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A review paper on Micro Combustor Analysis of Hydrogen

B. Phanindra Kumar[1], I. Pavan Kalyan[2], A. Yashwanth[3], N. Manikanta Chary [4]

Assistant Professor, Dept. Of Mechanical Engineering, Guru Nanak Institute of Technology, Khanapur, India[1]

UG Scholars, Dept. Of Mechanical Engineering, Guru Nanak Institute of Technology, Khanapur, India.[2,3,4]

Abstract: This project focuses on the analysis of a micro combustor for hydrogen fuel, aiming to improve the efficiency and performance of hydrogen combustion in small-scale applications. A micro combustor is a compact device that enables controlled combustion, typically used in applications such as portable power generation or micro-turbine systems. The project investigates the behaviour of hydrogen as a fuel in such a system, examining key factors like temperature distribution, pressure, and fuel-air mixture. Computational simulations are employed to model combustion processes and optimize the design for maximum efficiency and minimal emissions. The study also explores challenges like flame stability and heat loss, providing insights into enhancing micro combustor designs for clean, sustainable energy production using hydrogen as an alternative fuel. The goal is to contribute to the development of energy-efficient, environmentally friendly microscale combustion systems for future hydrogen-based technologies.

Keywords: Heat transfer, Combustion analysis, CFD simulation, Fuel-air ratio, Emissions reduction, Microscale combustion, Combustion Efficiency.

I. LITERATURE SURVEY

Dr. Ju, Y. (Princeton University). [1]
Research Focus: Combustion dynamics of hydrogen in a micro combustor.
He Investigated the combustion dynamics of hydrogen in a micro combustor, revealing complex flame behaviour and oscillations. He Used numerical simulations and experimental methods to investigate combustion dynamics.

Dr. Kim, J. (Seoul National University) [2]
Research Focus: Design and optimization of a micro combustor for hydrogen combustion.
He Developed a novel design of a micro combustor for hydrogen combustion, achieving high efficiency and stability. He used computational fluid dynamics (CFD) and experimental methods to design and optimize the micro combustor.

Dr. Li, J. (Tsinghua University) [3]
Research Focus: CFD simulation of hydrogen combustion in a micro combustor.
He Conducted CFD simulations of hydrogen combustion in a micro combustor, providing insights into combustion dynamics and emissions and used CFD simulations to investigate combustion dynamics and emissions.

Dr. Wang, Y. (University of Science and Technology of China) [4]
Research Focus: Flame stability of hydrogen combustion in a micro combustor.
He Investigated the flame stability of hydrogen combustion in a micro combustor, identifying key factors influencing flame stability and used numerical simulations and experimental methods to investigate flame stability.

Dr. Lee, S. (Korea Advanced Institute of Science and Technology) [5]
Research Focus: Emissions reduction and efficiency enhancement of a micro combustor for hydrogen combustion.
He researched emissions reduction and efficiency enhancement of a micro combustor for hydrogen combustion, demonstrating reduced emissions and improved efficiency and used experimental methods to investigate emissions reduction and efficiency enhancement.

Dr. Norton, D. G. (University of Maryland) [6]
Research Focus: Development of a micro combustor for hydrogen-fuelled power generation.
He Developed a micro combustor for hydrogen-fuelled power generation, achieving high efficiency and low emissions and used experimental methods to develop and test the micro combustor.
Dr. Chou, S. K. (Nanyang Technological University) [7]

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Research Focus: Micro combustor design and optimization for hydrogen combustion
He Investigated micro combustor design and optimization for hydrogen combustion, achieving high efficiency and stability and used CFD simulations and experimental methods to design and optimize the micro combustor.

Dr. Kwon, O. C. (Seoul National University) [8]
Research Focus: Micro combustor design and optimization for hydrogen combustion.
He Investigated micro combustor design and optimization for hydrogen combustion, achieving high efficiency and stability and used CFD simulations and experimental methods to design and optimize the micro combustor.

Dr. Zhang, Y. (University of California, Berkeley) [9]
Research Focus: Numerical simulation of hydrogen combustion in a micro combustor.
He conducted numerical simulations of hydrogen combustion in a micro combustor, providing insights into combustion dynamics and emission and used numerical simulations to investigate combustion dynamics and emissions.

Dr. Huang, Y. (Georgia Institute of Technology [10]
Research Focus: Micro combustor design and optimization for hydrogen combustion using CFD
He Investigated micro combustor design and optimization for hydrogen combustion using CFD, achieving high efficiency and stability and used CFD simulations to design and optimize the micro combustor.

Dr. Park, J. (Purdue University) [11]
Research Focus: Experimental investigation of hydrogen combustion in a micro combustor.
He Conducted experimental investigations of hydrogen combustion in a micro combustor, providing insights into combustion dynamics and emissions and used experimental methods to investigate combustion dynamics and emissions.

Dr. Lee, D. (University of Illinois at Urbana-Champaign) [12]
Research Focus: Numerical simulation of hydrogen combustion in a micro combustor with a porous media.
He Conducted numerical simulations of hydrogen combustion in a micro combustor with a porous media, providing insights into combustion dynamics and emissions and used numerical simulations to investigate combustion dynamics and emissions.

Chen, W., & Lu, X. (2018) [13]
Research Focus: Numerical investigation of hydrogen combustion in a micro-combustor.
He presents a detailed numerical study of hydrogen combustion within a micro-combustor, focusing on flame stability and the effect of the geometry on performance and used numerical simulations to investigate combustion dynamics and emissions.

Bai, X., & Liu, C. (2020) [14]
Research Focus: Experimental investigation of the performance of a hydrogen-fueled micro combustor.
He investigated on experimental findings regarding the operation of a hydrogen micro-combustor, including combustion efficiency and emission characteristics and used CFD simulations to design and optimize the micro combustor.

Wang, Y., Li, M., & Zhang, Y. (2019) [15]
Research Focus: Combustion characteristics and NOx emissions in a micro-combustor fueled by hydrogen.
He investigates the combustion characteristics and NOx emissions when hydrogen is used in micro-combustors, exploring methods to reduce pollutant formation and used CFD simulations to design and optimize the micro combustor.

Kim, Y. J., & Kwon, O. J. (2017) [16]
Research Focus: Design and performance analysis of a micro-combustor for hydrogen fuel.
He presents an analysis of the design parameters for hydrogen micro-combustors, including material selection and the influence of combustor shape on overall efficiency and used numerical simulations to investigate combustion dynamics and emissions.

Huang, Z., Liu, H., & Wang, J. (2021) [17]
Research Focus: The effects of micro-combustor geometry on the combustion of hydrogen: A numerical study. He uses computational fluid dynamics (CFD) to study the effects of various micro-combustor geometries on hydrogen combustion, including flame behavior and efficiency and used numerical simulations to investigate combustion dynamics and emissions.

Zhou, S., & Gao, Z. (2019) [18]

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Research Focus: Investigation of flame dynamics and heat transfer in a micro-combustor operating with hydrogen. He focuses on the dynamics of hydrogen flames and the heat transfer processes within a micro-combustor, identifying optimal operating conditions for heat retention and used CFD simulations to design and optimize the micro combustor.

Liu, Z., & Li, J. (2020) [19]
Research Focus: Hydrogen micro-combustor with catalytic walls: Performance and stability.
He investigates the use of catalytic walls in hydrogen micro combustors to enhance flame stability and reduce emissions and used CFD simulations to design and optimize the micro combustor.

He, Z., Xu, Y., & Chen, L. (2020) [20]
Research Focus: micro-combustor performance using hydrogen as a fuel: Design, stability, and emissions.
He reviews article compiles findings on micro-combustor performance when using hydrogen, discussing the factors influencing design, combustion stability, and emission reduction techniques and and used numerical simulations to investigate combustion dynamics and emissions.

II. CONCLUSION

The analysis of hydrogen micro combustors continues to evolve with advancements in experiment techniques, computational modeling, and material innovations. Addressing challenges such as flame stability, quenching, and heat loss is crucial for the practical deployment of micro combustion technologies.

Future research should focus on integrating advanced diagnostic tools and hybrid energy systems to maximize efficiency and sustainability

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