

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

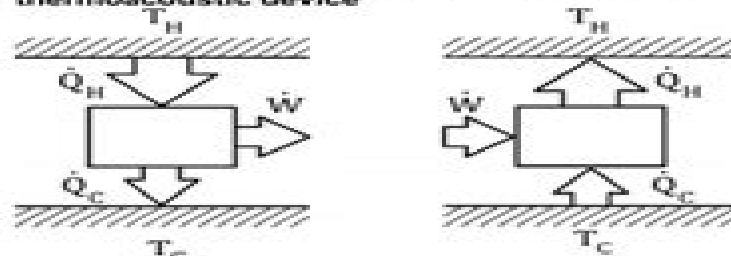


Figure 1. Schematic of function of thermoacoustic engine (left) and thermoacoustic heat pump (right)

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Difference Between Working Gases In Thermoacoustic Engine

Peter Kittel



Difference Between Working Gases In Thermoacoustic Engine:

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

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

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

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

Proceedings of the 20th International Cryogenic Engineering Conference **Recent Advances in Thermal Sciences and Engineering** Hemant B. Mehta, Manish K. Rathod, Rufat Abiev, Müslüm Arıcı, 2023-05-05 This book presents select proceedings of the International Conference on Advances in Fluid Flow and Thermal Sciences ICAFFTS 2021 and summarizes the modern research practices in thermal sciences and engineering The content of book involves advanced topics in heat transfer science automobile refrigeration and air conditioning cryogenics non conventional systems and energy storage Topics on cutting edge research in the area of hybrid nano PCM based systems solar based applications bio diesel and nano additives based combustion fuel cell and thermoacoustic engine are also included In addition this book contains recent research in the area of two phase thermal management of Li Ion Li titanium battery and LED systems using heat sink heat pipe pulsating heat pipe and thermosyphon with next generation refrigerants PCM and nanofluid Some thermal aspects of virus aerosol research advances in volumetric velocimetry and application of artificial intelligence in thermal systems are also covered This book is a valuable reference for academicians researchers and professionals working in the various fields of thermal sciences **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

Energy Production and Management in the 21st Century II C.A. Brebbia,F. Polonara,E.R. Magaril,G. Passerini,2016-09-28 Discussing the future of energy production and management in a changing world this book presents the proceedings of the 2nd International Conference on Energy Production and Management in the 21st Century The Quest for Sustainable Energy The intention of the book is to examine the future of energy production and management in a changing world and follows on from the first and very successful meeting held in Ekaterinburg Russia in 2014 Developed societies require an ever increasing amount of energy resources which creates complex technological challenges The challenge in many cases is the conversion of new sources of energy into useful forms such as electricity heat and fuel while finding efficient ways of storing and distributing energy Equal challenges lie with the production of such renewable energy at an acceptable cost including damage to the environment as well as with integration of those resources into the existing infrastructure The book deliberates the energy use of industrial processes including the imbedded energy contents of materials such as those in the built environment Energy production distribution and usage result in environmental risks which need to be better understood They are part of the energy economics and relate to human environmental health as well as ecosystems behaviour A number of topics are covered including Energy and the city Energy security Energy distribution Energy networks Processing of oil and gas emissions Pipelines Renewable energies Energy use in building Industry and transport Safety management Tight energy fields Energy and climate change and Biomass and biofuels *Los Alamos Science* ,1983

Handbook of Acoustics Malcolm J. Crocker,1998-03-09 Acoustical engineers researchers architects and designers need a comprehensive single volume reference that provides quick and convenient access to important information answers and questions on a broad spectrum of topics and helps solve the toughest problems in acoustical design and engineering The Handbook of Acoustics meets that need It offers concise coverage of the science and engineering of acoustics and vibration In more than

100 clearly written chapters experts from around the world share their knowledge and expertise in topics ranging from basic aerodynamics and jet noise to acoustical signal processing and from the interaction of fluid motion and sound to infrasound ultrasonics and quantum acoustics Topics covered include General linear acoustics Nonlinear acoustics and cavitation Aeroacoustics and atmospheric sound Mechanical vibrations and shock Statistical methods in acoustics Architectural acoustics Physiological acoustics Underwater sound Ultrasonics quantum acoustics and physical aspects of sound Noise its effects and control Acoustical signal processing Psychological acoustics Speech communication Music and musical acoustics Acoustical measurements and instrumentation Transducers The Handbook of Acoustics belongs on the reference shelf of every engineer architect research scientist or designer with a professional interest in the propagation control transmission and effects of sound

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

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

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 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 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 in 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 *Innovation in Nonlinear Acoustics: ISNA 17* Anthony A. Atchley,Victor W. Sparrow,Robert M. Keolian,2006-06-09 State College Pennsylvania 18 22 July 2005

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 *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

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