2019 X-ACADEMY BEIJING, CHINA SCHEDULE

2019 7th International Conference on Energy Engineering and Environmental Engineering (7th ICEEEE2019)

Beijing, China

July 19-20, 2019

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Simple Version of the Schedule

ICEEEE2019 CONFERENCE SCHEDULE

Venue: Mechanical Engineering Building, Beijing Jiaotong University		
July 19, 2019 (Friday)		
14:00-17:00		Registration at Lobby of Mechanical Engineering Building
July 20, 2019 (Saturday) Multi-Function Room on first floor		
09:00-10:00	Keynote Session	
	09:00-09:30	**Plenary Speech 1: Professor Dong Han** Title: Second-law Thermodynamic Analysis of Hydrogen Flames based on Thermochemistry and Chemical Kinetics
	09:30-10:00	**Plenary Speech 2: Professor Jinhua Wang** Title: Effect of highly hydrogen enrichment on lean premixed turbulent flame and swirl flame stabilization
10:00-10:20	Coffee Break&Photos	
	10:20-10:50	**Plenary Speech 3: Professor Zunhua Zhang** Title: Progress in the marine LNG engine with onboard hydrogen addition via reformed exhaust gas recirculation
10:50-12:00	Session 1	
12:00-13:00	Lunch	
13:00-15:00	Session 2	
15:00-15:10	Coffee Break	
15:10-15:40	Poster Session	
15:40-17:00	Session 3	
17:00 Conference Closed		

Committees

Conference Chair

Ruidan Su, Shanghai Advanced Research Institute, Chinese Academy of Sciences, China

Zuoyu Sun, Beijing Jiaotong University, China

Scientific Committee

Cangsu XU, Zhejiang University, China

Changwei Ji, Beijing University of Technology, China

Cong Geng, Beijing Jiaotong University, China

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Jinsheng Xiao, Wuhan University of Technology, China

Joe Dong, The University of New South Wales, Australia

Kai Han, Beijing Institute of Technology, China

Lixin YANG, Beijing Jiaotong University, China

Rongheng Lin, Beijing University of Posts and Telecommunications, China

Yusong Yu, Beijing Jiaotong University, China

Yongtae Ahn, Gyeongnam National University of Science and Technology, South Korea

Zhenzhong Yang, North China University of Water Resources and Electric Power, China

Venue

Conference Venue: Mechanical Engineering Building, Beijing Jiaotong University 北京交通大学，机械工程楼（近东门）

Add: No.3 Shangyuancun, Haidian District, Beijing (海淀区上园村3号)




Note:

1. All the participants are strongly advised to arrive before 8:50, July 20, 2019.
2. Certificate of Participation can be collected at the registration counter.
3. Please copy PPT files of your presentation to the secretary when registration.
4. The organizer doesn't provide accommodation, and we suggest you make an early reservation.
5. If you want to deliver oral presentation but your paper is not in the session list, please contact us by Email: cfp@iceeee.org (for ICEEEE2019)

Instruction about Oral Presentation

Devices Provided by the Conference Organizer:

Laptops

Projectors & Screen

Laser Sticks

Materials Provided by the Presenters:

PowerPoint or PDF files

Duration of each Presentation:

Regular Oral Session: about 10 Minutes of Presentation and 3 Minutes of Q&A.

Plenary Speech (Multi-Function Room-多功能会议厅)

July 20, 2019 (9:00-10:00)

Plenary Speech 1 9:00-9:30

Professor Dong Han
Shanghai Jiao Tong University, China

Title: Second-law Thermodynamic Analysis of Hydrogen Flames based on Thermochemistry and Chemical Kinetics

Abstract: Combustion is a highly irreversible process and is the primary source for exergy destruction in combustion engines. Previous studies pointed out that in combustion engines, 20% - 30% of the fuel chemical exergy would be lost as a result of combustion. However, the exergy loss regime in combustion has not been clearly elucidated. In this report, the exergy losses from flame propagation are attributed to entropy generation by heat conduction, mass diffusion and chemical reactions, as well as incomplete combustion. The contribution rates of different sources to the total exergy loss in hydrogen flames will be analyzed in detail. Further, the effects of fuel blending and charge dilution on the exergy loss from each source will be discussed based on the thermochemical and chemical kinetic analysis.

Plenary Speech 2 9:30-10:00

Professor Jinhua Wang
Xi'an Jiaotong University, China

Speech Title: Effect of highly hydrogen enrichment on lean premixed turbulent flame and swirl flame stabilization

Abstract: Hydrogen is the most promising clean fuel for engine and power generation.

Hydrogen enriched hydrocarbons have emerged as a foremost candidate of the future low carbon energy system. Especially for the lean premixed combustion system, such a scheme will be potential for high efficiency and low pollutant emissions. Despite of the previous studies, the hydrogen enriched turbulent premixed flames and more realistic flames such as swirl flames need further investigation. The detailed flame structure, the flame characteristics under straining, and the flame-flow interactions have not been well understood. In this talk, effect of highly hydrogen enrichment on lean premixed turbulent flame and swirl flame stabilization was presented. Experiments have been conducted on various burners and wide range of conditions in Clean Combustion Center of Xi'an Jiaotong University. Multi-species measurement of OH-PLIF, CH_2O-PLIF has been adopted. Multi-filed simultaneous measurement of PIV and OH-PLIF has been performed. The experimental results will help to better understand the hydrogen enriched flames.

One important impact of hydrogen addition is the enhancement on local molecular transport due to the high mass diffusion rate (about three times than methane). This leads to the common known preferential diffusion effects. Due to such effects, we observe the appearance of prevalent cusps on the flame front pointing to the burned region. The positively curved bulges convex to the unburned region also propagate upstream. Then the flame front is no longer smooth which we refer to as a kind of self-turbulence. This largely increases the turbulent burning velocity. Moreover, the external turbulence is found to promote the flame front wrinkling by distorting these positively curved bulges. Effects of hydrogen on the detail flame structure were investigated. The reaction zone and preheat zone were measured with synchronous OH and CH_2O-PLIF. The hydrogen is observed to decrease the preheat zone thickness. The reaction zone is not obviously broadened within the "thin reaction zone". However, the hydrogen is found to increase the thickness of the reaction zone slightly.

Hydrogen improves the flame stability, especially the blow-off of the high speed swirl flame in gas turbine combustor. The hydrogen addition was observed to increase the laminar flame speed and the adiabatic temperature. The hydrogen enriched hydrocarbons always tend to possess a negative Markstein number. This indicates an increased burning velocity of lean hydrogen flames under the strain, compared to the decrease trend of some large molecular fuels. The increased burning intensity with hydrogen is found to decrease the recirculating mass into the central recirculation zone (CRZ), which increases the CRZ temperature. The high adiabatic temperature also contributes to this effects. This is very important as a basic advantage for the flame stabilization. Another vital feature is that the hydrogen enhances the flame root. Flamelet conditioned excess straining and shear layer vortexes strongly act on the flame attachment. However, the hydrogen (1) increases the resistance to extinction at the flame root and (2) mitigates the effects of vortexes on promoting the blow-off.

10:00-10:20	Coffee Break & Photos

Plenary Speech

July 20, 2019 (10:20-10:50)

Plenary Speech 3 10:20-10:50

Professor Zunhua Zhang
Key Laboratory of High Performance Ship Technology, Wuhan University of Technology, China

Speech Title: Progress in the marine LNG engine with onboard hydrogen addition via reformed exhaust gas recirculation

Abstract: For marine engines fueled with liquefied natural gas (LNG), the technique of exhaust gas–fuel reforming, which is known as the reformed exhaust gas recirculation (REGR), can be employed to reduce the air pollutant emissions from them. Specifically, on-board hydrogen-rich gas mixtures (i.e., the reformate) can be generated through catalytic reforming of the exhaust gas–fuel mixtures, and then the reformate is recirculated into the engine cylinders. Thus fuel modification, high-efficiency combustion and exhaust gas aftertreatment can be realized simultaneously. The present report will present our research progress in the investigations of combustion characteristics and chemical kinetic mechanisms for blends of natural gas and the reformate, features of hydrogen generation from the exhaust gas–fuel reforming, the interaction among fluid flow, heat and mass transfer and catalytic reactions in the exhaust gas–fuel reformer, and the performance and emission characteristics of marine natural gas engines with REGR. The feasibility of the REGR technique has been validated via both the bench test and the numerical simulation. On this basis, the industrialization demonstration of the REGR technique will be conducted next. The

present study can provide solid support for the application of the REGR technique to the control of air pollutant emissions from marine engines fueled with LNG.

Session List

Session 1

July 20, 2019 (10:50-12:00)

1. Paper ID: 4
Title: Experimental and LES study on the effect of hydrogen enrichment on improved lean flame stability
Authors: Shilong Guo, Jinhua Wang, Weijie Zhang, Hao Xia, Bingxuan Lin, Yun Wu and Zuohua Huang
Abstract: To improve the understanding of the role of hydrogen in swirling flame stabilization, experimental and numerical study on CH4/H2/air flames were performed. Velocity fields and flame structures were obtained by PIV and OH-PLIF measurements respectively. With the increase of the hydrogen fraction, a more robust flame is obtained and the flame brush tends to expand in radial direction. Comparisons between the LES results and experimental data show that TF model coupled with the detailed mechanism is good at predicting the flow and flame structures. The axial velocity fluctuation subjected by the flame attachment decreases with increasing hydrogen fraction, which will decrease the risk of flame lift-off. Hydrogen addition changes combustion intensity at flame attachment, which is important for flame stabilization, from relatively weak to relatively strong. The burnt gases inside the recirculation zone of pure CH4/air flame suppress the oxidation of H2 and CO and result in a weak combustion at the flame attachment. Hydrogen addition in CH4/air improves this phenomenon significantly by enhancing H2 + OH = H + H2O.

2. Paper ID: 5
Title: Coordination Control Strategy for the Air Management of Heavy Vehicle Fuel Cell Engine
Authors: Sun Tian, Zhang xin, Liu Xiaohui and Ma Xuelong
Abstract: Air supply system is an important subsystem in the fuel cell engine with strongly non-linear and coupling interactions. This paper introduces a coordination control strategy for the air supply system of high power fuel cell engine in heavy truck. The working demand line of centrifugal air compressor is determined according to the characteristics of stack and the power demand of vehicle. There are strong coupling problems between air flow and pressure in the air supply system, such as the air compressor and electronic throttle opening. The internal model decoupling control (IMC) strategy was used to achieve independent management of air flow and pressure with better control effect compared to PID (Proportional-Integral-Differential) control strategy ensuring that the centrifugal air compressor works near the working demand

line. Meanwhile, the IMC strategy can maintain good control effect for model matching and model mismatch with robustness. The work efficiency of the centrifugal air compressor could be notably increased and avoid the phenomenon of surge by the coordination control strategy. At the same time, the output current of fuel cell engine can meet the load requirement which has the short response time and good follow-up effect.

3. Paper ID: 7
Title: Simulation of Heat and Mass Transfer in Proton Exchange Membrane Electrolysis Cell for Hydrogen Production
Authors: Zhang Zhuqian and Xing Xiaohui
Abstract: A full-scale, two-phase, single-channel proton exchange membrane electrolysis cell model is established in this work. The electrochemical model and the thermal model is coupled to explore the mass transfer of the channel, the catalytic layer and the diffusion layer, and the heat transfer of the entire electrolysis cell. The cell is operated at a temperature of 80℃ and an atmospheric pressure of 1 atm. Two different calculation models are compared and it is found that the calculation results of the model with bipolar plates are closer to the actual values. Simultaneously, effective water and thermal management strategy is proposed: The temperature of the electrolysis cell can be reduced effectively by supplying water to cathode side. The counter-flow mode has a lower temperature than the down-flow mode, but the temperature gradient in the counter-flow mode is greater. Reducing the channel depth and increasing the channel width can improve the water transmission in the electrolysis cell and reduce the temperature of the electrolysis cell, but a larger channel width will increase the electrical loss. Therefore, the selection of appropriate channel size is of great significance to the long-term stable operation of the electrolysis cell.

4. Paper ID: 8
Title: The physical and chemical effects of hydrogen addition on laminar premixed combustion characteristics of methane and ethane
Authors: Longkai Xiang, Fei Ren and Huaqiang Chu
Abstract: Methane and ethane are taken as the research objects. Using H_2 as diluent, based on ChemkinII/Premix Code and modified detailed chemical reaction mechanism: GRI 3.0*-Mech (introducing three hypothetical substances of FH_2, FO_2 and FN_2), the physical and chemical effects of hydrogen on laminar burning velocities, adiabatic flame temperatures, net heat release rates and elementary reactions responsible for temperature changes of two alkanes under different equivalence ratios were analyzed and determined. Results showed that the chemical effect of H_2 promotes the laminar burning velocities and adiabatic flame temperatures of methane and ethane, while the physical effect decreases the two parameters. In addition, the physical effects of H_2 inhibit the chemical reactions of methane and ethane, resulting in the decrease of net heat release rates. The chemical effect of H_2 accelerates the process of chemical reaction and obviously increases the net heat release rates. The two most important elementary reactions that promote the temperature rise of methane and ethane are $H + O_2 <=> OH + O$ and $CO + OH <=> H + CO_2$. The important reactions responsible for inhibiting the

temperature rise are H + CH3(+M) <=> CH4(+M) and H + O2 + H2O <=> HO2 + H2O.

5. Paper ID: 13
Title: Thermodynamic analysis of fossil fuels reforming for fuel cell application
Authors: Song Yu, Han Kai and Wang Dong Yang
Abstract: At present, the infrastructure of hydrogen production, storage and transportation is poor. Fuel reforming for hydrogen production from liquid fossil fuels such as kerosene, petrol and diesel is of great significance for wide application of on-board fuel cell and distributed energy resources. In this work, the produced and reaction heat generation of kerosene, petrol and diesel reformed by steam reforming (SR), partial oxidation (POX) and autothermal reforming (ATR) were studied through thermodynamic analysis. Based on the thermodynamic analysis, the effect of reforming methods on the system ideal thermal efficiency are analysed .The results shows that the hydrogen concentration of syngas obtained from steam reforming is highest regardless of the fuel types. The hydrogen yield per unit volume of diesel is largest under same reforming method. Autothermal reforming has the largest ideal thermal efficiency in three reforming methods.

6. Paper ID: 14
Title: Investigating the explosion of ethyl acetate in the presence of hydrogen
Authors: Francis Oppong, Cangsu Xu, Luo Zhongyang, Wenhua Zhou, Wu Siyuan, Xiaolu Li and Jianxi Zhou
Abstract: The explosion characteristics of ethyl acetate (EA)/hydrogen-air mixtures have been investigated in this document using a constant volume combustion vessel. Experiments were carried out at the initial pressure of 1, 2, and 3 bar and the initial temperature of 358 K for a wide range of equivalence ratios (0.4-1.4). Hydrogen was mixed with compressed air in the proportion of 4%, 8% and 12% and added to EA. The experimental pressure data were refined to determine the explosion characteristics. The explosion characteristics of EA/hydrogen-air of the different hydrogen fractions were compared to evaluate their influence on EA explosion. The study indicated that the mixture with 12% hydrogen increased the explosion pressures, maximum pressure rise rate on the lean side of the mixture when compared to 8% and 4%. The opposite reflection was exhibited at rich mixtures. Also, increased hydrogen fraction extended the flammability limit of ethyl acetate in lean mixtures. However, as the content of hydrogen increased the peak of the explosion pressure and pressure rise rate shifted to the lean side of the mixture. The explosion time at 8% and 12% hydrogen were relatively elongated in rich mixtures.

12:00-13:00	Lunch (Hong Guo Yuan Hotel)

Session 2 (Multi-Function Room-多功能会议厅)

July 20, 2019 (13:00-15:00)

1. Paper ID: 15

Title: A numerical study on premixed hydrogen/air flames in a narrow channel with thermally orthotropic walls

Authors: Puyi Zou, Youcheng Deng, Xin Kang and Jianyong Wang

Abstract: Premixed hydrogen/air flame stabilizations in a parallel plate micro-combustor with thermally isotropic and orthotropic wall materials are numerically studied using a low-Mach number, reacting flow solver developed based on the OpenFOAM Framework. For a range of simulated equivalence ratios and inflow velocities, two modes of flame shapes (convex-shaped and concave-shaped) are observed, accompanying with variations of the number of heat release rate peaks in flame structures, which can be attributed to the appearance of some critical O-participating and H-participating elementary reactions. Flame stability limits are studied for three sets of wall thermal conductivities of k = 16 W/m·K , k = 128 W/m·K (isotropic) and kxx = 128 W/m·K & kyy = 16 W/m·K (orthotropic). The low velocity limits show invariant with wall thermal conductivities, while the high velocity limits in descending order are found to be: "k = 128 W/m·K" > "kxx = 128 W/m·K & kyy = 16 W/m·K" > "k = 16 W/m·K". The logic behind is the competition between two mechanisms: the wall pre-heating effects and the transverse heat losses to the ambient. The critical convective heat transfer coefficients that reflect the combustor's ability to resist heat losses are also investigated among the three cases. The reduction of the transverse thermal conductivity can have a high critical coefficient value in the low-inflow velocity regime while makes negligible impacts on extending the critical coefficient in the high-inflow velocity regime. In summary, the use of thermally orthotropic wall materials leads to a slightly decreased high velocity limit (~3% lower) but a considerably increased critical convective heat transfer coefficient in the high-inflow velocity-regime (~25% higher).

2. Paper ID: 17

Title: Simulation and experimental study of the NOx reduction by unburned H2 in TWC for a hydrogen engine

Authors: Bao Ling-zhi, Sun Bai-gang, Luo Qing-he, Wang Xi, Liu Fu-shui and Li Chao

Abstract: The unburned H2 can be used to reduce NO emission in conventional TWC (three-way catalyst) for a hydrogen internal combustion engine. To explore the effects and feasibility of this reaction in, a Perfectly Stirred Reactor simulation model of TWC has been built with simplified mechanisms. Experiments on a 2.3L turbocharged hydrogen engine are used to verify the conclusion. It shows that rising initial temperature accelerates the reduction of NO and the maximum reaction rate occurs at 400℃ temperature. The conversion efficiency of NO remains approximately 0 when temperatures below 300℃. The efficiency reaches a peak value of approximately 98% with 400℃ and declines gradually. The unburned H2 to NO mixing ratio greater than 1.5 in TWC guarantees 100% NO conversion efficiency. The experiments indicate that the NOx

concentration decreases from 2056ppm to 41ppm at the stoichiometric ratio after the treatment of TWC and NOx reaches 0ppm with a rich ratio. Results also demonstrate that the suitable reaction temperatures for TWC locate in the range of 400℃ to 500℃. Therefore, if the temperature and the mixing ratio are appropriate, it can achieve zero emissions with NOx reduction by unburned H2 in conventional TWC for a hydrogen engine.

3. Paper ID: 18

Title: Water Content Diagnosis for Proton Exchange Membrane Fuel Cell based on Wavelet Transformation

Authors: Tiancai Ma, Weikang Lin, Yanbo Yang, Kai Wang and Wenya Jia

Abstract: The fuel cell reliability and durability are still the main factors limiting the large scale commercialization. To a certain degree, water content, transportation, distribution and state in the fuel cell influence the fuel cell State of Health (SOH). However, It's very difficult to measure water content inside fuel cell directly. The PEMFC system voltage fluctuate during hydrogen purging process, due to the removal of liquid water will affect the reactants transformation. Different internal water content will cause different voltage fluctuations. For this characteristic, a water content diagonis method based on wavelet transformation is proposed and validated in this paper. By several PEMFC system experiment results in test bench, this method can diagnosis the water content in PEMFC properly.

4. Paper ID: 20

Title: The economic and environmental impact of power to hydrogen/power to methane facilities on the integrated electricity-natural gas energy systems

Authors: Jing Liu and Wei Sun

Abstract: The curtailment of renewable energy would be reduced by converting it to hydrogen or methane using power to hydrogen (P2H) or power to methane (P2M). Both hydrogen and methane can be injected into the exiting natural gas system which has significantly potential of unlocking inherent flexibility of the integrated system. The efficiency of P2H is much higher but it has the maximum hydrogen mixture level. In this paper, the coordinated operation strategy of the integrated electricitynatural gas energy systems considering P2H and P2M is proposed aiming to minimize the operation cost and reduce the wind power curtailment. In addition, a strategy for handling the constraints of hydrogen mixture level limits is premised. The simulation results of three case studies demonstrate the economic environmental benefits of P2H/P2M in terms of cost reduction, emissions decline and wind power curtailment reduction. The benefits differences between P2H and P2M has also been compared and analyzed.

5. Paper ID: 24

Title: Adaptive Sliding-mode Control Based on Neural Network Estimation for PEMFC-powered Bidirectional DC Motor

Authors: Xuncheng Chi, Xuechao Wang, Shengwei Quan, Xuefeng Han, Ying Shen and Ya-Xiong Wang

Abstract: Proton exchange membrane fuel cell (PEMFC), according to its advantages of high energy density, zero emission, and low noise, has been widely applied in industrial

appliances. A full bridge converter is used to implement PEMFC-powered DC motor bidirectional rotation in this paper. An adaptive backstepping sliding-mode control (ABSMC) technique integrated with Chebyshev neural network (CNN) is proposed to realize the angular velocity and bus voltage regulations of DC motor. Based on the equivalent-circuit method, the control-oriented model of the PEMFC-powered motor system is structured. By constructing Lyapunov function, the adaptive laws and control laws can be obtained to achieve bus voltage and angular velocity regulations simultaneously. Moreover, the proposed neural network is applied to estimate the uncertainties of the system through orthogonal basis Chebyshev polynomials. To highlight the advantages of proposed technique, a proportional-integral (PI) control was introduced subsequently and two controllers are compared via numerical simulations. The simulation results demonstrate that CNN estimation method in conjunction with backstepping sliding-mode shows a fast and accurate response even though the existence of system uncertainties and external disturbances.

6. Paper ID: E902

Title: Stabilization of Power Fluctuation of Renewable Energy Based on Hybrid Energy Storage System

Authors: Weibin Xu, Xinyan Zhang, Jiajun Zhang, Lei Yu, Yang Yu

Abstract: As energy shortages become more prominent, renewable energy is widely exploited. Renewable energy sources such as wind energy and solar energy are affected by the non-uniformity and non-steadiness of the natural environment, resulting in fluctuations and randomness of output power. When incorporated into the grid, it will cause fluctuations in grid voltage and frequency, affecting the power quality of the grid. The energy storage system can be used as an energy buffering device to stabilize the grid-connected power to meet the grid-connected standard. A hybrid energy storage system is proposed to stabilize the fluctuation of renewable energy generation, and the energy storage control method and energy distribution method are given. Finally, using the actual data of a wind farm, the hybrid energy storage composed of hydrogen storage energy and supercapacitor energy storage is used to stabilize the wind power fluctuations. The simulation results verify the technical rationality and economic practicability of the proposed method.

7. Paper ID: E903

Title: Effects of channel length on propagation behaviours of diffusion H2/air flames in a Y-shaped micro-combustor

Authors: Ying Xiang, Aiwu Fan

Abstract: Combustion characteristics of non-premixed H2-air flames in Y-shaped micro-combustors with horizontal channel length of 100 mm and 200 mm were experimentally compared. The micro-combustors consist of three quartz channels with an identical inner diameter of 2.0 mm. The mixture was ignited by heating the end of the horizontal channel with a butane torch. The results show that six and three flame propagation modes were observed in the 200-mm and 100-mm micro-combustors, respectively. Moreover, it is found that the flame oscillation duration is much longer with a larger noise intensity in the 200-mm micro-combustor. As a result, the mean

propagation speed under L=100 mm is much larger. In addition, the edge flame is longer on the lean side under L=100 mm and almost identical on the rich side for the two combustors. Furthermore, the luminosity of edge flame in the 100-mm micro-combustor is much brighter. Numerical analysis reveals that the deflection of propagating flame in the Y-shaped micro-combustor is determined by the stoichiometric line. In summary, the short combustor has a smaller heat loss ratio and a stronger flame-wall thermal coupling, which can enhance the combustion intensity and increase the flame propagation speed.

8. Paper ID: E907

Title: Effects of Combustion Modes On Combustion Characteristics of Hydrogen Internal Combustion Engine Under Low Load

Authors: Wei Wei, Yue Lou, Paixia Wu, Zhenzhong Yang, Gaolin Qin

Abstract: In this paper, a four-cylinder inlet hydrogen fuel injection internal combustion engine (HICE) is used as the prototype to establish a simulation model of internal combustion engine. The simulation of the different combustion modes under low load effects on hydrogen fuel combustion characteristics is presented, using CONBERGE coupled chemical reaction mechanism. With the increase of fuel air ratio, the OH concentration at the flame front surface becomes thicker and the combustion process tends to be stable. Equivalent combustion reduces the concentration of OH, temperature and pressure in the cylinder, prolongs the combustion delay period and combustion duration, reduces the heat release rate and increases thermal efficiency. In the case of enrich combustion, the temperature and pressure in the cylinder are higher than the lean combustion, the combustion delay period and the combustion duration are shorter, and the heat release rate and the indicated thermal efficiency are also improved.

9. Paper ID: E909

Title: Comparison study of the performance of a HICE under high load with equivalent fuel-air ratio

Authors: Gaolin Qin, Yu Zhang, Junfa Duan, fushui Liu and Wei Wei

Abstract: Based on the CONVERGE coupling chemical reaction mechanism of a fourcylinder inlet jet hydrogen internal combustion engine, a CFD three-dimensional simulation model was established and the model was verified and demarcated. The effects of combustion and emission characteristics of a HICE on different combustion modes under high load were studied. The simulation results showed that the equivalent combustion reduced the intensity of combustion, the instantaneous heat release rate delayed, the peak temperature and the maximum explosive pressure in the cylinder decreases, and there was a time delayed, which reduces the dynamic performance of the hydrogen internal combustion engine. When a small amount of concentrated combustion, the dynamic performance is not different from that of lean combustion.

15:00-15:10	Coffee Break

Poster Session (Smart Room-智慧教室)

July 20, 2019 (15:10-15:40)

1. Paper ID: 9
Title: Dispersion and behavior of hydrogen for the safety design of hydrogen production plant attached with nuclear power plant
Authors: Kai Wang, Xiaojun Zhang and Yang Miao
Abstract: Development of nuclear energy and hydrogen energy both as renewable energy open up a vast range of prospects. The scheme for H2 generation station in nuclear power plant has been carried out in china. However, Nuclear Energy is expected to encourage a safety culture that prevents serious accidents while dispersion of hydrogen from a container produces a risk of combustion. The dispersion and behavior of hydrogen production plant attached with nuclear power plant are still poorly understood. In this paper, a dispersion of hydrogen model is established and is calculated under two typical condition with corrected ideal gas state equation. The flammability of hydrogen after dispersion is studied. The range of flammability of dispersion of hydrogen production plant with different pressures, positions and temperatures is obtained. This work could contribute to the marginal hydrogen safety design for hydrogen production station and lay the foundation for the establishment of a safe distance standard that it's necessary to prevent hydrogen explosion.

2.Paper ID: 19
Title: A Review of Hydrogen Stations Location Models
Authors: ZeZhou Ye, RongHeng Lin
Abstract: Hydrogen is emerging as low-carbon and zero-carbon energy source for a sustainable future. The lack of hydrogen stations has become a major obstacle to the promotion of hydrogen energy. The study of hydrogen stations location has significant economic, social and military implications. Hydrogen stations location problem belongs to the facility location problem. However, hydrogen stations location problem is different from other usual facilities location problem in choosing the potential locations. These potential locations for hydrogen stations should possess the characteristics of easy public access, high visibility and safety considering the characteristics of hydrogen. This review investigated the existing research efforts and conducted a comprehensive

overview of the work on hydrogen stations location models. Firstly, the hydrogen stations location models are classified according to the structure of the planning area and the number of objectives, and then the detailed explanations and solution methods for each model are given. Finally, we concluded the strength and weakness of each model for hydrogen stations location. To our best knowledge, this paper might help researchers get a full understanding of related researches in hydrogen stations location.

3.Paper ID: 21
Title: Dynamic behaviors of PEM fuel cells under load changes
Authors: Xiaolong Li, Kai Han and Yu Song
Abstract: In this study, based on the finite-rate water absorption/desorption of membrane, a one-dimensional isothermal single-phase transient model was established to study the dynamic behaviors of proton exchange membrane (PEM) fuel cells under different cathode inlet humidity conditions in the presence of a voltage step change. Both the current overshoot and undershoot phenomena were observed. In addition, the distribution of water inside the electrolyte and the influence of water distribution on the response current of the cell were analysed. When voltage stepped up/down, the water content in anode generally increased/decreased, and the water content in cathode is reversed. If the cathode intake is completely humidified, the water vapor in cathode is always supersaturated causing the ionic resistance is determined by the change of water content in anode. If the cathode is partially humidified, the water content in cathode has a large change space, and the change of water content in membrane of anode can be balanced to some extent, so that the change of ionic resistance maintains within a small range.

4.Paper ID: 22
Title: Hydro-Graph: A Knowledge Graph for Hydrogen Research Trends and Relations
Authors: Qiyu Fang, Rongheng Lin and Budan Wu
Abstract: The field of hydrogen research is a huge community, generating a large amount of literature every year. Researchers need to do a lot of review to get a general understanding of the field, and to realize the research trends and relations. Since the reviews are done manually by the researchers, it is not only inefficient but the timing of the reviews might not be real time. This paper presents a tool called Hydro-graph, which aims to provide researchers in the field of hydrogen research with a knowledge graph of relevant fields. It can help researchers quickly understand the development status, research hotspots and research trends of a certain field. Furthermore, it can find representative authors in the field, and analyse their research direction and development process. Experimental results show that Hydro-graph can effectively help researchers in the hydrogen research community to analyse relevant fields.

5.Paper ID: 23
Title: Toward a Hydrogen Society: Hydrogen and Smart Grid Integration
Authors: Yingying Zhao, and Rongheng Lin
Abstract: Hydrogen has an important role as a smart solution for Smart Grid, as it can be used as an energy carrier, a storage medium, and a clean fuel cell. The integration of Hydrogen and Smart Grid can minimize the impact on the environment while maximizing

sustainability. There have been already many studies on different aspects of this topic. For a better understanding of the related work, this paper proposed a comprehensive overview of the work on the integration of Hydrogen and Smart Grid. Related literature is organized and analyzed from four categories, including Smart grids and hydrogen, Hydrogen fuel cell electric vehicles, Hydrogen economy, and Models for energy system of Smart Grid. And each subject has been introduced more carefully. What's more, for a clear understanding for readers, we provide overall scenario views for the organization of the related work.

6.Paper ID: E904
Title: The effect of flow direction variation on the performance of a single cell for an anode-supported planar solid oxide fuel cell
Authors: Young Jin Kim, Min Chul Lee
Abstract: This study was performed for a numerical analysis of a single cell for an anode-supported planar solid oxide fuel cell (SOFC) to investigate the performance related to reversible potential and irreversible losses based on three different flow configurations: co-flow, counter-flow, and cross-flow. To understand the performance differences based on the typical three flow configurations, the distributions of temperature, species, and current density were examined, and the trends and the fractions of the various losses were analyzed. The calculated results showed that the co-flow configuration had a tendency to deliver the highest performance and the lowest irreversible losses of all the three configurations because the temperature and the fuel composition in the co-flow configuration changed in the opposite direction along the flow direction. These losses were compensated by multiplying the more uniform current density and the total irreversible resistance by the opposite directional change for the temperature and the fuel composition.
In designing the anode-supported planar SOFC, the uniformity of flow rate in each channel, which affects significantly to both performance and lifetime of the cell, has been checked. From this numerical analysis result, the design performance of single cell was satisfactorily verified by obtaining negligible flow deviation in each channel of the designed separator deviation, which was less than 3% of the average velocity.

7.Paper ID: E907
Title: Effects of Combustion Modes On Combustion Characteristics of Hydrogen Internal Combustion Engine Under Low Load
Authors: Wei Wei, Yue Lou, Paixia Wu, Zhenzhong Yang, Gaolin Qin
Abstract: In this paper, a four-cylinder inlet hydrogen fuel injection internal combustion engine (HICE) is used as the prototype to establish a simulation model of internal combustion engine. The simulation of the different combustion modes under low load effects on hydrogen fuel combustion characteristics is presented, using CONBERGE coupled chemical reaction mechanism. With the increase of fuel air ratio, the OH concentration at the flame front surface becomes thicker and the combustion process tends to be stable. Equivalent combustion reduces the concentration of OH, temperature and pressure in the cylinder, prolongs the combustion delay period and combustion duration, reduces the heat release rate and increases thermal efficiency. In the case of

enrich combustion, the temperature and pressure in the cylinder are higher than the lean combustion, the combustion delay period and the combustion duration are shorter, and the heat release rate and the indicated thermal efficiency are also improved.

8.Paper ID: E908

Title: Investigation of Combustion Characteristics of A HICE Under Middle Load

Authors: Quancai Li, Yunbo Yang, Zhenzhong Yang, Wei Wei and Yiming He

Abstract: A hydrogen-fueled internal combustion engine (HICE) of simulation model coupling chemical reaction mechanism was established by a prototype of the four-cylinder inlet jet hydrogen internal combustion engine using CONVERGE. Based on the experimental data, the model was verified and calibrated at first, then the effects of different combustion modes on combustion under middle load characteristics of hydrogen internal combustion engine were simulated. The simulation results show that the equivalent combustion reduces the intensity of combustion in the cylinder than lean combustion, the flame front is thicker and the instantaneous heat release rate is advanced, the peak of temperature and the maximum explosive pressure in the cylinder decreases with time lag, which reduces the dynamic performance of the hydrogen internal combustion engine. When a small amount of concentrated combustion, the dynamic performance of the combustion has little difference compared with lean combustion

9.Paper ID: E909

Title: Comparison study of the performance of a HICE under high load with equivalent fuel-air ratio

Authors: Gaolin Qin, Yu Zhang, Junfa Duan, Fushui Liu and Wei Wei

Abstract: Based on the CONVERGE coupling chemical reaction mechanism of a fourcylinder inlet jet hydrogen internal combustion engine, a CFD three-dimensional simulation model was established and the model was verified and demarcated. The effects of combustion and emission characteristics of a HICE on different combustion modes under high load were studied. The simulation results showed that the equivalent combustion reduced the intensity of combustion, the instantaneous heat release rate delayed, the peak temperature and the maximum explosive pressure in the cylinder decreases, and there was a time delayed, which reduces the dynamic performance of the hydrogen internal combustion engine. When a small amount of concentrated combustion, the dynamic performance is not different from that of lean combustion.

10.Paper ID: E910

Title: Effect of Excess Hydrogen on Hydrogen Fueled Internal Combustion Engine under Full Load

Authors: Hairong Zhu, Junfa Duan, Fushui Liu

Abstract: Detailed hydrogen-air chemical reaction mechanisms were coupled with three dimension grids of an experimental hydrogen fueled internal combustion engine to establish a CFD combustion model based on CONVERGE software. The effect of excess hydrogen ratio on the combustion and emissions characteristics of the hydrogen fueled combustion engine under full load was studied based on the CFD model. Simulation results showed that excess hydrogen lead to higher concentration of OH species in flame

front, and quicker hydrogen-oxygen reaction and flame propagation speed, which in turn lead to higher pressure and temperature in cylinder. The increased pressure and temperature in turn contributed to the increase of indicate power but un-burned hydrogen lead to decrease of efficiency. NOx, especially NO emissions decreased significantly with excess hydrogen under full load not only because increase of H concentration, and decrease of O and OH concentration, which lead to reversed reaction of NO formation through thermal NO routes. Low excess hydrogen ratio can achieve a good trade-off between power and emissions under high load.

11.Paper ID: E912

Title: A data-driven modeling method for PEMFC air compressor

Authors: Zhihua Deng, Qihong Chen, Liyan Zhang and Zhichao Fu

Abstract: At present, the modeling methods of the air compressor of PEMFC system are mostly based on the mechanism, and itself has the characteristics of non-linearity, multi-parameter, time-varying and variable coupling, so the model established is very complex and even difficult to model. In order to solve this problem, in this paper, we proposed a nonlinear autoregressive moving average with exogenous inputs (NARMAX) model for nonlinear dynamic air compressor subsystem identification. In the proposed model, identification procedure is formulated as an optimization procedure of Recurrent Neural Network (RNN), it has the ability to adapt to the time-varying characteristics. Specifically, training of RNN achieves the NARMAX model structure determination and the complicated parameter estimation, and convergence of RNN guarantees that a NARMAX model of random initial state will approach a valid identification model with accurate state parameters. The air flow mean square error is obtained by proposed method is 1.097e-07, which is considered precise; the MAP simulation results of two methods show that the proposed method is more accurate, therefore, the results show that the model of air compressor subsystem is valid and instruct design of air supply system's controller.

12. Paper ID: E914

Title: Combustion and emissions properties of a lean-burn splithydrogen- direct-injection blended gasoline engine under various second-direct-injection-timings

Authors: Xiaoyu Cong, Changwei Ji and Shuofeng Wang

Abstract: Split-hydrogen-direct-injection blended can make gasoline burn in stratified hydrogen-air atmosphere, and improve the properties of gasoline engines. Second-direct-injection-timing is one of the important parameters affecting the hydrogen concentration distribution. In this research, an experimental study is carried out on the combustion and emissions properties of a lean-burn split-hydrogen-directinjection blended gasoline engine under various second-direct-injection-timings, running at a low-speed and part-load condition. The results show that, with the delay of second-direct-injection-timing from 150 to 50 CAD BTDC, flame development and propagation periods are shortened firstly and then prolonged with the delay of second-direct-injection-timing, The cyclic coefficient of variations in indicated mean effective pressure are less than 2.0% until second-direct-injection-timing is set later than 90 CAD BTDC. HC and CO emissions are reduced firstly and then risen again. The lowest

values of HC and CO emissions are 2461 and 655 ppm, which are dropped 29.1% and 21.6% compared with the values under pure gasoline injection mode, respectively.

13. Paper ID: E919
Title: Productivity analysis of fractured wells in reservoir of hydrogen and carbon based on dual-porosity medium model
Authors: Yi Xue, Teng Teng, Faning Dang, Zongyuan Ma, Haibin Xue, Guanglei Zhang
Abstract: Hydraulic fracturing is an advantageous technology in creating hydrogen and carbon reservoirs. This study analyzes the production of hydraulically fractured organic reservoir of hydrogen and carbon. First, based on the diffusion and desorption mechanism in reservoir matrix and the gas flow in reservoir fractures, a multi-scale dual-porosity medium model of hydrocarbon reservoir is established. Then, the mathematical model is solved and verified through a historical matching of field gas production data. Finally, sensitivity study was performed to determine the key parameters to improve the recovery efficiency in organic reservoir of hydrogen and carbon. Results show that improving fracture permeability can improve gas recovery efficiency. The matrix desorption can contribute to natural gas production in the late stage of hydrogen and carbon reservoir. Long sizes of hydraulic fractures have large contact surfaces for gas diffusion and increase gas generation and cumulative gas production.

14.Paper ID: E920
Title: Effects of particle sizes on performances of the horizontally buried-pipe steam generator using waste heat in a bioethanol steam reforming hydrogen production system
Authors: Bin Zheng, Peng Sun, Yongqi Liu, Jian Meng, Youtang Wang, Xilei Kong, Hui Liu
Abstract: This paper reports the effects of particle sizes on performances of the horizontally buried-pipe steam generator using waste heat in a bioethanol steam reforming hydrogen production system. The discrete element geometric model of the horizontally buried-pipe steam generator was set up. The model has been used to investigate the effects of particle sizes (20 mm to 80 mm). The results showed that with the particle size increases, the flatness of the particle layer decreases, the flow ununiformity of the particle layer increases, the volatility of the particle residence time distribution increases, the standard deviation of the particle residence times increases, the voidage of the particle system increases, the thermal resistance of the particle side in the steam generator increases, the steam production decreases, and the hydrogen production of bioethanol steam reforming system decreases.

Session 3 (Multi-Function Room-多功能会议厅)

April 19, 2019 (15:40-17:00)

1. Paper ID: E925
Title: Determining correlation between final hydrogen temperature and refueling parameters from experimental and Numerical Data

Authors: Shanshan Deng, Jinsheng Xiao, Pierre Bénard, Richard Chahine

Abstract: During the hydrogen filling process, excessive temperature rise may cause the hydrogen storage tank to fail. Therefore, preventing the temperature from rising too high is an important guarantee for the safety of hydrogen storage cylinder. Based on the analytical solution of the final hydrogen temperature derived from the hydrogen filling theoretical model, the relationship between the final hydrogen temperature and the initial temperature, inlet temperature and ambient temperature has obtained. In order to further determine the relationship, we have added numerical data from dual-zone model established by Matlab/Simulink to simulate the Type III 25L tank and the Type IV 174L tank, which were verified based on the simulated numerical data. The results show that both the experimental data and the numerical data can verify the relationship of the final hydrogen temperature and the results are consistent. An increase in the initial temperature and inlet temperature results in an increase in the final temperature. At the same time, the effect of the initial temperature and the inlet temperature on the final temperature was stronger in Type IV tank than in Type III tank. This study provides guidance for hydrogen refueling stations of hydrogenation standards.

2. Paper ID: E910

Title: Effect of Excess Hydrogen on Hydrogen Fueled Internal Combustion Engine under Full Load

Authors: Hairong Zhu, Junfa Duan, Fushui Liu

Abstract: Detailed hydrogen-air chemical reaction mechanisms were coupled with three dimension grids of an experimental hydrogen fueled internal combustion engine to establish a CFD combustion model based on CONVERGE software. The effect of excess hydrogen ratio on the combustion and emissions characteristics of the hydrogen fueled combustion engine under full load was studied based on the CFD model. Simulation results showed that excess hydrogen lead to higher concentration of OH species in flame front, and quicker hydrogen-oxygen reaction and flame propagation speed, which in turn lead to higher pressure and temperature in cylinder. The increased pressure and temperature in turn contributed to the increase of indicate power but un-burned hydrogen lead to decrease of efficiency. NOx, especially NO emissions decreased significantly with excess hydrogen under full load not only because increase of H concentration, and decrease of O and OH concentration, which lead to reversed reaction of NO formation through thermal NO routes. Low excess hydrogen ratio can achieve a good trade-off between power and emissions under high load.

3. Paper ID: E913

Title: Spontaneous ignition of high-pressure hydrogen and boundary layer characteristics in tubes

Authors: Xiaodan Xu, J. Jiang, Yiming Jiang, Zhilei Wang, Qingyuan Wang, Weiyang Yan, and Xuhai Pan

Abstract: Hydrogen is efficient, environmentally friendly and widely used, but the danger of spontaneous ignition caused by leakage of high-pressure hydrogen tanks cannot be ignored. This paper comprehends the spontaneous ignition of high-pressure hydrogen under different conditions by experimental and numerical investigation. It also

summarizes attenuation of the shock wave and evolution of the flow field, and explores the effects of boundary layer on velocity of the leading shock wave, contact surface and expansion waves. The consequences indicate that under the release pressure of 15 Mpa, ignition products of hydrogen are more evident than that under the release pressure of 5 Mpa. When the release pressure augments with other conditions equal, velocity of the shock wave improves and the boundary layer thickness increases obviously. When the tube diameter decreases, the boundary layer thickness aggrandizes. In a 4-mm-Diameter tube, the boundary layer thickness is greater than that in a 10-mm-Diameter tube. Beyond that, the formation of the boundary layer will lead to a decrease in the velocity of leading shock wave and an increase in the velocity of contact surface by degrees, but the volume of the oxyhydrogen mixture zone increases with time on account of the large gap between two velocity bases.

4. Paper ID: E916

Title: A novel interconnector design of SOFC

Authors: Wei Kong, Hongyan Huang, Zhen Han, Xiang Gao and Xiaorong Wang

Abstract: In this study, a novel interconnector design is proposed, which is named as intersectional interconnector. The solid oxide fuel cell (SOFC) models are established for the conventional interconnector, cylindrical interconnector and intersectional interconnector. The results indicate that the design of the intersectional interconnector is beneficial to the transport of gas in SOFC, which is of the minimum of anode concentration polarization compared with the conventional interconnector and cylindrical interconnector. Furthermore, the cathode ohmic polarization of the intersectional interconnector decrease by 30.49% compared with the conventional interconnector. Thus, the intersectional interconnector reduces the current path and improves the performance of SOFC. When the cathode porosity is larger or the cathode conductivity is smaller, the advantage of the intersectional interconnector is more remarkable.

5. Paper ID: E918

Title: Investigation on the non-axisymmetric flow of a low specific speed centrifugal compressor

Authors: Wang Chenfang, Zhang Ruidong, Jia Shaokun, Wang Zhixing

Abstract: Effect of the volute on the overall performance and flow mechanism of a low specific speed centrifugal compressor is studied in this paper. A full Three-Dimensional flow simulation model suitable for centrifugal compressor simulation at low specific speed is established. The overall performance of the impeller with and without volute is obtained through simulation, and the flow detail is analysed of the compressor working at off-design conditions at design speed (40 000 r/min). Results show that the stable working range of the compressor with volute is only 64.57% of that without volute impeller at design speed. The circumferential static pressure distribution at the outlet of the compressor impeller near the surge point fluctuates less, but the circumferential static pressure at the outlet of the centrifugal compressor impeller near the clogging condition fluctuates sharply, which leads to uneven flow in different impeller passages of the compressor and reduces the working stability of the compressor.

6. Paper ID: E921

Title: Effect of shunt honeycomb ceramics thickness on Finned Tube heat transfer in Ventilation Methane Oxidation Steam Generator for Hydrogen Production

Authors: Peng Sun, Bin Zheng, Yongqi Liu, Shuai Tang, Kai Zhang, Jiguo Xu, Rongrong Bi

Abstract: Shunt honeycomb ceramics (SHC) are adopted to constrain the steam parameter fluctuation within commercial hydrogen production through gasification method with the steam obtained by the energy released from ventilation air methane oxidation. However, the effect of SHC thickness on heat extraction trait have not been fully studied. This paper carried out a numerical simulation study on the effect of SHC thickness. Results show that the existence of SHC increases pressure drop is increased by 23.5%, decrease the temperature difference between inlet and outlet, increases average heat flux may be increased by 7.4%. Radiation heat transfer accounts for 0.2374~0.3398 of total heat exchange, and as the SHC thickness grows, radiation heat transfer increases gradually.

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