MATFYZ CONNECTIONS

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Impact of Air Humidity, Reactor Geometry and AC/DC Power on Electrical and Chemical Characteristics of Discharge in Honeycombs

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Abstract
Car exhaust treatment is essential for mitigating harmful environmental and health effects caused by emissions from car engines. A usual approach for car exhaust emission control is the use of honeycomb monoliths integrated with advanced catalytic materials. Catalytic systems are widely used in diesel and car exhaust treatment due to their large surface area and effectiveness in converting harmful pollutants. Traditioemphasized textnally, these systems rely on thermal energy to drive catalytic reactions. However, integrating non-thermal plasma (NTP) technology into these reactors offers a promising alternative. It reduces dependence on thermal energy while significantly enhances reaction rates and pollutant removal efficiency [1]. NTP enables accelerated chemical transformations under varied operating conditions such as gas composition, humidity, and flow rate, making it a versatile and energy-efficient solution for modern exhaust treatment applications.

The present investigation examines the effects of reactor geometry and critical operating parameters on the stabilization of plasma discharge within a honeycomb monolith reactor. Experiments were conducted at different gas flow rates and relative air humidity levels to characterize discharge behavior. Comparative analyses of AC and DC power sources were performed to evaluate energy efficiency and to identify conditions capable of sustaining a stable and intense plasma discharge with minimal power input. Upon achieving discharge stabilization, the generation and chemical composition of reactive species were systematically analyzed using FTIR spectroscopy, allowing for the elucidation of underlying reaction mechanisms between plasma-generated species and volatile organic compounds. Building upon the optimized operating conditions, the reactor design was further scaled up through the incorporation of a second honeycomb monolith. This two-stage configuration is intended to expand the active discharge region and enhance the residence time of gas-phase molecules, thereby improving overall treatment efficiency.

Acknowledgement
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Reference

[1] S. Saud, D. B. Nguyen, R. M. Bhattarai, N. Matyakubov, V. T. Nguyen, S. Ryu, H. Jeon, S.B. Kim, Y.S. Mok, Journal of Hazardous Materials 426 (2022) 127843

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