Low Current Gliding Arc Discharges for CO_2 Conversion: The Role of the Active Cooling

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The focus of this work is a low current gliding arc discharge (GAD) at atmospheric pressure, applied for the conversion of CO_2 into CO and O_2. The experimental setup is designed to study three different modifications of the GAD: classic GAD, magnetically accelerated GAD (MAGAD) and magnetically retarded GAD (MRGAD). For the latter two, permanent magnets help generate a Lorentz force acting in either the same direction as the gas flow, or opposite to it, respectively.

The research presented aims to optimize the discharge configurations from [1] with respect to dissociation of CO_2 (X_{CO2}, %), energy efficiency of the conversion process (η, %) and durability (operation time). The GAD consists of two diverging electrodes, placed between two quartz glass plates. An active cooling system is used to enhance the cooling rate of the arc and the gas in the afterglow. To find the best conditions for gas treatment, the cooling rate is also modified by changing the distance between the plates (the thickness of the electrodes) in the range $d = 1 - 4$ mm. The latter affects the gas velocity for a given gas flow rate and the amount of gas subject to higher temperatures. Experiments with different materials for the electrodes (Cu, Stainless Steel, Al) were also carried out to see if further improvements in the device's stability and cooling could be achieved.

The results for the three discharge configurations for all values of the glass wall distance are obtained for gas flows from 2 to 12 L/min and discharge currents from 50 to 210 mA. The data shows that the best overall performance is achieved by the MRGAD configuration at certain optimal conditions. The conversion rate for this configuration is $X_{CO2} = 6-8$ % and the energy efficiency is $\eta = 25-30$ %. In this regime the relative velocity of the flowing gas and the arc is increased compared to the other regimes. The optimal distance between the glass plates was found to be $d = 3$ mm.

[1] Ivanov V, Paunska Ts, Lazarova S and Kolev St 2023 *Journal of CO_2 Utilization.* **67** 102300 (12pp).