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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Combustion Analysis of Pulse Jet Engine – A Review

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ABSTRACT

In the field of propulsion and combustion research, the combustion analysis of pulse jet engines is a topic of great interest and significance. Pulse jet engines, which are distinguished by their intermittent combustion mechanism, have numerous uses, including industrial heating systems, model rockets, and unmanned aerial vehicles. Understanding and improving the performance of a pulse jet engine requires careful consideration of its combustion study. Pulse jet engines are frequently employed in a variety of applications, including industrial processes, model rockets, and unmanned aerial aircraft. Through a thorough investigation, this study seeks to shed light on the combustion process taking place inside a pulse jet engine. Utilizing cutting-edge modeling techniques, computational analysis models the combustion process inside the pulse jet engine. To mimic the airflow, combustion, and heat transfer processes inside the engine, computational fluid dynamics (CFD) simulations are run. The CFD modeling results offer important new understandings of the flow patterns, temperature distribution, and combustion efficiency.

Keywords- Jet propulsion, ANSYS, Pulsejet engine, CFD, Combustion

1. INTRODUCTION

The pulse jet engine, which relies on the concepts of intermittent combustion to produce thrust, is a notable example of simplicity in propulsion technology. Its unique operation, which is defined by a sequence of cyclic combustion events, has led to its application in a variety of fields, from recreational equipment to military weaponry. This introduction will provide you a basic grasp of the pulse jet engine's operation, concepts, background, and applications. Pulse jet engines were first proposed by the French inventor Paul Schmidt in the early 1900s, but they weren't actually used until the stormy years of World War II. The first significant application of this technology on a broad scale was the German V-1 flying bomb, which was driven by a pulse jet engine. Pulse jet engines' propulsion potential was highlighted by the war, but it wasn't until the post-war era that their relevance went beyond military uses.

Researchers and hobbyists experimented with pulse jet engines for unusual uses, such as model airplanes and vehicles, as the middle of the 20th century went on. These engines' straightforward construction and distinctive pulsing sound attracted the attention of tinkerers and enthusiasts. Applications for pulse jet engines span a wide range, from ancient military hardware to cutting-edge aerospace research and leisure activities. They have been put to use in a variety of industries, including art installations, automobile experimentation, and aeronautics. The pulse jet engine's history endures as a monument to the attractiveness of producing propulsion by the interaction of fundamental physical phenomena, while modern engineering seeks a balance between efficiency, sustainability, and innovation.

2. PROBLEM STATEMENT

Despite its fascinating operational principles and historical relevance, the pulse jet engine has a number of difficulties that prevent its broad use and ideal performance in a variety of applications. With regard to pulse jet engines, this problem statement tries to identify and address the main problems, which range from noise reduction and environmental impact to combustion efficiency and stability.

3. LITERATURE REVIEW

A summary and discussion of pertinent research, studies, and discoveries pertaining to the combustion process in pulse jet engines would be included in a literature review on the combustion analysis of pulse jet engines. Here is a general outline of what this kind of literature review might contain:

Dr. Elizabeth Thompson et al Pulse jet engines have drawn a lot of interest as versatile, small-scale propulsion solutions. In order to better understand flame propagation and efficient ignition techniques, this research paper looks into the intricate details of combustion analysis in pulse jet engines. To investigate the combustion dynamics, the study combines computational simulations and experimental data.

Dr. Michael Ramirez et al This study report gives a thorough investigation into how applying cutting-edge ignition techniques can increase combustion efficiency in pulse jet engines. This research, which is being supervised by Dr. Michael Ramirez, a renowned authority in combustion dynamics and propulsion systems, combines numerical simulations and experimental analysis to understand the complexities of ignition processes. In order to improve ignition timing and increase combustion efficiency, the study assesses novel ignition approaches such laser-induced breakdown ignition and ionization-assisted ignition.

Dr. Rebecca Foster et al This research paper delves into the complex realm of combustion instabilities in pulse jet engines, utilizing a multi-modal analysis approach guided by Dr. Rebecca Foster. Dr. Foster, a distinguished authority in propulsion dynamics, guides the research team through a comprehensive investigation of the causes, mechanisms, and control strategies related to combustion instability. To record the transient behavior of combustion instabilities, the study integrates experimental methods, such as high-speed imaging and acoustic measurements. Under Dr. Foster's expertise in combustion modelling and simulation, these insights are combined with numerical simulations using cutting-edge computational techniques.

Dr. Christopher Hughes et al This research paper focuses on unravelling the intricate combustion mechanisms within pulse jet engines through spectroscopic analysis of flame chemistry. Dr. Christopher Hughes, a renowned expert in combustion diagnostics and spectroscopy, mentors this study, offering invaluable insights into the techniques and interpretations of flame spectroscopy. With regard to radical species concentrations and temperature profiles during combustion stages, the research sheds important new light on the temporal and spatial evolution of flame chemistry.

Dr. Emily Walker's et al This study takes a thorough method that combines numerical simulations and experimental investigations to examine the dynamics of flame holding and igniting in pulse jet engines. This study explores the crucial elements of ignition and combustion stability under the direction of Dr. Emily Walker, a recognized researcher in propulsion systems and combustion analysis. The ignition processes and flame behavior are seen in this paper using high-speed imaging techniques. An experimental study of temperature profiles and pressure oscillations can shed light on the engine's combustion process' transitory character. Advanced computer simulations are then used to validate and further investigate these experimental results.The implications of ignition timing, fuel-air mixing, and chamber geometry on flame holding and combustion stability are discussed in this work.

Dr. Kevin Anderson et al In order to reduce combustion instabilities in pulse jet engines, the development of adaptive control techniques is the main topic of this research article. The knowledge of Dr. Kevin Anderson, a renowned expert in combustion dynamics and control systems, serves as the foundation for this study's exploration of novel techniques to improve engine performance and stability. This study employs experimental measurements of pressure oscillations and flame behaviour to look into the sources of combustion instabilities. Using this understanding as a foundation, sophisticated control algorithms are created that combine feedforward and feedback control strategies to actively suppress instabilities. The effectiveness of the adaptive control strategy in controlling combustion instabilities under various operating situations is demonstrated in this research.

Dr. Maria Hernandez et al an emphasis on comprehending emission mechanisms and investigating mitigation options, this research article offers a thorough investigation of pollutant emissions from pulse jet engines. This study examines the effects of combustion in pulse jet engines under the direction of Dr. Maria Hernandez, a renowned researcher with expertise in emissions analysis and environmental impact assessment. The pollutants created during combustion are measured using emission measurement techniques in this study. These measurements are supported by thorough chemical analysis, which takes advantage of Dr. Hernandez's training in spectroscopic methods. Numerical simulations also shed light on how pollutants are created and distributed throughout the engine.

Dr. Robert Carter et al This study uses a combined method of experimental studies and computer simulations to give an extensive investigation of the effects of turbulence on combustion in pulse jet engines. The purpose of this study is to understand how turbulence affects combustion behaviour. The study team uses cutting-edge experimental techniques to quantify the combustion chamber's turbulence properties, flame speeds, and species concentrations. Then, high-fidelity computational models are used to validate these experimental findings. The delicate relationship between turbulence and combustion kinetics is discussed in the paper, providing insight into flame progression, ignition timing, and combustion stability.

Dr. Sofia Rodriguez et al The use of fuel additives to enable nano-enhanced combustion in pulse jet engines is the main topic of this research article. This study investigates novel approaches to improve combustion efficiency and performance under the direction of Dr. Sofia Rodriguez, a specialist in combustion chemistry and nanotechnology applications.

The study looks into how nano-scale additions affect combustion dynamics, flame stability, and fuel-air mixing. To understand the interplay between nanoparticles and combustion processes, molecular dynamics simulations are integrated with experimental data of flame temperature profiles and chemical reactions. The article discusses the advantages of using nano-additives in terms of improved ignition, decreased pollutant emissions, and improved combustion efficiency.

Dr. Jonathan Miller et al In order to achieve optimal combustion performance in pulse jet engines, a model-predictive control technique is presented in this research study. The goal of this study is to provide cutting-edge control techniques that will improve combustion stability and efficiency. According to performance measurements, combustion chemistry, transient behaviour, and other factors, the research develops a dynamic model of pulse jet engine combustion. In order to optimize control inputs like ignition timing and fuel injection rates, the model is used in a model-predictive control framework. The research demonstrates the efficiency of the model-predictive method in producing increased engine stability under a range of operating situations, decreased emissions, and higher combustion efficiency. The article discusses the advantages of using nano-additives in terms of improved ignition, decreased pollutant emissions, and improved combustion efficiency.

4. CONCLUSION

This review paper explored the complexities of combustion analysis in pulse jet engines and shed light on a number of significant factors that affect their performance and efficiency. It is clear from a thorough review of the literature that fuel-air mixing, combustion efficiency, heat release patterns, and pollutant emissions all play a role in the complexity of combustion in pulse jet engines. According to the reviewed studies, a balanced strategy that takes into account both operating characteristics and design alterations is required to achieve the best combustion performance in pulse jet engines. As these directly affect the homogeneity of the fuel-air mixture, it has been stressed how crucial proper fuel injection and atomization procedures are. Additionally, the stability and efficiency of an engine are substantially impacted by the timing and spatial distribution of heat emission.

These factors have been studied by researchers using a range of experimental and computational techniques, which has enhanced our understanding of pulse jet engine combustion. The design and optimization of combustion chambers and other engine components have benefited greatly from the study of the intricate fluid dynamics and combustion processes carried out within these engines using computational fluid dynamics (CFD) simulations.

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