DC glow discharge - Fluidized bed reactor for CO2 recycling

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The increase in global temperature is attributed to the greenhouse gas effect especially from carbon dioxide (CO_2) emissions. Non-thermal plasmas can provide the highly energetic environment needed for CO_2 conversion. Therefore, a plasma-catalysis approach could offer a significant advantage by improving conversion, selectivity and energy efficiency. Fluidized bed reactors increase the surface contact area with the gas phase and improve the heat transfer [1-3]. A DC glow discharge ignited in a fluidized bed with and without Alumina (Al_2O_3) particles is investigated with aid of Optical Emission Spectroscopy at low pressure. It is observed a decay in Oxygen atom density through the fluidization of the material and an increase in the intensity of CO systems, specifically Angstrom band system which could be due CO density, electron density and/or electric field, in comparison to the plasma alone. This indicates that fluidized particles indeed cause a reduction in the O presence and could lead to an increase in CO density. In addition, temperature of rotation was calculated by CO Angstrom system [4]. The temperature does not increase significantly although the presence of Al_2O_3 particles seems to constrain the plasma spatially. The plasma-assisted catalytic behavior was further investigated by FTIR spectroscopy for the characterization of the downstream gas from glow discharge/FBR resulting on superior performance than the glow discharge alone. The performance data obtained by Dielectric Barrier Discharge (DBD)-FB reactor is compared and it is concluded that the presence of alumina improves the dissociation of CO_2. Despite the very low catalytic activity of alumina alone yet it has a physical effect changing the chemistry. The development of this innovative route is crucial to understanding the enhancement of plasma-surface interaction for CO2 recycling.

References

[1] Wang et al., Catal. Today, **148**, pp. 275–282 (2009)
[2] Chen et al. J. CO2 Utilization, **54**, p. 101771 (2021)
[3] Pou et al, J. CO2 Utilization, **27**, pp. 528–535 (2018)
[4] Yamada et al, Jpn. J. Appl. Phys., **60** (2021)