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Na & Ca removal from Zhundong coal by a novel CO_2-water leaching method and the ashing behavior of the leached coal

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ABSTRACT

Zhundong coalfield in China is the largest intact coalfield in the world. However, serious fouling and slagging issues occurred when the Zhundong coal combustion, because of its high Na and Ca contents. In this study, a novel CO_2-water leaching method was proposed to remove Na and Ca in Zhundong coal. The removal efficiencies of Na and Ca and the ash characteristics of the leached coal were investigated in detail. The results show that the CO_2-water leaching can be easily achieved at room temperature under atmospheric pressure. The removal efficiencies of Na and Ca by the CO_2-water leaching were significantly higher than those of water leaching. It is attributed to the effective removal of the organic Na and Ca in the coal. In addition, the $CaCO_3$ in the coal was also effectively removed by CO_2-water leaching. The volatility of Na from CO_2-water leached coal is only 25% of that of raw coal during the combustion at 900 °C. The alkali-acid ratio (B/A) of the CO_2-water leached coal ash was significantly lower than those of the raw coal and the water leached coal ashes. The fusion temperature of the CO_2-water leached coal ash significantly increased, compared with those of the raw coal and the water leached coal ashes. The deformation temperature of the CO_2-water leached coal ash was as high as 1202 °C, much higher than those of the raw coal and water leached coal ashes, which were 1098 °C and 1142 °C, respectively. Besides, the agglomeration and sintering phenomena of coal ash was also inhibited significantly by the CO_2-water leaching. Therefore, the CO_2-water leaching method was found to be an effective and promising method for AAEM removal from Zhundong coal, and can markedly mitigate the fouling and slagging during Zhundong coal combustion.

1. Introduction

Zhundong coalfield, located in Xinjiang province of China, is the largest intact coalfield in the world with the forecast reserve of about 390 billion tons [1]. The Zhundong coalfield can meet the need of coal utilization for more than 100 years at the current consumption rate in China [2]. Zhundong coal is characterized by good ignition characteristics and low environmental pollution due to the high volatile content and low ash and sulfur contents [3]. However, the content of sodium (Na) in Zhundong coal ash is very high, generally more than 4% on ash basis, far more than the normal Na content level in typical Chinese coal, which is generally between 1% and 2% [4,5]. Additionally, the calcium (Ca) content of Zhundong coal is also rather higher than other typical Chinese coal [6]. Serious problems, such as fouling, slagging and corrosion, are induced on the boiler heating surfaces during the Zhundong coal combustion, which seriously affected the safe operation of the coal-fired boiler [7]. Many studies were conducted to investigate the ash deposition in coal-fired boilers during burning Zhundong coal. It was found that the condensing and depositing of Na and Ca sulfates play important roles on the ash deposit on convection heating surfaces [6]. Na and Ca compounds (such as Na_2O, CaO), having a strong flux effect, also aggravated the slagging problem during Zhundong coal combustion, due to the formation of low-temperature eutectic and the decline of the ash fusion temperature.

Currently several methods are available or proposed to solve these critical problems, such as blended coal combustion [8], additive utilization [9] and leaching pretreatment [10]. Coal blending has been employed to ease these ash deposition problems. However, coal blending is confined by its high expense of transportation which is not a long strategy to effectively and fundamentally settle the ash-related

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