淨零排放

使用氬氣大氣電漿束以促進二氧化碳轉化之研究
Characterization of atmospheric pressure plasma jets and their use for CO_2 splitting.

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摘要

CO_2 is the main cause of global warming. The United Nations set a net-zero carbon target of 2050 in the 2021 Glasgow Climate Agreement. At present, the relevant research methods for CO_2 treatment include: carbon capture, carbon sequestration and carbon conversion. Carbon conversion can is mainly developed through photocatalysis, thermo-catalysis and plasma activation. Among them, plasma approach has the advantages of relative safety, high energy input and low temperature. The plasma in the form of dielectric barrier discharge (DBD) can react at room temperature and normal pressure. The present study selects DBD plasma for the discussion of conversion efficiency. The principle of converting CO_2 by DBD is that electrons and excited Ar hit CO_2 to break the bond into CO and O. The minimum energy required for C=O double bond breaking is about 5.5eV, and according to the electron distribution probability, the number of high-energy electrons with more than 5.5eV is very limited, so it is thought that the collision should dominated by the Ar ion (Ar^+) and Ar metastable state (Ar*) in the plasma. This may be the main cause of CO_2 bond breaking. In this study, the conversion of CO_2 was done by atmospheric pressure plasma jet (APPJ). APPJ is a kind of dielectric barrier discharge. The plasma gas is composed of argon fixed at 10 slm with different flows of CO_2 (6, 9, 12, 15 sccm). The pulse frequency was 13.16kHz and 16.67kHz, and the working voltage was set at 9kV, 9.5kV and 10kV respectively. The experiment environment was room temperature and atmospheric pressure. The goal was aiming to understand various parameters in plasma affect conversion efficiency. The OES spectral analysis was use to explore the plasma intensity under different process parameters. The electron temperature (T_e) and electron density (n_e) were calculated accordingly. The analysis results of plasma spectra showed that the effect of working voltage on plasma intensity is not obvious; However, as the pulse frequency increased, the plasma spectrum can maintain a certain intensity at higher CO_2 input flows. In sum, the maximum conversion rate of 77.61% was obtained when the CO_2 input was 6 sccm, when the pulse frequency was 16.67 kHz, and the operating voltage was 10 kV. Based on the experimental results, we found that when the same pulse frequency and operating voltage was selected, as the input flow of CO_2 increases, the electron density and conversion rate will decrease, and the electron temperature will increase. As a result, we can achieve maximum conversion rates with lower CO_2 inputs, higher pulse frequencies and operating voltages.

關鍵字: 噴射式大氣電漿、碳轉化、介電質阻擋放電
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