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Difference between working gases in thermoacoustic engine

Martin Veselý[1,a], Tomáš Vít[1]

[1]Technical University of Liberec, Studentská 2 Liberec 461 17, Czech Republic

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 claim 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].

[a]Corresponding author: martin.vesely3@tul.cz

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

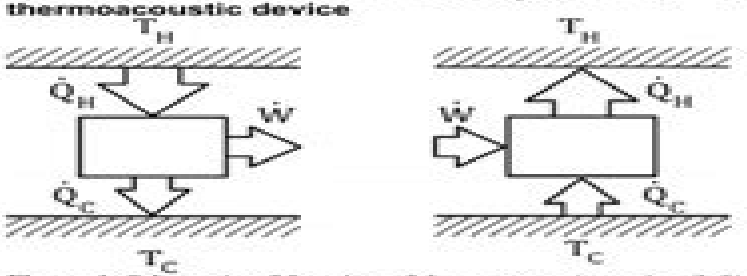

Figure 1. Schematic of function of thermoacoustic engine (left) and thermoacoustic heat pump (right)

Difference Between Working Gases In Thermoacoustic Engine

David Kirk

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

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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

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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 Accoustics: 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

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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 *Scientific and Technical Aerospace Reports* ,1992 **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

Difference Between Working Gases In Thermoacoustic Engine Book Review: Unveiling the Power of Words

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