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Article

Experimental Study of Reverse Underground Coal Gasification

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Abstract: Underground coal gasification (UCG) produces less pollution and is safer than traditional coal mining. In order to investigate the effects of different gasifying agents or comprehensive analyses of the characteristics of the gas components in the three zones for the reverse underground coal gasification process, a model test was carried out. The results showed that the oxygen concentration of a gasifying agent is recommended to be higher than 21%, which will lead to more combustible gases and a higher calorific value of gas. Higher flow rates and oxygen content generally afforded more desirable gas compositions and calorific values, with the latter as high as 1430.19 kcal/Nm^3. For the enriched oxygen gasifying agent in the reverse gasification process, the flow increase from 10 to 20 Nm^3/h affords a rapid increase in the growth rate of the flame front, from 1.80 to 4.88 m/day, which is much faster than that for the air gasifying agent. Increasing the gas injection rate and oxygen concentration will increase the growth rate of the flame front. This affects the distribution of the three zones and further leads to different characteristics of the gas components.

Keywords: underground coal gasification; reverse; gas composition; temperature field; three zones

1. Introduction

Underground coal gasification (UCG) converts coal into combustible gas through controlled in situ combustion, thus transforming ordinary "physical" mining into "chemical" mining. In this process, hole or channel drilling is achieved on the surface and obviates the need for underground work, large mining equipment, ground gasification equipment, and surface gasifier construction. This greatly reduces the environmental damage caused by traditional physical mining, and coal exploitation can be maximized even for steeply inclined, thin, ultra-deep, or inferior coal seams, or otherwise uneconomical coal resources that are not suitable for physical mining. The approach is highly regarded around the world, particularly as a second-generation mining method [1–4]. As an important means of clean coal technology, UCG integrates geological and environmental science; detection and coal mining technologies; computational analysis; chemical, coal chemical, and energy technologies; resource economics; and management science. UCG has many advantages, including safety and lower costs, and is also environmentally friendly [5–9]. As early as 1979, the United Nations World Coal Vision Conference clearly pointed out that UCG is an important way to fundamentally solve a series of technical and environmental issues caused by traditional coal mining methods, and its development should direct world coal mining research.

The UCG system is illustrated in Figure 1. An injection well is used to introduce the gasifying agents (air or oxygen), and the coal is ignited under certain conditions. A flame front is generated and