

Difference between working gases in thermoacoustic engine

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Abstract. Presented paper includes description of design and assemblage of experimental device for evaluating difference between thermoacoustic device in which was used as working gas air and device in which was used as working gas helium.

1 Introduction

The interaction of heat and sound has been a subject of interest to scientists since 1816, when Laplace [1] corrected Newton's first theoretical calculation of the speed of sound in air. [2] Newton assumed that the acoustic expansions and compressions of the gas occurred isothermally, without any associated variations in the temperature of the gas.

Laplace included the effects of the changes in gas temperature that accompany the adiabatic expansions and compressions of the sound wave and derived the correct result for the adiabatic sound speed that was 18% faster than Newton's isothermal result. These thermal effects, which accompany sound waves, are essential to the operation of thermoacoustic engines and refrigerators. [3]

The term "thermoacoustics" was introduced by Nikolaus Rott. In the literal sense, Rott's claims is entirely justified, since the field is concerned with transformations between thermal and acoustical energy.

A detailed theoretical analysis of standing wave systems, based on the linear acoustics model was performed by Swift [4], who also provided some examples of the early developments at Los Alamos National Laboratory. He also provided a detailed analysis of a practical standing-wave engine where 7000W of thermal energy was converted to 630W of acoustic power [5].

Currently is engaged in thermoacoustic Los Alamos National Laboratory, University of Utah, University of Manchester, National Taiwan University and many other universities and research centres around the world.

2 Theory of thermoacoustic engines

Thermoacoustic devices are using simple design and reliable device, which are using interaction between heat and acoustics for energy conversion [4].

Between advantages of thermoacoustic devices belongs simple design. Thermoacoustic devices do not contains any moving parts, like are shafts, bearings, etc.

For operation that devices are not necessary any special, expensive or dangerous component materials, refills or lubricants. Hence are thermoacoustic devices therefrom view more nature friendly and cheaper for production, than other refrigerators or electric generators.

In view of possibility operation with low temperature gradient, is possible utilize waste heat from a lot of industrial and energetic processes.

Between disadvantages of thermoacoustic devices belongs fact, that currently the majority of thermoacoustic devices have low efficiency. Reason of this is that thermoacoustic phenomena is currently still in research stage.

But it is possible assume that efficiency will increase and thermoacoustic engines and prime movers start be more often used in practical applications.

2.1 Schematic and description of a thermoacoustic device

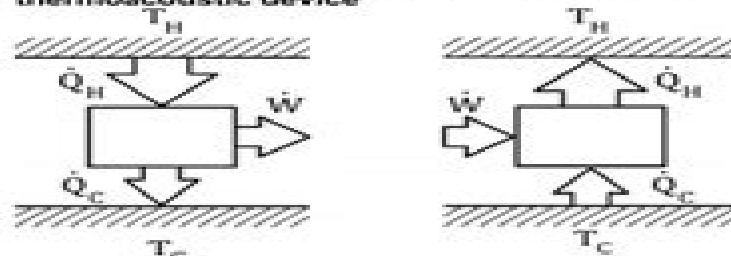


Figure 1. Schematic of function of thermoacoustic engine (left) and thermoacoustic heat pump (right)

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Difference Between Working Gases In Thermoacoustic Engine

Christos N. Markides, Kai Wang



Difference Between Working Gases In Thermoacoustic Engine:

Power Generation Technologies for Low-Temperature and Distributed Heat Christos N. Markides, Kai Wang, 2023-06-13 Power Generation Technologies for Low Temperature and Distributed Heat presents a systematic and detailed analysis of a wide range of power generation systems for low temperature lower than 700 800 C and distributed heat recovery applications Each technology presented is reviewed by a well known specialist to provide the reader with an accurate insightful and up to date understanding of the latest research and knowledge in the field Technologies are introduced before the fundamental concepts and theoretical technical and economic aspects are discussed as well as the practical performance expectations Cutting edge technical progress key applications markets as well as emerging and future trends are also provided presenting a multifaceted and complete view of the most suitable technologies A chapter on various options for thermal and electrical energy storage is also included with practical examples making this a valuable resource for engineers researchers policymakers and engineering students in the fields of thermal energy distributed power generation systems and renewable and clean energy technology systems Presents a wide range of power generation technologies based on thermomechanical cycles membrane technology thermochemical thermoelectric photoelectric and electrochemical effects Explains the fundamental concepts and underlying operation principles in each case and provides theoretical performance expectations and practical technical and economic characteristics Reviews the cutting edge technical progress key applications markets emerging and future trends and includes practical examples of all technologies Details advantages and disadvantages of each technology to allow the reader to make informed decisions of their own for different applications

Advances in Cryogenic Engineering Peter Kittel, 2013-11-11 The Oregon Convention Center Portland Oregon was the venue for the 1997 Cryogenic Engineering Conference The meeting was held jointly with the International Cryogenic Materials Conference John Barclay of the University of Victoria and David Smathers of Cabot Performance Materials were conference chairmen Portland is the home of Northwest Natural Gas a pioneer in the use of liquid natural gas and Portland State University where cryogenic research has long been conducted The program consisted of 350 CEC papers considerable more than CEC 95 This was the largest number of papers ever submitted to the CEC Of these 263 papers are published here in Volume 43 of Advances in Cryogenic Engineering Once again the volume is published in two books CEC PAPER REVIEW PROCESS Since 1954 Advances in Cryogenic Engineering has been the archival publication of papers presented at the biennial CEC ICMC conferences The publication includes invited unsolicited and government sponsored research papers in the research areas of cryogenic engineering and applications All of the papers published must 1 be presented at the conference 2 pass the peer review process and 3 report previously unpublished theoretical studies reviews or advances in cryogenic engineering

Proceedings of the Twentieth International Cryogenic Engineering Conference (ICEC20)
Liang Zhang, 2006-02-20 Proceedings of the 20th International Cryogenic Engineering Conference **Thermoacoustics**

Gregory W. Swift, 2017-10-05 This updated new edition provides an introduction to the field of thermoacoustics All of the key aspects of the topic are introduced with the goal of helping the reader to acquire both an intuitive understanding and the ability to design hardware build it and assess its performance Weaving together intuition mathematics and experimental results this text equips readers with the tools to bridge the fields of thermodynamics and acoustics At the same time it remains firmly grounded in experimental results basing its discussions on the distillation of a body of experiments spanning several decades and countries The book begins with detailed treatment of the fundamental physical laws that underlie thermoacoustics It then goes on to discuss key concepts including simple oscillations waves power and efficiency The remaining portions of the book delve into more advanced topics and address practical concerns in applications chapters on hardware and measurements With its careful progression and end of chapter exercises this book will appeal to graduate students in physics and engineering as well as researchers and practitioners in either acoustics or thermodynamics looking to explore the possibilities of thermoacoustics This revised and expanded second edition has been updated with an eye to modern technology including computer animations and DeltaEC examples

Stirling And Thermal-lag Engines: Motive Power Without The Co2 Allan J Organ, 2022-12-29 Existing literature focuses on the alleged merits of the Stirling engine These are indeed latent but decades on remain to be fully realised This is despite the fact that Stirling and other closed cycle prime movers offer a contribution to an ultra low carbon economy By contrast with solar panels the initial manufacture of Stirling engines makes no demands on scarce or exotic raw materials Further calculating embodied carbon per kWh favours the Stirling engine by a wide margin However the reader expecting to find the Stirling engine promoted as a panacea for energy problems may be surprised to find the reverse Stirling and Thermal Lag Engines reflects upon the fact that there is more to be gained by approaching its subject as a problem than as a solution The Achilles heel of the Stirling engine is a low numerical value of specific work defined as work per cycle per swept volume per unit of charge pressure and conventionally denoted Beale number NB Measured values remain unimproved since 1818 quantified here for the first time at 2% of the NB of the modern internal combustion engine The low figure is traced to incomplete utilisation of the working gas Only a small percentage of the charge gas if any is processed through a complete cycle i e between temperature extremes The book offers ready made tools including a simplified algorithm for particle trajectory map construction an author patented mechanism delivering optimised working gas distribution flow and heat transfer data re acquired in context and an illustrated re derivation of the academically respected Method of Characteristics which now copes with shock formation and flow area discontinuities All formulations are presented in sufficient detail to allow the reader to pick up and run with them using the data offered in the book The various strands are drawn together in a comprehensively engineered design of an internally focusing solar Stirling engine presented in a form allowing a reader with access to basic machining facilities to construct one The sun does not always shine But neither will the oil always flow This new title offers an entr e to technology appropriate to

the 21st century Cryocoolers 12 Ronald G. Jr. Ross, 2007-05-08 The last two years have witnessed a continuation in the breakthrough shift toward pulse tube cryocoolers for long life high reliability cryocooler applications One class of pulse tubes that has reached maturity is referred to as Stirling type because they are based on the linear Oxford Stirling cooler type compressor these generally provide cooling in the 30 to 100 K temperature range and operate at frequencies from 30 to 60 Hz The other type of pulse tube cooler making great advances is the so called Gifford McMahon type Pulse tube coolers of this type use a G M type compressor and lower frequency operation to achieve temperatures in the 2 to 10 K temperature range Nearly a third of this proceedings covers these new developments in the pulse tube arena Complementing the work on low temperature pulse tubes is substantial continued progress on rare earth regenerator materials and Gifford McMahon coolers These technologies continue to make great progress in opening up the 2 4 K market Also in the commercial sector continued interest is being shown in the development of long life low cost cryocoolers for the emerging high temperature superconductor electronics market particularly the cellular telephone base station market At higher temperature levels closed cycle J T or throttle cycle refrigerators are taking advantage of mixed refrigerant gases to achieve low cost cryocooler systems in the 65 to 80 K temperature range Protocells Steen Rasmussen, Mark A. Bedau, Liaohai Chen, David Deamer, David C. Krakauer, 2022-06-07 The first comprehensive general resource on state of the art protocell research describing current approaches to making new forms of life from scratch in the laboratory Protocells offers a comprehensive resource on current attempts to create simple forms of life from scratch in the laboratory These minimal versions of cells known as protocells are entities with lifelike properties created from nonliving materials and the book provides in depth investigations of processes at the interface between nonliving and living matter Chapters by experts in the field put this state of the art research in the context of theory laboratory work and computer simulations on the components and properties of protocells The book also provides perspectives on research in related areas and such broader societal issues as commercial applications and ethical considerations The book covers all major scientific approaches to creating minimal life both in the laboratory and in simulation It emphasizes the bottom up view of physicists chemists and material scientists but also includes the molecular biologists top down approach and the origin of life perspective The capacity to engineer living technology could have an enormous socioeconomic impact and could bring both good and ill Protocells promises to be the essential reference for research on bottom up assembly of life and living technology for years to come It is written to be both resource and inspiration for scientists working in this exciting and important field and a definitive text for the interested layman

Smart Structures: From Concepts To Applications Amr M Baz, 2024-08-16 This book presents a comprehensive coverage of smart structures from the basic concepts to a wide spectrum of critical applications including piezoelectric based sensors actuators and self sensing actuators Throughout the book attempts have been made to develop electrical analogies of the structural piezoelectric interactions The book is organized into seven chapters The first three chapters cover the basic

concepts of structural dynamics control piezoelectric actuators and piezoelectric sensors The following four chapters cover a wide range of important applications in active vibration control passive shunted piezoelectric networks comprehensive piezoelectric energy harvesting technology and piezoelectric based periodic and metamaterial structures Every chapter concludes with several problems

Cryocoolers 13 Ronald G. Ross, 2007-02-15 The last two years have witnessed a continuation in the breakthrough shift toward pulse tube cryocoolers for long life high reliability cryocooler applications New this year are papers describing the development of very large pulse tube cryocoolers to provide up to 1500 watts of cooling for industrial applications such as cooling the superconducting magnets of Mag lev trains cooling superconducting cables for the power industry and liquefying natural gas Pulse tube coolers can be driven by several competing compressor technologies One class of pulse tube coolers is referred to as Stirling type because they are based on the linear Oxford Stirling cooler type compressor these generally provide cooling in the 30 to 100 K temperature range and operate at frequencies from 30 to 60 Hz A second type of pulse tube cooler is the so called Gifford McMahon type Pulse tube coolers of this type use a G M type compressor and lower frequency operation 1 Hz to achieve temperatures in the 2 to 10 K temperature range The third type of pulse tube cooler is driven by a thermoacoustic oscillator a heat engine that functions well in remote environments where electricity is not readily available All three types are described and in total nearly half of this proceedings covers new developments in the pulse tube arena Complementing the work on low temperature pulse tube and Gifford McMahon cryocoolers is substantial continued progress on rare earth regenerator materials

Innovations in Mechanical Engineering G. S. V. L. Narasimham, A. Veeresh Babu, S. Sreenatha Reddy, Rajagopal Dhanasekaran, 2022-03-02 This book comprises select proceedings of the International Conference on Innovations in Mechanical Engineering ICIME 2021 It presents innovative ideas and new findings in the field of mechanical engineering Various topics covered in this book are aerospace engineering automobile engineering thermal engineering renewable energy sources bio mechanics fluid mechanics MEMS mechatronics robotics CAD CAM CAE CFD design and optimization tribology materials engineering and metallurgy surface engineering nanotechnology polymer science manufacturing production management industrial engineering and rapid prototyping This book will be useful for the students researchers and professionals working in the various areas of mechanical engineering

Heat Transfer Enhancement of Heat Exchangers Sadik Kakaç, Arthur E. Bergles, F. Mayinger, Hafit Yüncü, 2013-03-09 Heat transfer enhancement in single phase and two phase flow heat exchangers is important in such industrial applications as power generating plant process and chemical industry heating ventilation air conditioning and refrigeration systems and the cooling of electronic equipment Energy savings are of primary importance in the design of such systems leading to more efficient environmentally friendly devices This book provides invaluable information for such purposes

EngOpt 2018 Proceedings of the 6th International Conference on Engineering Optimization H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, A.L. Araújo, J.M. Guedes, J.O. Folgado, F. Moleiro, J. F. A.

Madeira,2018-09-13 The papers in this volume focus on the following topics design optimization and inverse problems numerical optimization techniques efficient analysis and reanalysis techniques sensitivity analysis and industrial applications The conference EngOpt brings together engineers applied mathematicians and computer scientists working on research development and practical application of optimization methods in all engineering disciplines and applied sciences *Los Alamos Science* ,1983

The 5th International Conference on Vibration and Energy Harvesting Applications (VEH 2024) Lihua Tang,Kean Aw,Guobiao Hu,Junlei Wang,2025-03-24 This book presents select proceedings of the 5th International Conference on Vibration and Energy Harvesting Applications VEH 2024 This book covers latest research and technological advances in the field of vibration analysis energy harvesting and its applications Topics covered in the book include innovative research works related to vibration analysis energy harvesting their applications and results on the mechanical design optimization dynamics power management circuits and systems MEMS technology nanotechnology new materials self powered IoT applications and other related areas The book can be a valuable reference for researchers and professionals interested in vibration analysis energy harvesting its applications and allied fields Scientific and Technical Aerospace Reports ,1992

Reducing Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two National Academies of Sciences, Engineering, and Medicine,Transportation Research Board,Division on Engineering and Physical Sciences,Board on Energy and Environmental Systems,Committee on Assessment of Technologies and Approaches for Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles, Phase Two,2020-05-15 Medium and heavy duty trucks motor coaches and transit buses collectively medium and heavy duty vehicles or MHDVs are used in every sector of the economy The fuel consumption and greenhouse gas emissions of MHDVs have become a focus of legislative and regulatory action in the past few years This study is a follow on to the National Research Council s 2010 report Technologies and Approaches to Reducing the Fuel Consumption of Medium and Heavy Duty Vehicles That report provided a series of findings and recommendations on the development of regulations for reducing fuel consumption of MHDVs On September 15 2011 NHTSA and EPA finalized joint Phase I rules to establish a comprehensive Heavy Duty National Program to reduce greenhouse gas emissions and fuel consumption for on road medium and heavy duty vehicles As NHTSA and EPA began working on a second round of standards the National Academies issued another report Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium and Heavy Duty Vehicles Phase Two First Report providing recommendations for the Phase II standards This third and final report focuses on a possible third phase of regulations to be promulgated by these agencies in the next decade

Smart Innovation in Mechanical Engineering Abdel El Kharbachi,Ika Dewi Wijayanti,Putu Suwarta,Ivan Tolj,2025-03-16 This book presents the select proceedings of the 6th International Conference on Mechanical Engineering ICOME held from 30 to 31 August in Bali Indonesia ICOME is a series of international conferences in mechanical engineering held every two years in Indonesia The covered topics include

aerodynamics and fluid mechanics air conditioning and cooling systems turbomachinery and alternative fuels modeling simulation and optimization thermodynamics and heat transfer and combustion systems This book also covers advanced topics in materials for medical devices defense industrial independence and mechanical science and technology advances Given the contents the book is useful for students researchers and professionals in the area of mechanical engineering and materials

Selected Problems in Fluid Flow and Heat Transfer Artur J. Jaworski, 2019-09-20 Fluid flow and heat transfer processes play an important role in many areas of science and engineering from the planetary scale e g influencing weather and climate to the microscopic scales of enhancing heat transfer by the use of nanofluids understood in the broadest possible sense they also underpin the performance of many energy systems This topical Special Issue of *Energies* is dedicated to the recent advances in this very broad field This book will be of interest to readers not only in the fields of mechanical aerospace chemical process and petroleum energy earth civil and flow instrumentation engineering but equally biological and medical sciences as well as physics and mathematics that is anywhere that fluid flow and heat transfer phenomena may play an important role or be a subject of worthy research pursuits

Low Temperature and Cryogenic Refrigeration Sadik Kakaç, M.R. Avelino, H.F. Smirnov, 2012-12-06 Refrigeration plays a prominent role in our everyday lives and cryogenics plays a major role in medical science space technology and the cooling of low temperature electronics This volume contains chapters on basic refrigeration systems non compression refrigeration and cooling and topics related to global environmental issues alternative refrigerants optimum refrigerant selection cost quality optimization of refrigerants advanced thermodynamics of reverse cycle machines applications in medicine cryogenics heat pipes gas solid absorption refrigeration multisalt resorption heat pumps cryocoolers thermoacoustic refrigeration cryogenic heat transfer and enhancement and other topics covering theory design and applications such as pulse tube refrigeration which is the most efficient of all cryocoolers and can be used in space missions

Recent Trends in Physics of Material Science and Technology Ford Lumban Gaol, Keshav Shrivastava, Jamil Akhtar, 2014-12-27 This book discusses in detail the recent trends in Computational Physics Nano physics and Devices Technology Numerous modern devices with very high accuracy are explored In conditions such as longevity and extended possibilities to work in wide temperature and pressure ranges aggressive media etc This edited volume presents 32 selected papers of the 2013 International Conference on Science Engineering in Mathematics Chemistry and Physics The book is divided into three scientific Sections i Computational Physics ii Nanophysics and Technology iii Devices and Systems and is addressed to Professors post graduate students scientists and engineers taking part in R D of nano materials ferro piezoelectrics computational Physics and devices system and also different devices based on broad applications in different areas of modern science and technology

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