

Rural Combustion Smoke Purification and Carbon Smoke Collection Device

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Abstract: Despite the continuous advancement of environmental protection work, burning straw and other wood in rural areas that produce a large amount of smoke and carbon smoke is still a common occurrence. Therefore, it is necessary to design an efficient combustion smoke purification and carbon smoke collection device, that uses technologies such as multi-stage filtration, adsorption, and catalytic reaction to absorb harmful substances in the smoke and collect carbon smoke to avoid environmental pollution, thereby improving rural air quality and ensuring the thorough implementation of rural environmental protection work.

Keywords: Rural combustion smoke purification; Carbon smoke collection device; Design and application

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1. Introduction

The problem of smoke pollution caused by rural combustion materials is becoming increasingly severe. Traditional combustion materials such as straw and wood produce a large amount of smoke and carbon smoke during the combustion process, which not only affects air quality control but also endangers people's health. Therefore, relevant departments and organizations must invest more manpower and resources in the development of rural combustion smoke purification and carbon smoke collection devices, to reduce smoke and carbon smoke pollution, protect the rural environment, and ultimately use technological innovation to provide technical support for rural environmental protection work. How to further design and promote rural combustion smoke purification and carbon smoke collection devices is one of the important issues that relevant management personnel urgently need to solve. This article will delve into this issue, aiming to provide a reference basis for management personnel to implement the goals of "carbon neutrality" and "carbon peak."

2. Application background of carbon smoke collection device for rural combustible smoke purification

2.1. Application scenarios

The rural combustion smoke purification and carbon smoke collection device belongs to the category of green,

energy-saving, and environmentally friendly products. Its production cost is low, the product operation is simple, and it has high applicability. To actively respond to the country's proposed "agriculture, rural areas, and farmers" work and actively promote the "dual carbon" policy, the device plays an important role in building a stable economic and social environment. Actively implementing the concept of low-carbon environmental protection in rural areas can effectively improve air quality and create beautiful countryside. At the same time, the collected carbon smoke can be used as ink raw material, bringing economic benefits and driving the development of related industrial chains ^[1].

2.2. Current application status of traditional devices

Carbon smoke collection is an important part of the entire carbon smoke treatment process and the most difficult problem to deal with. Traditional carbon smoke collection devices hinder the normal combustion of materials during carbon smoke collection, invisibly increasing the difficulty of environmental protection treatment. At the same time, it also increases the design and operating costs of carbon smoke environmental protection treatment system equipment. In rural areas where chimneys are used, the following methods will be adopted to complete carbon smoke collection. Firstly, settling tanks will be used to collect soot, but the actual collection effect is average. The second is to use the upward tilt of the export end to collect ash. Although the collection effect is relatively ideal, the equipment cost of the delayed environmental protection treatment system is relatively high. The third is to rely on a cylindrical structure with a closed upper end and an open lower end as the collector, but its disadvantage is that it can only be used in enclosed smoke collection places. However, the collection device mentioned above has problems such as large volume, complex structure, and complex operation, which makes its collection effect average, especially unsuitable for the aging population. From this, it can be seen that designing and promoting carbon smoke collection devices with simple structure, convenient operation, and fast installation is an important issue that urgently needs to be solved ^[2].

3. Specific design of carbon smoke collection device for rural combustible smoke purification

3.1. System architecture

The rural combustion smoke purification and carbon smoke collection device is used for the purification and collection of rural coal smoke. The device includes the inlet end of the carbon smoke collection main pipe connected to the chimney, and there are several exhaust ports on the exhaust end array of the carbon smoke main pipe. The collection carbon smoke hood has a carbon collection abdominal cavity inside, and the carbon smoke filters are distributed in the cavity and installed separately at the exhaust ports of the carbon smoke collection main pipe. Multiple carbon smoke filters and pairs of exhaust ports are matched to clean the exhaust gas discharged from the exhaust ports, and the exhaust fan is set at the top of the carbon smoke collection hood ^[3].

3.2. Core technology

Firstly, during combustion, a large amount of carbon material often emerges from the chimney, which can easily damage the general fiber mesh. This material is woven with 316 L steel wire. The 316 L stainless steel wire mesh filter has high temperature resistance, strong corrosion resistance, and good filtration performance.

Secondly, during this process, a double-sided metal ultrasonic cleaning brush is used on the device, which has strong heat resistance and can remove and collect carbon particles accumulated on the filter screen, with high removal efficiency.

Thirdly, the carbon collection hood includes a cavity portion and a smoke inlet, which is set on the base

of the carbon collection hood, just above the smoke exhaust hole. One end of the chimney is connected to the middle and lower parts of the smoke collection pipe in phases. Its end is connected to the upper part of the cavity, and it has good capture performance ^[4].

Fourthly, the device has carbon smoke adsorption technology for desulfurization and recovery of flue gas. This method can achieve effective utilization of renewable energy, in line with the concept of circular economy, and can also effectively control atmospheric sulfur pollution. It is a technology worth developing and popularizing.

Fifthly, the device adopts a simple design concept, with solar panels installed inside for easy installation, and can be reused with just a click. In this way, it has the advantages of easy installation, simple operation, and lower cost. In addition, the combination of smoke collection pipes, smoke collection hoods, and smoke pipes can smoothly transport unorganized smoke to the smoke purification device, reduce environmental pollution, and protect human health. At the same time, it can also generate certain profits for farmers with small investments ^[5].

4. Market promotion of carbon smoke collection devices for rural combustible smoke purification

4.1. Market environment

4.1.1. Achieve the carbon goals and deepen green development

The device can steadily advance the path of green, low-carbon, and high-quality development, ensuring the timely achievement of carbon peak and carbon neutrality goals ^[6].

4.1.2. Policy support for rectification of severe rural pollution

In recent years, with the rapid development of the rural economy, the problem of environmental pollution in rural areas has become increasingly severe, especially the burning of straw and wood, which seriously pollutes the atmospheric environment ^[7]. Incineration of combustibles has various social and economic factors. At the same time, the burning and collection of combustibles are closely related to the social economy. This is closely related to the current transformation of rural lifestyle and production methods, as well as the mobility of rural labor. At present, the utilization and comprehensive recovery of crop straw resources in China still faces many difficulties ^[8].

To further strengthen the protection of the rural environment, more attention should be paid to the treatment of agricultural and rural pollution, which can lay a solid foundation for the subsequent implementation of the rural revitalization strategy ^[9]. At the same time, it also plays an important role in achieving green and low-carbon development in rural areas and the construction of rural ecological civilization. At present, rural management work needs to focus on the comprehensive improvement of the rural living environment, and based on existing villages, efforts should be made to strengthen inclusive, basic, and bottom-up livelihood projects ^[10].

4.2. Market capacity

The device has a huge market potential, with rural areas accounting for about 36.11%, especially in the northern region where there are a large number of rural farmers with a huge market capacity, which can meet the production and usage needs of the device.

4.3. Wide market prospects

Carbon smoke belongs to a type of black carbon particles, that are produced after incomplete combustion of carbon-containing fuels. It is also an important component of atmospheric fine particulate matter, seriously

polluting air quality. Based on China's energy structure, most of them use coal and biomass as solid fuels, and China is also the world's largest energy producer and consumer. According to data from 2022, while consuming 5.41 billion tons of standard coal, the consumption of coal, oil, and natural gas increased by 4.3%, 3.1%, 1.2%, and 3.6%, respectively ^[11]. It is not difficult to see from the energy consumption structure that in 2022, coal and carbon dioxide accounted for the highest proportion of total energy consumption in the country, at 56.2%, while clean energy consumption such as natural gas, hydropower, nuclear energy, wind energy, and solar energy accounted for about 25.9%.

In addition, there are large rural areas in China, and most of them use burning materials such as straw and firewood for cooking and heating, especially during the autumn harvest season when outdoor burning is more common. Solid fuels such as media and biomass produce various harmful substances during the combustion, gasification, and pyrolysis processes, among which a large amount of carbon smoke, commonly known as "black smoke", is produced and becomes an important source of atmospheric carbon smoke. It should be noted that carbon smoke aerosols will absorb a large amount of solar radiation within the wavelength range of light to infrared, which will reduce atmospheric visibility and also affect the formation of cloud condensation nuclei, ultimately affecting regional air quality and even global climate.

Among them, the entire winter in the northern region of China is in a severe cold zone, with December and January being the coldest stages, with indoor and outdoor temperature differences as high as 30 °C, which requires a large amount of heat energy consumption. Based on data research, it can be concluded that nowadays, heated kang is still the main way of heating in rural areas of Northeast China, and it is necessary for farmers to burn a large amount of combustibles for cooking and heating ^[12].

5. Promotion strategy

The use and promotion of rural combustion smoke purification and carbon smoke collection devices are mostly aimed at northern rural areas and farmers. Pilot testing can be carried out in rural areas of the three northeastern provinces and Inner Mongolia, and then spread to surrounding rural areas, to complete device promotion and marketing. Especially in terms of product marketing, methods such as knowledge marketing, online marketing, green marketing, personalized marketing, innovative marketing, and integrated marketing can be used to expand marketing channels and innovate marketing methods. In terms of device product promotion, various new media platforms and app software can be relied on for advertising, which should include image advertising and product brand promotion, especially highlighting the advantages of low-carbon environmental protection, energy conservation, and emission reduction, laying a solid foundation for future expansion to domestic and foreign markets ^[13]. Specifically, marketing personnel should distribute relevant promotional materials, which should include product introductions, price advantages, prominent advantages, and so on. Secondly, optimize the design of image promotion advertisements, which include large billboards and require the use of unified image recognition. Thirdly, advertising should be placed in magazines and newspapers to vigorously promote the advantages of low-carbon and environmentally friendly installation, thereby establishing a good product brand image. Fourthly, by maintaining communication with users through online media, companies can provide high-quality after-sales service to users, understand their shortcomings and needs, and continuously adapt to the market to adjust device functions. Fifth, actively communicate with local government departments, understand the latest relevant policies and regulations, and obtain policy support from government departments, to contribute to promoting coordinated development between humans and nature. This can not only save costs but also open up the market ^[14].

6. Development prospect analysis

Companies need to design and promote rural combustion smoke purification and carbon smoke collection devices driven by the concept of green environmental protection, to adapt to the needs of new rural development and construction, and develop efficient and green carbon smoke collection equipment for them. While pursuing higher economic benefits, all sectors of society should also pursue harmony between humans and nature. The agreement between economic and social benefits requires the design and production of collection devices based on environmental protection concepts, relying on their devices to complete the recycling and reuse of carbon smoke. At the same time, ecological and economic benefits can be obtained after being put into use. In this way, not only can companies actively respond to national policy calls, effectively promote low-carbon environmental protection, and continuously approach the carbon goals, but in the future development situation, energy conservation, emission reduction, and low-carbon environmental protection will become the mainstream trend. The research and use of rural combustion smoke purification carbon smoke collection devices have good development prospects^[15]. It is hoped that this device can be widely applied in more rural areas and become an important force in improving the quality of the rural environment.

7. Conclusion

Overall, by implementing national policies and guidelines, it is possible to reduce rural combustion pollution and protect the rural ecological environment by designing and promoting rural combustion purification and carbon smoke collection devices. This allows rural farmers to enjoy convenient living while also gaining certain economic benefits.

Disclosure statement

The author declares no conflict of interest.

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