Energy and exergy analysis of alternating injection of oxygen and steam in the low emission underground gasification of deep thin coal

Recent studies have shown that by coupling the underground coal gasification (UCG) with the carbon capture and storage (CCS), the coal energy can be economically extracted with a low carbon footprint. To investigate the effect of UCG and CCS process parameters on the feasibility of the UCG-CCS process, we utilize a validated mathematical model, previously published by the same authors, that can predict the composition of the UCG product, temperature profile, and coal conversion rate for alternating injection of air and steam for unmineable deep thin coal layers. We use the results of the model to conduct an energy and exergy analysis of the UCG process. We study the effect of various process parameters on the efficiency of the UCG process, the zero-emission recovery factor of coal, and the total CO₂ emission of the process. Moreover, we compare the alternating injection of air/steam with the injection of an air and steam mixture. Exergy analysis shows that the alternating injection of air/steam describes a practical process for UCG at low pressure. However, injecting a mixture of steam and oxygen results in a practical recovery factor of coal higher than the alternating injection process. Additionally, we show that the zero-emission conversion of unmineable deep thin coal resources in a coupled UCG-CCS process, that is not practical with the current state of technology, can be realized by increasing the energy efficiency of the carbon dioxide capture process.

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