of the dust emissions and 67% of the NOx emissions. Due in large part to the emissions caused by burning coal. Coal, especially low rank coals such as lignite, is the most abundant and widely distributed fossil resource of the world. The effective and clean conversion process using low rank coals has recently become one of the most desired technologies to be developed worldwide, since their utilization can substantially lower the energy production cost. Pyrolysis is one of general term referring to a family of processes for producing liquid fuels from coal. Pyrolysis coal will become a viable option for the production of transportation fuels in China with cheap and abundant low-lank coals.

2. Literature Review

China has a great deal of coal resources. More than 40% of the coal reserve is low-rank coal which contains an estimate of more than 6.4 billion tons[1]. The project pyrolyze low-rank coal (mainly

lignite and sub-bituminous) at most 800℃ and discuss the factors affecting coal tar yield. The project also tries to improve the coal thermochemical conversion process for purpose of increasing the light oil yield and reducing other components of tar. The research is ultimately aimed at improving energy efficiency and reducing carbon emission.

The behaviors of low-rank coal (such as lignite, high volatile bituminous, and subbituminous coal) pyrolysis are studied by fixed tubular furnace under mild conditions. The experimental data is recorded and analyzed to establish the mass balance calculation of coal pyrolysis. My studies of pyrolysis products are summarized the coal conversion processes and speculated coal structures. The pyrolysis characteristics of low-rank coal/biomass are investigated in order to improve the light oil content of tar and inhibit the heavy components. Some experimental studies are in progress to compare different kinds of biomass effects on light oil yield of tar in coal pyrolysis. Free radicals were different groups of paramagnetic centers which were detected in pyrolysis processes. It was reported that the necessary first step in any combustion pathway is the generation of oxidized radical species [2]. These radicals could then be stabilized in the presence of hydrogen donor solvents. Pyrolysis processes have different influences on different paramagnetic centers. Analysis of the free radicals distribution in pyrolysis products would provide a new way to understand the key effect to increase light oil yield of tar. The research of low-rank coal pyrolysis processes has significance for rational utilization of coal resources and optimizing pyrolysis process at low cheating rate. The experimental study of fixed-bed pyrolysis will reveal the internal connection about the coal structure with composition and distribution of pyrolysis products. Coal is a combustible black or brownish-black sedimentary rock[3]. The solid fossil fuels are extremely complex and depend on the origin, history, age, and rank of the coal. The structure of coal consists of a mixture of different hydrocarbon compounds, such as polycyclic aromatic hydrocarbon, alkyl side chain, and functional group. All the properties of coal are related to its molecular and supermolecular structure. Traditionally, coal structure was studied by characterization of pyrolysis liquids and also by examining the solvent from coal. The organic compounds obtained by pyrolysis were characterized using column chromatography, GC, GC-MS, 1H-NMR, and 13C-NMR [4~ 6]. Coal pyrolysis analysis was used commonly to speculate coal structural fragment and its activity [7]. Study of the fundamental relations between the structure and properties of coal may permit the development of coal chemistry that yields coal products with specified properties. This calls for means of efficiently utilizing the chemical and energy potential of coal. Pyrolysis is the first step of several methods that are being developed for producing fuel from coal, which may include either direct liquefaction or indirect liquefaction [8]. It is also considered as an effective way for clean use of coal because desulfurized char and tar can be obtained [9, 10]. China has a huge quantity of low-rank coal, especially lignite. The study of lignite utilization which is limited to high levels of water and ash, and low calorific value contribute to adjust energy structure and ease up the energy contradiction of supply and demand. In recent years, interest in pyrolysis was rekindled by the rising demand of oil. The pyrolysis of slow and low cheating rate is more suited to convert lignite or sub-bituminous coal with high volatile for advantage of less investment and cost. During pyrolysis, the yield of gaseous and liquid products can vary from 25% to 70% by weight, depending on a number of variables, such as coal type, type and composition of the atmosphere present, final pyrolysis temperature, time-temperature path, and pressure [11, 12]. Efficient utilization of all the products, solid, liquid, and gaseous, is essential if favorable economics for a pyrolysis process are to be achieved. The high aromaticity of coal pyrolysis liquids indicates that conversion to gasoline is preferred to conversion to diesel fuel. It is worth to devote attention to hydroprocessing techniques, such as hydrotreating and hydrocracking in low-temperature tar processing, with the primary objectives of reducing viscosity, reducing polynuclear aromatics, and removing heteroatoms (sulfur, nitrogen, and oxygen) to produce usable fuels and chemicals.

3. Conclusion

The research of low-rank coal pyrolysis processes has significance for rational utilization of coal resources and optimizing pyrolysis process at low cheating rate. The experimental study of fixed-bed

pyrolysis will reveal the internal connection about the coal structure with composition and distribution of pyrolysis products.

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