The 8th International Symposium on Clean and High-Efficiency Combustion in Engines (ISCE 2022)

Documents

Hosted by

State Key Laboratory of Engines (SKLE), Tianjin University
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Agenda

August 12th : The eighth International Symposium on Clean and High-Efficiency Combustion in Engines

Conference Venue

Fontaine Blanche Hotel, Kunming, China
768Juxian Ave. University town, Chenggong district Kunming city, Yunnan China

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Emergency-Aid telephone number

Crime emergency	110
Fire emergency	119
Medical-aid telephone	120

Technical Program

08:00—08:15	Opening ceremony	
Session 1 (Chinese Presentation)		Chair: TBD
08:15—08:50	Combustion Homogenization Is An High Efficiency And Low Emissions Approach For Diesel Engines	Prof. Wanhua Su Tianjin University
08:50—09:25	Soot prediction for engine fuels based on data-driven intelligent algorithm	Prof. Zhen Huang Shanghai Jiao Tong University
09:25—09:55	集成控制技术推进 RCCI 发动机的高效清洁燃烧	Prof. Lizhong Shen Kunming University of Science and Technology
09:55—10:20	Coffee break	
Session 2 (English Presentation)		Chair: TBD
10:20—10:55	Stratified Charge Formation and Combustion of Hydrogen for Engine Application	Prof. Choonsik Bae Korea Advanced Institute of Science and Technology
10:55—11:30	Recent advances and remaining needs for science-based optimization of internal combustion engines	Dr. Paul Miles Sandia National Laboratories
11:30—12:00	The future of the internal combustion engine	Prof. Rolf D. Reitz University of Wisconsin, Madison
12:00—13:30	Lunch	
Session 3 (Chinese Presentation)		Chair: TBD
13:30—14:00	新一代通航涡电复合发动机研究及发展	Prof. Yangjun Zhang Tsinghua University
14:00—14:30	基于振动的柴油机状态辨识技术	Dr. Fengchun Liu China North Engine Research Intitute
14:30—15:00	基于射流点火方式的汽油机高效燃烧技术研究与探索	Dr. Hong Chen GAC Group
15:00—15:30	氢气发动机的开发	Dr. Xucong Li FEV China
15:30—15:45	Coffee break	
Session 4 (English Presentation)		Chair: TBD

15:45—16:20	Advances in Pre-chamber Combustion Technology for Fuel-Flexible High Efficiency Engines	Prof. Hong Im King Abdullah University of Science and Technology
16:20—16:55	Current Status and Issues of IC Engine Study for Carbon Neutrality	Prof. Yasuo Moriyoshi Chiba University
16:55—17:30	Hydrogen ICE for CO2 Neutral Transport	Mr. Bernhard Raser AVL List GmbH
17:30—18:05	IC Engine Powertrain Technology	Prof. Hua Zhao Brunel University London
18:05—20:00	Dinner	

Introduction to Keynote Speakers

Combustion Homogenization Is An High Efficiency And Low Emissions Approach For Diesel Engines

Prof. Wanhua Su, State Key Laboratory of Engines, Tianjin University, China

Wanhua Su is a Professor of State Key Laboratory of Engines, Tianjin University, China. He graduated from Tianjin University in 1965 and got postgraduate diploma in Internal Combustion Engine in 1968. He is a member of Chinese Academy of Engineering and a chief scientist of Major State Fundamental Research Development Program of China (973 Program), and has been focusing on the field of Engine Combustion and Engine Control.

Speech Abstract

Based on the inherent thermodynamic and chemical non-equilibrium properties of internal combustion engine, the description method and mathematical model of non-equilibrium thermodynamic and chemical dynamics and related parameters are established. The concepts of low exergy loss combustion and low loss thermodynamic parameters for internal combustion engines are presented. The lean HCCI combustion processes can achieve effective engine thermal efficiency of more than 60% when heat transfer losses are effectively reduced.

The goal of achieving lean HCCI combustion in the early stage was entrusted to LTC low-temperature combustion technology. We proposed the co-control theory of combustion boundary conditions and fuel chemistry. By controlling working medium temperature and pressure, as well as fuel chemical characteristics, controllable homogeneous compression combustion low-temperature combustion can be achieved under a load of IMEP equal to about 1.1MPa, and ITEg can reach 53%. However, for high load diesel engines, especially super-intensified diesel engines, the combustion duration is too long to achieve the goal of high efficiency and low emissions. The key to solve this bottleneck is to have ideal spray characteristics.

The spray characteristic of diesel engine has the most direct influence on the combustion path of spray. The famous φ-T diagram (Kamimoto and Kitamura et al.) reveals the effect of spray equivalent ratio distribution on combustion rate and release temperature during spray combustion, and then predicts the composition of combustion products. Further studies suggest that lean HCCI combustion with fuel of high cetane number is the combustion mode of the most efficient and cleaner. Because the LHCCI combustion mode can eliminate any conditions that produce soot and nitrogen oxides, it can control the ignition phase, it can control the combustion rate, and it can have the most reasonable combustion duration. In the final analysis, the efficient and clean combustion of lean-burn homogeneous diesel engine lies in the realization of ideal spray characteristics. In our study, the ideal spray characteristics are summed up as the mass fraction of thin mixture ($1 \geqslant \Phi \geqslant 0$) in spray should be greater than 50%.

The pursuit of "ideal spray characteristics" should be the core of diesel engine combustion science and technology.

Soot prediction for engine fuels based on data-driven intelligent algorithm

Prof. Zhen Huang, Shanghai Jiao Tong University, China

Zhen Huang, 中国工程院院士，国际燃烧学会 Fellow，上海交通大学讲席教授，智慧能源创新学院院长。中国民主促进会中央委员会副主席，全国政协常委。主要从事发动机新型燃烧模式、低碳零碳燃料相关研究。发表学术著作 3 部、论文 300 余篇，获国家自然科学奖二等奖 1 项、国家技术发明奖二等奖 1 项。中国工程院院刊《Frontiers in Energy》执行主编，Energy Sci. Eng. 和 Int. J. Engine Res.编委。

Speech Abstract

本报告提出了数据融合的智能算法与发动机燃料碳烟研究相结合的新方法。建立了多燃料适应性的成烟倾向预测方法，探究不同分子结构和燃料组分及其耦合作用等对碳烟生成特性的影响规律，对燃料设计理论具有重要支撑，也从成烟倾向角度为模型燃料构建提供了优化途径。进一步结合机器学习算法与火焰三维重构技术有效预测湍流火焰中的三维碳烟分布，为内燃机缸内碳烟颗粒生成研究提供了新的有效手段。

集成控制技术推进 RCCI 发动机的高效清洁燃烧

Prof. Lizhong Shen, Kunming University of Science and Technology, China

Lizhong Shen，男，1956 年 4 月生，教授，博士生导师。1987 年毕业于浙江大学，获工学硕士学位，1994 年受国家教委委派以高级访问学者的身份在德国不伦瑞克技术大学内燃机研究所进修一年。现兼任中国内燃机学会监事，中国内燃机学会高原内燃机分会主任委员。长期致力于内燃机学科的建设与发展工作，在高原内燃机研究方面业绩卓著。主持各类科研 50 余项，其中国家自然科学基金项目 5 项，省级重点科技项目 6 项；在国内外核心期刊发表论文 100 余篇，其中 SCI/EI 检索论文 60 余篇。获云南省科技进步二等奖 2 项、云南省科技进步三等奖 4 项，排名均为第一；获中国内燃机学会突出贡献奖。获国家授权专利 45 项，其中发明专利 5 项。开创了高校与企业的无缝对接的产学研合作模式，领衔建立了以高原特色为研究方向的云南省内燃机重点实验室。担任昆明理工鼎擎科技股份有限公司董事长。

Speech Abstract

内燃机的 RCCI 燃烧方式是实现低碳高效清洁燃烧的一种技术路线。如何更好地在柴油机中采用第二种燃料，在柴油引燃下实现 RCCI 燃烧方式，满足国六排放法规要求，控制技术与控制策略成为实现 RCCI 燃烧方式的核心技术。报告系统分析了集成控制器的技术构成与实现。以甲醇/柴油双燃料发动机为例，从全工况控制、工况切换、瞬态控制、DPF 的再生、高原环境下的功率恢复，以及发动机的保护与安全性等方面进行论述，进一步证明了集成控制器实现 RCCI 燃烧的技术先进性。

Stratified Charge Formation and Combustion of Hydrogen for Engine Application

Professor Choonsik Bae, Korea Advanced Institute of Science and Technology, Korea

Professor Choongsik Bae joined the faculty of the Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology (KAIST) in 1998. From 2014 to 2017, he served as Chair, School of Mechanical and Aerospace Engineering and Head of Mechanical Engineering. He is also the director of Combustion Engineering Research Center (CERC) in KAIST, vitalizing the efforts in research as well as education. He was the Chair of IEA IA ECERC (International Energy Agency Implementing Agreement Energy Conservation and Emission Reductions in Combustion) leading international collaborative tasks in combustion technology among 12 OECD countries through 2011 to 2012. He was the visiting professor of University College of London in 2005 and the invited professor of Tokyo Institute of Technology from 2012. He is also active in the interaction with the industry that he has worked as a Technical Advisor of Hyundai Motors on the occasion of his sabbatical leave in 2011 to 2012. He visited Imperial College of London as an invited professor 2017-2018. From 2018, he served as the President of ILASS-Korea (Institute for Liquid Atomization and Spray Systems – Korea), and as the Vice-President of KSAE (Korean Society of Automotive Engineers). He was invited as a member of NAEK (The National Academy of Engineering of Korea) in 2019, credited for his achievement on teaching and research. He has been the Dean of College of Engineering in KAIST during 2019-2020, working for innovation in engineering education. He also has led an emergency initiative to develop quarantine system to counter COVID-19 fully utilizing science and technology as a Director of Mobile Clinic Module Project. He received Arch T. Colwell Merit Award in 1997 and Harry Horning Memorial Award in 2006 from Society of Automotive Engineers (SAE) for his outstanding contribution to the literatures in powerplant system. He was elected as a fellow of SAE in 2012. He received Academic Award from Korean Society of Automotive Engineers in 2004 and Distinguished Research Award from KAIST in 2011. He received A Man of Merit Award from Ministry of Knowledge Economy (MKE) in 2012. He received the Distinguished Service Award from KAIST in 2018, an Academic Award from Daejeon Metropolitan City in 2019, and Presidential Award in 2021 for the development of Korean vehicle industries.

Speech Abstract

Hydrogen is considered a promising fuel to realize carbon-neutral transportation applied in internal combustion engines. Due to the low-energy density of hydrogen, a high-pressure injection is required to implement a high-load operation in a confined injection time. To understand the jet behavior, the hydrogen jet has been visualized in a constant volume chamber (CVC) under the injection pressure of 10 MPa. The jet structure was captured with schlieren high-speed imaging under various ambient pressure conditions. Furthermore, the hydrogen rich-area has been measured

by laser-induced breakdown spectroscopy. The optical diagnostics were adopted to investigate the characteristics of hydrogen stratified charged combustion. Finally, the hydrogen stratified charged combustion was investigated in a single-cylinder research engine which has a volume of 0.5 L. Although hydrogen has a high diffusivity, the stratification of hydrogen jet was feasible in high ambient pressure. The visible range of wavelength was emitted when the hydrogen formed a highly-rich mixture. The basic engine experiment results indicated that stratified hydrogen can reduce the heat transfer loss compared to that of the homogeneous charged mixture condition. However, a locally rich-hydrogen mixture is accompanied by high NOX emissions. Therefore, stratified charged hydrogen combustion was feasible and could improve the efficiency of the engine by reducing heat loss characteristics but the problem of NOx should be resolved.

Fuel/Engine Interactions: Potential for Efficiency Improvement

Dr. Paul Miles, Sandia Lab, USA

Paul C. Miles manages Applied Combustion Research at Sandia National Laboratories where he has actively researched flow, mixing, and combustion processes for over 3 decades. Dr. Miles is a Fellow of the Society of Automotive Engineers (SAE), and has been recognized with several awards for technical and programmatic accomplishments by the SAE, ASME, and USDRIVE. He is a past co-chair of the SAE Powertrain, Fuels and Lubricants activities and serves as the Operating Agent for the International Energy Agency Combustion Technology Collaboration Programme. Dr. Miles also serves as an associate editor of the SAE Journal of Engines, is a member of the editorial board of the International Journal of Engine Research, and serves on the advisory or organizing committees of several international conferences. He received his PhD in Mechanical Engineering from Cornell University, following a BSME from the Georgia Institute of Technology.

Speech Abstract

Despite the recent advances of electrified powertrains, improvements in the efficiency and emissions of the internal combustion engine will be needed to meet global goals of CO2 emission reduction and to protect local environments. These improvements will rely to a significant extent on science-based optimization using the computational models that have been developed over the last four decades. This presentation reviews modeling advances in several key areas and identifies key topics where further progress is needed not only to improve performance and emissions but to also adapt engine technologies to future renewable fuels.

The future of the internal combustion engine

Prof. Rolf D. Reitz, University of Wisconsin, Madison, USA

Prof. Rolf D. Reitz received the PhD degree in Mechanical and Aerospace Engineering from Princeton University in 1978. He joined UW-Madison in 1989 and was named Wisconsin Distinguished Professor from 1999 to 2015 when he became Emeritus. He also has had an extensive record of achievement in the private sector as a Research Staff member at the General Motors Research Laboratories (1982-89) and as co-founder of Wisconsin Engine Research Consultants, LLC in 1999. He has served as chair of the Institute of Liquid Atomization and Spraying Systems--North and South America and is former director of the UW-Madison Mechanical Engineering Department's world-renowned Engine Research Center. He is co-founder and coEditor (Americas) of the International Journal of Engine Research, and he was the founding Editor-in-Chief of the Frontiers Journal of Engine and Automotive Engineering. He has published over 550 journal papers with a google h-index over 100, and he has received numerous professional awards, including the ASME Soichiro Honda Medal and Internal Combustion Engine Awards, the DOE Vehicle Technologies R&D Program Award, the ETH Zurich Aurel Stodola Medal, the ICLASS Arthur H. Lefebvre Award, plus many SAE awards (Myers, Johnson, Horning).

Speech Abstract

Internal combustion (IC) engines operating on fossil fuels provide about 25% of the world's power (about 3000 out of 13,000 million tons oil equivalent per year), and in doing so, they produce about 15% of the world's greenhouse gas (GHG) emissions. Reducing fuel consumption and emissions has been the goal of engine researchers and manufacturers for decades. Indeed, major advances have been made, making today's IC engine a technological marvel. However, the reputation of IC engines has been dealt a severe blow by recent emission scandals, as well as by concerns for the environment that require renewed research efforts toward the reduction of transportation sector emissions. Currently there is a trend to replace fossil-fuel powered IC engines with electric-drives or engines powered with alternative low carbon fuels with the goals of further reducing fuel consumption and emissions, and to decrease vehicle GHG emissions. As responsible engineers and stewards of the environment for future generations, it is up to our community to provide an assessment of progress made in the development of IC engines over the past century to meet the world's mobility and power generation needs, and to assess the potential for future benefits offered by competitor technologies to make responsible recommendations for future directions. This presentation will discuss future prospects for the IC engine.

Electric Turbocompund Engine for General Aviation

Prof. Yangjun Zhang, Tsinghua University, China

Prof. Yangjun Zhang，清华大学车辆与运载学院教授，教育部长江学者特聘教授；1995 年获北京航空航天大学航空发动机专业工学博士学位。主要从事发动机流体力学理论、涡增涡电动力技术及其在汽车和航空等运载领域应用的研究。获国家科技进步二等奖 2 项，获中国机械工业技术发明一等奖等省部级奖 7 项，为莱特兄弟奖章中国首位获得者。现为汽车安全与节能国家重点实验室常务副主任、中国空天动力联合会新型能源动力专委会主任、中国通用航空产业联盟副理事长，国际流体机械与系统杂志（IJFMS）主编。

Speech Abstract

飞行汽车即将开启低空智能交通的新通航时代，为通航动力发展带来了新机遇，同时也对通航动力提出了电动化发展新要求。以高性能涡电增压、高功率密度电机和高效热电管理为核心关键技术的高功率密度涡增内燃机电动力，是新一代通航动力的重要发展方向。突破高功率密度涡增内燃机电动力的核心关键技术，抢占新一代通航动力科技制高点，研发新一代通航涡增内燃机电动力系统产品，将为智能低空物流和出行发展提供动力支撑，将实现通航动力技术的跨越发展。新一代通航涡增内燃机电动力技术的研究及发展，将促进我国新型无人装备研发和现役无人装备改进，有效解决现有无人装备纯电动力续航时间短、传统内燃机动力不能实现分布式推进等瓶颈问题，满足新域新质国防装备发展需求。

基于振动的柴油机状态辨识技术

Dr. Fengchun Liu, China North Engine Research Intitute, China

Dr. Fengchun Liu 中国北方发动机研究所研究员，发动机测试技术专业团队负责人。长期从事大功率柴油机的试验测试技术研究工作，曾参研国家自然科学基金、国防基础预研、国家重大型号研制等科研和工程项目 10 多项，曾获得省部级科学技术进步奖 2 项。

Speech Abstract

新研动力产品样机验证阶段故障较多，设计师往往直接通过强化故障件结构强度、提升材料特性以及改善加工工艺等措施提升薄弱部位的工作可靠性，而忽略了工作振动引起的破坏，最终使产品重量和生产成本偏离目标、定型周期延长。经过多年研究和验证，可其工作，振动形态分析和预判，提前发现部件工作载荷高于设计值的异常影响因素。基于振动的柴油机状态辨识技术能快速定位异常部件，可对柴油机故障机理准确辨识，进而提出针对性的改善方法，满足柴油机长期稳定可靠运行要求。该技术的应用为柴油机研制优化验证过程提供了一种高效的评估方法。

基于射流点火方式的汽油机高效燃烧技术研究与探索

Dr. Hong Chen, GAC Group, China

Dr. Hong Chen， 2014 年获同济大学工学博士学位，现为高级工程师职称，任广州汽车集团股份有限公司汽车工程研究院能源应用室主任。长期从事发动机燃烧技术的研究，主持广汽传祺 10 余款发动机燃烧控制系统的设计与开发，负责超高热效率先进燃烧技术矩阵的探索与研究，曾获多项省市级、行业内奖项。

Speech Abstract

本研究针对汽油发动机高效燃烧及超低排放控制的需要，设计开发了汽油机专用预燃室点火系统，实现预燃室喷油与点火系统的集成化布置。基于热力学单缸机试验开发平台，结合超稀薄燃烧模式，试验研究了不同点火技术对稀薄燃烧汽油机热效率改善潜力，分析了预燃室结构参数及燃烧系统核心控制参数对汽油机燃烧及排放特性的影响规律，探索了基于射流点火的汽油机高效燃烧技术路径，结合燃烧化学动力学分析手段，深入揭示了射流火焰形成及其与缸内混合气相互作用与引燃机理，为汽油机预燃室射流点火技术工程化应用提供理论支撑与基础研究数据。

氢气发动机的开发

Dr. Xucong Li, FEV China

Dr. Xucong Li， FEV 中国，高级项目经理，参与过关键项目包括甲醇裂离气在点燃式发动机上的应用、甲醇和柴油双燃料发动机在内燃机上的应用、氢气和气体发动机的开发和应用、汽油机后处理硬件的开发和应用、汽油机后处理包括三元催化和 GPF 的标定等。专业经验代用燃料包括氢气，甲醇和天在发动机上的应用技术、柴油机燃烧系统开发和标定、天然气发动机和柴油机车辆的后处理硬件的开发标定等。

Speech Abstract

目前，节能减排是全球汽车行业发展的必然趋势。电子合成燃料（氢气，氨气以及甲醇等）在内燃机上的应用在现有汽车工业基础上是切实可行而且能够快速实现的思路。氢气从生产到应用技术日益成熟，在发动机上的应用可以实现零碳排放，前景十分光明。本报告主要从以下几个方面对氢气发动机的研发进行介绍：氢气发动机研发应用的背景和驱动力、氢气发动机在不同应用场景的技术路线、氢气发动机关键技术开发，包括喷雾光学研究、燃烧系统仿真以及排放系统开发，以及 FEV 研发能力和案例介绍等。

Advances in Pre-chamber Combustion Technology for Fuel-Flexible High Efficiency Engines

Prof. Hong Im, King Abdullah University of Science and Technology, Saudi Arabia

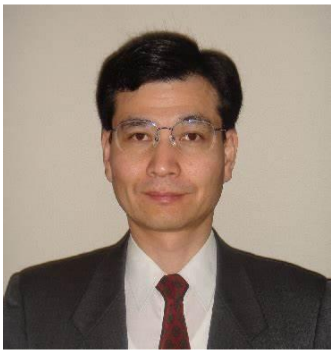
Prof. Hong G. Im received his B.S. and M.S. in from Seoul National University, and Ph.D. from Princeton University. After postdoctoral researcher appointments at the Center for Turbulence Research, Stanford University, and at the Combustion Research Facility, Sandia National Laboratories, he held assistant/associate/full professor positions at the University of Michigan. He joined KAUST in 2013 as a Professor of Mechanical Engineering. He is a recipient of the NSF CAREER Award and SAE Ralph R. Teetor Educational Award, and has been inducted as an International Member of the National Academy of Engineering of Korea, a Fellow of the Combustion Institute and American Society of Mechanical Engineers (ASME) and an Associate Fellow of American Institute of Aeronautics and Astronautics (AIAA). He has also served as an Associate Editor for the Proceedings of the Combustion Institute, and currently on the Editorial Board for Energy and AI. Professor Im's research and teaching interests are primarily fundamental and practical aspects of combustion and power generation devices using high-fidelity computational modeling. Current research activities include direct numerical simulation of turbulent combustion at extreme conditions, large eddy simulations of turbulent flames at high pressure, combustion of hydrogen, ammonia, and other e-fuels, spray and combustion modeling in advanced internal combustion engines, advanced models for pollutant formation, plasma-assisted combustion, and cryogenic carbon capture.

Speech Abstract

Despite the rapidly increasing market share of electrified vehicles, internal combustion engines (ICE) remain important as a viable solution in various applications. However, higher efficiency, lower emissions, and fuel flexibility are key enablers for the ICE to fulfill its mission towards sustainable carbon neutrality in the transportation sector. The pre-chamber combustion concept shows great promises in achieving this goal by allowing stable lean combustion utilizing conventional and renewable fuels. KAUST and Saudi Aramco have been collaborating under the FUELCOM project to revive the prechamber application in a novel drop-in design for modern light- and heavy-duty engines in order to demonstrate ultra-efficient and near-zero-emission performance, by utilizing the state-of-the-art optical and metal engine facilities, high-pressure laser diagnostics, well-controlled spray chamber, along with improved chemical kinetic description validated by experiment and theory, and high fidelity computational fluid dynamic simulations. This presentation provides an overview of the recent and ongoing activities to showcase our synergistic effort to design and implement an active pre-chamber technology in heavy-duty engines. Various gaseous and liquid fuels are used, including methane, gasoline, and hydrogen. Extensive experiments and detailed in-cylinder investigations revealed the importance of the fuel-air mixing inside the pre-chamber and its link to the optimal ignition and subsequent main chamber combustion. Based on the fundamental insights gained from the studies, advanced machine learning techniques are also employed to identify optimal pre-chamber design. Key highlights of research methodologies, predictive tools, physical behavior of the pre- and main chamber interactions, and the resulting outcomes in practical engine performance will be presented.

Current Status and Issues of IC Engine Study for Carbon Neutrality

Prof. Yasuo Moriyoshi, Chiba University, Japan



Prof. Yasuo Moriyoshi

Professor, Chiba University
Society of Automotive Engineers (SAE) Fellow
Society of Automotive Engineers of Japan (JASE) Fellow
Japan Society of Mechanical Engineers (JSME) Fellow

Speech Abstract

IC engine must approach a carbon neutral system for the survival. Drastic improvement of thermal efficiency, change of fuel and zero emission of harmful gas are requested. Firstly, the process in Japan will be introduced. Secondly, the process in Chiba University will be explained, such as PN emission, high speed knock, conversion of fuel, cycle-to-cycle variation, ignition, pre-chamber combustion, post-oxidation and engine control.

Hydrogen ICE for CO_2 Neutral Transport

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Bernhard Raser holds a master's degree in Automotive Engineering from the University of Applied Sciences in Graz as well as a Master's degree in International Industrial Management from the University of Applied Sciences in Kapfenberg. Apart from significant work experience on the field of energy supply, he joined AVL List GmbH and has been working for more than 15 years in the automotive industry. After working as a development engineer for different OEMs he became group leader and project manager for exhaust aftertreatment and OBD calibration. Bernhard Raser performed his automotive development work mainly in the field of heavy-duty on-road applications as well as non-road mobile machines for different markets. Since 2018 he is responsible for Product Line Management for Commercial On-Road vehicles with combustion engine based powertrain.

Speech Abstract

To counter steer the progressing global warming CO_2 neutral propulsion concepts for the mobility sector are required. Target of the commercial vehicle industry is to develop technologies and solutions, which allow a robust target achievement in a technological as well as timely manner. The required technology mix will comprise of a fuel consumption reduction on the currently dominant diesel-based powertrain and of a certain penetration rate of alternative, per definition CO_2 neutral, energy carriers. These will contain the direct usage of electricity as well as of hydrogen as energy carrier. The hydrogen internal combustion engine offers, in comparison to a fuel cell, concrete advantages in view of maintaining of the value creation chain and protection of powertrain and vehicle related investments in production facilities. Considering the preservation of base engine and powertrain components, as well as the avoidance of a fully electric vehicle configuration, the hydrogen combustion engine inevitably is the bridge technology towards fuel cells. The hydrogen engine concepts that have been published in the recent history show weaknesses in view of performance, dynamic and fuel consumption and therefore are not competitive against existing aggregates like diesel or natural gas engines, nor against fuel cell powertrains. In this speech, the required steps will be demonstrated which are required, to solve the current conflict of objectives in order to establish the hydrogen internal combustion engine as a short-term available CO_2-neutral powertrain technology for heavy-duty commercial vehicles and to illustrate the potential of this powertrain concept.

IC Engine Powertrain Technology

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Hua Zhao 现任英国伦敦布鲁奈尔大学（Brunel University London）副校长，及工学,设计和理学大学院院长. 并同时担任英国华人教授协会主席（Association of British Chinese Professors, ABCP。） 1984年大学毕业于天津大学，1989年在英国利兹大学获得博士学位。1989-1994年在剑桥大学和帝国理工学院担任研究员。自1994年至今在布鲁奈尔大学工作，先后担任汽车/赛车专业主任，机械与航空系主任，先进动力及燃油研究中心主任，科研副院长。曾任英国大学内燃机联合会主席，英国机械工程师学会内燃机/动力系统及燃油专家委员会主任。2009年被授予高级科学博士学位，2012年被选举为国际汽车工程学会会士 （FASE），2015 年当选为英国皇家工程院院士（FREng）。2019年入选英国高校科研评估委员会 (REF2021)委员， 2021年当选为中国工程院外籍院士。担任过中国科技部973重大基础研究项目首席科学家，国内外多个汽车公司和发动机厂家的高级顾问。近年来发表的国际期刊及国际会议论文400余篇， 出版和编著6部专著， 国际专利7项， 获奖5项， 主持和完成了几十项欧盟，英国政府和工业界资助的科研项目，培养了 40 多名博士和博士后。主持了多个国际会议；在英国，欧洲,日本，美国,中国,韩国的多所高校和公司讲座。和国内外的工业界有着广泛的合作.

Speech Abstract

内燃机为近代的工业和社会发展做出了重要的贡献,其优越的动力性和灵活性使得内燃机被广泛的应用于不同的工业和交通的动力系统。本报告将讨论一下如何应对气候变暖的挑战，和电气化及智能化赋予的机会，如何进一步提高内燃动力系统的总体效率和实现超低及零污染物排放，以及如何有效的利用可再生燃料及零碳燃料实现按照全生命周期评价的零排放的未来动力系统。