20199509 / 2019-32-0509	The Best Paper of SETC2019
20199xxx / 2019-32-0xxx	Nine High Quality Papers of SETC2019
20199xxx / 2019-32-0xxx	To be published in SAE Journal

SETC2019 Session Timetable

			Ran 1	Ran 2	Cosmos 1	Cosmos 2	Himawari
Tuesday, November 19th	8:30-10:00		Opening Ceremony & Keynote Speech (Himawari)				
	10:00-10:30		Networking Break & Poster Session				
	10:30-12:00		Collegiate Events	Alternative Fuels I	Diesel Engine I	Measurement & Simulation I	Fuel Supply Systems
		Chair	Takashi Mitome	Toru Nakazono	Tomoaki Yatsufusa	Tadao Okazaki	Akira Iijima
		Co-Chair	Stefan Sturm	Michael Lang	Adrian Irimescu	Stephan Schmidt	Simona Silvia Merola
		3	20199532 / 2019-32-0532	20199526 / 2019-32-0526	20199590 / 2019-32-0590	20199567 / 2019-32-0567	20199535 / 2019-32-0535
				20199581 / 2019-32-0581	20199592 / 2019-32-0592	20199538 / 2019-32-0538	20199546 / 2019-32-0546
				20199621 / 2019-32-0621		20199545 / 2019-32-0545	
	12:00-13:15		Lunch & Poster Session				
	13:15-14:45		Materials & Manufacturing	Alternative Fuels II	Diesel Engine II	Measurement & Simulation II	Engine Controls
		Chair	Aki Kodai	Hiroya Ueda	Tomoaki Yatsufusa	Tadao Okazaki	Yutaka Nitta
		Co-Chair	Christoph von Hiller	Michael Lang	Giovanni Ferrara	Stephan Schmidt	Ken Fosaaen
		3	20199504 / 2019-32-0504	20199515 / 2019-32-0515	20199596 / 2019-32-0596	20199548 / 2019-32-0548	20199511 / 2019-32-0511
			20199516 / 2019-32-0516	20199607 / 2019-32-0607	20199599 / 2019-32-0599	20199570 / 2019-32-0570	20199519 / 2019-32-0519
			20199544 / 2019-32-0544	20199620 / 2019-32-0620	20199618 / 2019-32-0618	20199518 / 2019-32-0518	20199568 / 2019-32-0568
	14:45-15:15		Networking Break & Poster Session				
	15:15-16:45			Functional Safety	Small & Micro CHP Systems	Measurement & Simulation III	Hybrids, Electric Drives & Fuel Cells
		Chair		Takashi Mitome	Toru Nakazono	Minoru Iida	Yasuyuki Muramatsu
		Co-Chair		Giovanni Ferrara	Alessandro Bellissima	Stephan Schmidt	Kai Beck
		3		20199537 / 2019-32-0537	20199576 / 2019-32-0576	~~20199550 / 2019-32-0550~~	20199555 / 2019-32-0555
					20199588 / 2019-32-0588	20199542 / 2019-32-0542	20199623 / 2019-32-0623
					20199604 / 2019-32-0604	20199543 / 2019-32-0543	20199525 / 2019-32-0525
	16:45-17:00		Networking Break				
	17:00-18:00		Special Speech (Himawari)				
Wednesday, November 20th	8:30-10:00		Emissions I	Alternative Fuels III	HCCI I	Measurement & Simulation IV	Engine Technology I
		Chair	Hiromi Deguchi	Toru Nakazono	Tatsuya Kuboyama	Tadao Okazaki	Yuji Araki
		Co-Chair	Mikael Bergman	Kai Beck	Glenn Bower	Stefan Sturm	Roland Kirchberger
		3	20199613 / 2019-32-0613	20199595 / 2019-32-0595	20199522 / 2019-32-0522	20199502 / 2019-32-0502	20199509 / 2019-32-0509
			20199612 / 2019-32-0612	20199606 / 2019-32-0606	20199608 / 2019-32-0608	20199552 / 2019-32-0552	20199591 / 2019-32-0591
						20199571 / 2019-32-0571	20199580 / 2019-32-0580
	10:00-10:30		Networking Break & Poster Session				
	10:30-11:30		Emissions II	Alternative Fuels IV	HCCI II		Engine Technology II
		Chair	Hiromi Deguchi	Toru Nakazono	Akira Iijima		Yutaka Nitta
		Co-Chair	Stefan Sturm	Ken Fosaaen	Glenn Bower		Roland Kirchberger
		3	20199513 / 2019-32-0513	20199611 / 2019-32-0611	20199528 / 2019-32-0528		20199582 / 2019-32-0582
			20199617 / 2019-32-0617	20199614 / 2019-32-0614	20199573 / 2019-32-0573		
	11:30-13:00		Lunch & Poster Session				
	13:00-14:30		Lubricants	Engine Components I	Vehicle Components	NVH Technology I	
		Chair	Yuji Mihara	Takahito Murase	Masayuki Baba	Chanat Ratanasumawong	
		Co-Chair	Mikael Bergman	Adrian Irimescu	Alexander Winkler	Stephan Schmidt	
		3	20199505 / 2019-32-0505	20199508 / 2019-32-0508	20199597 / 2019-32-0597	20199512 / 2019-32-0512	
			20199510 / 2019-32-0510	20199523 / 2019-32-0523		20199593 / 2019-32-0593	
			20199601 / 2019-32-0601	20199541 / 2019-32-0541		20199609 / 2019-32-0609	
	14:30-15:00		Networking Break & Poster Session				
	15:00-17:30		Plenary Session (Himawari)				
Thursday, November 21st	8:30-10:00		Advanced Combustion I	Engine Components II	Vehicle Dynamics	NVH Technology II	Two Stroke Engine I
		Chair	Koji Yoshida	Takahito Murase	Hisayuki Sugita	Chanat Ratanasumawong	Tatsuya Kuboyama
		Co-Chair	Simona Silvia Merola	Mike Marcella	Glenn Bower	Ken Fosaaen	Pierre Duret
		3	20199565 / 2019-32-0565	20199530 / 2019-32-0530	20199569 / 2019-32-0569	20199531 / 2019-32-0531	20199524 / 2019-32-0524
			20199551 / 2019-32-0551	20199610 / 2019-32-0610	20199572 / 2019-32-0572	20199533 / 2019-32-0533	20199549 / 2019-32-0549
					20199578 / 2019-32-0578	20199587 / 2019-32-0587	20199579 / 2019-32-0579
	10:00-10:30		Networking Break & Poster Session				
	10:30-12:00		Advanced Combustion II	Engine Components III		NVH Technology III	Two Stroke Engine II
		Chair	Akihito Kasai	Naoya Isozaki		Tadao Okazaki	Tatsuya Kuboyama
		Co-Chair	Simona Silvia Merola	Mike Marcella		Ken Fosaaen	Pierre Duret
		3	20199586 / 2019-32-0586	20199553 / 2019-32-0553		20199527 / 2019-32-0527	20199562 / 2019-32-0562
			20199616 / 2019-32-0616	20199584 / 2019-32-0584		20199594 / 2019-32-0594	
			20199622 / 2019-32-0622	20199585 / 2019-32-0585			
	12:00-14:00		Lunch / Closing Ceremony (Himawari)				

Notes:

Paper 20199550/2019-32-0550 is invalid because no one was present at the conference to make a presentation of the paper on the scheduled day. Although the published programs and proceedings of SETC2019, which had been prepared in advance, include the number, manuscript and related information of paper 20199550/2019-32-0550, the technical committee of SETC will not publish it as an authorized paper.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Ran 1
3. Time	10 : 30 - 11 : 00
4. Session	Collegiate Events
5. Chair (Affiliation),	Takashi Mitome (SUZUKI MOTOR CORPORATION)
Co-chair (Affiliation)	Stefan Sturm (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199532 / 2019-32-0532
7. Paper title	Rework of an In-Line Two-Cylinder Engine for the Application in Formula Student
8. Authors (Affiliation)	Michael Feigl, Dominik Rößmann, Michael Trzesniowski (University of Applied Sciences FH Joanneum)

9. Abstract

Formula Student is an international design competition, where students all over the world develop, design and build their own race car and afterwards compete with each other at different disciplines at events worldwide. The development process includes every module of the race car and the team of joanneum racing graz has focused on the powertrain since the beginning.

The following paper contains an overview of the reworking process of an in-line two-cylinder engine for the application in Formula Student. The intention was to increase the BMEP and at the same time reach a desired power/weight ratio of the engine. The process of selecting the most appropriate turbocharger by means of experimental testing on an engine dynamometer, as well as its optimization by means of numerical simulation, is outlined. Subsequently, the paper discusses the challenges regarding valve timing and finding the best trade-off between power and residual gas with the help of 1D-simulations. The necessary implementation of an intercooler and its efficiency optimization is also addressed. Finally, the calibration and optimization of the setup on the engine test bed is presented.

After the selection of the most suitable turbocharger for the engine and the reworking of its compressor side, it was possible to achieve a maximum boost pressure of 2.76 bar absolute. Charge air cooling and closed loop boost control guaranteed fast boost pressure build up. Together with the optimized cam timing, which reduced residual gas, and an increased compression ratio, the overall torque output of the engine resulted in 135 Nm at 4000 rpm and a maximum power of 63 kW at 6000 to 6500 rpm. The overall target of increasing the BMEP of the selected engine and at the same time achieving a lower power/weight ratio than the previous engine (FS133) was accomplished with a final value of 0.81 kW/kg.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Ran 2
3. Time	10 : 30 - 12 : 00
4. Session	Alternative Fuels I
5. Chair (Affiliation),	Toru Nakazono (LEMA / Yanmar Co., Ltd.)
Co-chair (Affiliation)	Michael Lang (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199526 / 2019-32-0526
7. Paper title	Effect of Thermal Barrier Coating on Performance and Emissions of a DI Diesel Engine
8. Authors (Affiliation)	Yogeshwar Paik, Chinmaya Ranjan Sahu, Krishna Kumar Pandey, Saroj Kumar Barik, S. Murugan (National Institute of Technology, Rourkela), Debidutta Debasish (CSIR- Institute of Minerals and Materials Technology, Bhubaneswar)

9. Abstract

Recycling is an attractive solution to problems associated with the disposal of industrial and municipal wastes that are significantly available worldwide. Plastic in different forms is used in many applications day-to-day life. Some plastics can be converted into fuel or energy by thermal and catalytic degradation of plastic waste through pyrolysis processes. The oil obtained from pyrolysis of waste plastic can be used as an alternative fuel for CI engines. Most of the cases, it is reported by many researchers that the engine performance of a CI engine would be inferior when it is run on plastic pyrolysis oil (PPO) or its diesel blends than the diesel-fueled diesel engine operation. Reducing heat loss from engine components may improve the thermal efficiency and reduce fuel consumption of a CI engine. The heat loss can be reduced in CI engines by introducing thermal barrier coating (TBC). In this investigation, the effect of TBC on the performance and emissions of a CI engine run on PPO and its diesel blends was studied. For the investigation, a single cylinder, four stroke, air cooled, direct injection (DI) diesel engine developing a power of 4.4kW at a rated speed of 1500rpm was used. The PPO obtained from a pyrolysis plant was blended with diesel at four different percentages. The blends were denoted as PPO10, PPO20, PPO30 and PPO40, ...

6. Paper No.(JSAE/SAE)	20199581 / 2019-32-0581
7. Paper title	Influence of the Kind of Fuel Kind in the Ignition of Diesel Dual Fuel Operation with Introduced Natural Gas Combining EGR and Supercharging
8. Authors (Affiliation)	Yasufumi Yoshimoto (Niigata Institute of Technology), Eiji Kinoshita, Takeshi Otaka (Kagoshima University)

9. Abstract

A number of studies in diesel dual fuel (DDF) operation which introduces natural gas from the intake pipe and ignites it by a diesel fuel injection in the combustionchamber have been conducted using conventional diesel engines. The present study investigated the influence of theignition fuel on engine performance, combustion characteristics, and emissions with a combination of EGR and supercharging in DDF operation. The experiments employed iso-pentanol blended fuels for the ignition. Isopentanol is a next generation bio-alcohol fuel produced fromcellulosic biomass, and actual use can be expected. The experiments were conducted at two CNG supply rates, 0% (ordinary diesel operation) and at a 40±4% (DDF operation) energy basis, and with EGR rates varied from 0 to 26%. The boost pressure was set at two conditions, 100 kPa (naturally aspirated, N/A) and 120 kPa (supercharged, S/C) with a supercharger. Four kinds of ignition fuels were used, JIS No.2 diesel fuel as a reference, neat methyl laurate (LME) which is a major component of coconut oil biodiesel, and two iso-pentanol blended fuels with 30% mass ratios, DiP30 (70% diesel and 30% iso-pentanol) and LiP30 (70% LME and ...

6. Paper No.(JSAE/SAE)	20199621 / 2019-32-0621
7. Paper title	Performance and Emission Parameters of an LHR Engine Run on Jatropha Biodiesel and Its Diesel Blend
8. Authors (Affiliation)	Sanju Sureshan Nair, Krishna Kumar Pandey, S. Murugan (National Institute of Technology, Rourkela), Debidutta Debasish (CSIR- Institute of Minerals and Materials Technology, Bhubaneshwar)

9. Abstract

Biodiesel is a renewable fuel which can be obtained from transesterification of vegetable oils, animal fat, and algae. Edible and non-edible oils can be used as feedstock for biodiesel production. It is considered to be a potential renewable fuel for compression ignition (CI) engines. It can be used as a sole fuel or in a blended form with diesel. In India, research work is focused on the utilization of non-edible oils for biodiesel production. Particularly rigorous research works have been carried out on the use of biodiesel obtained from Jatropha Curcas, Madhuca Indica, Pongamia Pinnata, Karanja etc. The thermal efficiency of CI engines run on Jatropha biodiesel or its blends is less than 40%. Heat loss through cooling water, exhaust, and unaccounted losses are the reasons for lower thermal efficiency. Reduction of heat loss from CI engines shall increase the thermal efficiency of the engine. In this aspect, low heat rejection (LHR) engines offer increased thermal efficiency and reduced particulate emissions. In this experimental research work, an attempt was made to use Jatropha biodiesel (JME) and its 20% diesel blend (JME20) in an LHR engine. For this purpose, a single cylinder, four stroke, air cooled, direct injection (DI) diesel engine developing a power output of 4.4kW at a constant speed of 1500 rpm was converted into LHR engine. ...

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Cosmos 1
3. Time	10 : 30 - 11 : 30
4. Session	Diesel Engine I
5. Chair (Affiliation),	Tomoaki Yatsufusa (Hiroshima Institute of Technology)
Co-chair (Affiliation)	Adrian Irimescu (Istituto Motori-CNR)

6. Paper No.(JSAE/SAE)	20199590 / 2019-32-0590
7. Paper title	An Analysis of Diesel Spray Characteristics with Small Injection Amount Under Similarity Law Condition
8. Authors (Affiliation)	Yu Jin, Chang Zhai, Keiya Nishida, Yoichi Ogata (Hiroshima University)

9. Abstract

In this paper, the Diesel spray characteristics were studied by HS video camera and the Laser Absorbing Scattering (LAS) technique means of the combustion deterioration problem caused by the engine downsizing based on the geometrical similarity was investigated. In the experiments, three Diesel injectors with the hole diameters of 0.07mm, 0.101mm and 0.133mm were used. The injection pressures of the injectors with three different diameters were 45MPa, 93MPa and 160MPa, respectively. The Diffused Background Illumination (DBI) method was employed for the nonevaporating spray experiment to obtain spray tip penetration and spray angle at room temperature. The LAS technique was employed for the evaporating spray experiment to obtain the equivalence ratio distributions, evaporation rate, and vapor phase tip penetration. Moreover, the Wakuri Momentum Theory was applied to analyze the data obtained by both the non-evaporating and the evaporating spray experiments. The non-evaporating results show that the spray tip penetrations scaled by the similarity law matched well from the injectors of different hole diameters. However, the scaled spray angle of the injector with smaller hole diameter is smaller than that of the injector with larger hole diameter. Furthermore, the spray of the smaller hole diameter injector seems to have smaller mean equivalence ratio than that of the larger hole diameter injector. The scaled vapor phase penetration of the injector with medium hole diameter is larger than that of other injectors. The fuel spray from the injector with smaller hole diameter has slower evaporation rate.

6. Paper No.(JSAE/SAE)	20199592 / 2019-32-0592
7. Paper title	Effects of Spray Internal EGR Using CO2 Gas Dissolved Fuel on Combustion Characteristics and Emissions in Diesel Engine
8. Authors (Affiliation)	Tomoyuki Mukayama, Yoshitaka Hattori (Doshisha University), Masaki Kuribayashi, Go Asai (YANMAR CO., LTD.), Eriko Matsumura, Jiro Senda (Doshisha University)

9. Abstract

We have proposed the application of Exhaust Gas Recirculation (EGR) gas dissolved fuel which might improve spray atomization through effervescent atomization instead of high injection pressure. Since EGR gas is included in the spray of EGR gas dissolved fuel, it directly contributes to combustion, and the further reduction of NOx emissions is expected rather than the conventional external EGR. In our research, since highly contained in the exhaust gas and highly soluble in the fuel, CO2 was selected as the dissolved gas to simulate EGR gas dissolved. In this paper, the purpose is to evaluate the influence of the application of CO2 gas dissolved fuel on the combustion characteristics and emission characteristics inside the single cylinder, direct injection diesel engine. As a result, by use of the fuel, smoke was reduced by about 50 to 70%, but NOx reduction does not have enough effect. However, NOx emissions is reduced with external EGR, and the effect of NOx reduction is effective by combined the external EGR and the CO2 gas dissolved fuel.

Abstracts of Technical Sessions

1. Date Tuesday, November 19
2. Room. Cosmos 2
3. Time 10 : 30 - 12 : 00
4. Session Measurement and Simulation I
5. Chair (Affiliation), Tadao Okazaki (LEMA / Kubota Corporation)
   Co-chair (Affiliation) Stephan Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199567 / 2019-32-0567
7. Paper title	Prediction of Air Temperature Distribution Around Rider on Idling Motorcycle by CFD Using DES Model
8. Authors (Affiliation)	Yuzo Fujita, Hiroshi Tatsumi (Honda Motor Co., Ltd.)

9. Abstract

In this study, we investigated how to calculate and predict the air temperature distribution around the rider of a stationary motorcycle with the engine at idle. To analyze the air temperature distribution of an idling motorcycle, we needed to accurately predict the mixing of the forced convection air from the radiator fan and the natural convection air caused by the air temperature difference. For the calculation, we used two types of turbulent flow models: realizable k-ε (RKE) and detached eddy simulation (DES). First, in view of the mixing of the radiator exhaust with outside air, we made three-dimensional measurements of the air temperature distribution around the vehicle body to evaluate the accuracy of calculations made by the two models. We then used the models to predict the air temperature distribution around the rider for different air outlet duct configurations as well as for two motorcycles with different displacement values. The results showed that, although the RKE model effectively reproduced the qualitative trend of the air temperature distribution, it showed poorer prediction accuracy than the DES model. On the other hand, the DES model successfully reproduced the trends for different air outlet duct configurations, and the prediction error of air temperature around the rider was within 5ºC of the actual measurements for the two different motorcycles. Although the DES computation time of 72 hours was seven times that of RKE, ...

6. Paper No.(JSAE/SAE)	20199538 / 2019-32-0538
7. Paper title	Experimental Study of Aerodynamic Drag Control on Bluff Body Using Synthetic Jets
8. Authors (Affiliation)	Naoto Kato, Shunsuke Watanabe, Hiroaki Hasegawa (Utsunomiya University)

9. Abstract

Since flow separation causes increase of the drag on bluff bodies, its control method has been studied for many years. Active control methods are currently focused as an alternative to passive ones because they impose a larger drag penalty under certain conditions. Although the effectiveness of a steady jet using suction, blowing or pulsed jets has been demonstrated, it is difficult to obtain an effect commensurate with weight increase because the mechanism is complicated. One method of solving this problem is a synthetic jet. Synthetic jets are produced by periodic ejection and suction of fluid from an orifice induced by oscillation of a diaphragm inside a cavity. Small engine powered vehicles demand less drag, a compact package and light weight because the drivers expect fuel efficiency, load capacity and economy. Synthetic jets can supply them because they contribute drag reduction and require only simple components. In this study, the influence of synthetic jets on the drag of a simple bluff body representing a road vehicle is measured. Drag measurement was performed by varying synthetic jet parameters: jet location, reduced frequency, velocity ratio of jet flow and uniform flow. The vortex structure around the body was visualized by utilizing a smoke wire method. As a result, among the jet parameters, only reduced frequency had no effect on drag.

6. Paper No.(JSAE/SAE)	20199545 / 2019-32-0545
7. Paper title	Development of Drive Cycle Using Fleet Data for Two-Wheelers in Indian Market
8. Authors (Affiliation)	Arvind Satish, Abhijith Sabu, Johnson Xavier Saldanha, Nagesh A P (Bosch Limited, India)

9. Abstract

Generally, to produce reliable two-wheelers, manufacturers resort to intense engineering efforts to make sure the two-wheeler can withstand the most harsh testing conditions and requirements. This sometimes leads to a higher cost in realizing such outlier requirements. Thus, a drive cycle matching the actual riding characteristics will enable better understanding of the requirements and an optimized engineering effort. There have been several attempts by governmental and non-governmental organizations to realize a real drive cycle for various cities and countries, trying to capture the typical riding style in those regions. But the drive patterns observed in most representative cycles do not match with the scenario in India with frequently dense traffic, constrained roads and slow driving speeds. To understand the driving pattern in India, a drive cycle generation algorithm is developed which uses real time on-road data captured from a fleet of vehicles in India and creating a database of micro-trips. These micro-trips are first categorized based on their average speeds. The algorithm concatenates these micro-trips to make a drive cycle, such that the average speed of the resulting drive cycle matches closely to the average speed of the captured on-road data. The algorithm then iterates different sequencing of these micro-trips in the drive cycle to minimize the error in various parameters like average acceleration, time percentage of acceleration, & deceleration, time percentage of idle, between the resulting drive cycle and the captured on-road data. ...

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Himawari
3. Time	10 : 30 - 11 : 30
4. Session	Fuel Supply Systems
5. Chair (Affiliation),	Akira Iijima (Nihon University)
Co-chair (Affiliation)	Simona Silvia Merola (Istituto Motori-CNR)

6. Paper No.(JSAE/SAE)	20199535 / 2019-32-0535
7. Paper title	Development of an Injection System for Small Engines with Adaptive Control for Sensorless Lambda Operation
8. Authors (Affiliation)	Bernhard Ernst, Marek Lajda (PRUEFREX Engineering e Motion GmbH & Co. KG)

9. Abstract

With increasing requirements for small engines in terms of functionalities and emission standards, it is essential to be able to offer an integrated full-featured injection system that will meet future requirements. The system described is particularly suitable for small to medium-sized combustion engines, such as power generators, lawnmowers and small motorcycles, and has a corresponding cost structure, compactness and a high degree of integration. The main subject of the development is an electronic fuel injection system, which can provide information about the current air-fuel mixture through model-based software algorithms and also has an integrated ignition coil. This article describes the procedure and the status of the research results of this development project. The basis of the method as already known from similar approaches of stimulating the running engine by a defined feedforward control of the injection quantity. The engine response is analyzed by the developed algorithm and conclusions about the actual air-fuel ratio are drawn. Thus, without the need for a hardware sensor, an engine operation in the application-specific lambda range can be realized. The studies have been performed with a mechanical and an electronic speed governor, as well as different moment of inertia of the flywheel in terms of function, accuracy and required time on a single-cylinder 4-stroke gasoline engine.

6. Paper No.(JSAE/SAE)	20199546 / 2019-32-0546
7. Paper title	Performance Investigation of a PFI Gasoline Engine by Applying Various Kinds of Fuel Injectors
8. Authors (Affiliation)	Fuchao Shen, Yasuo Moriyoshi, Tatsuya Kuboyama (Chiba University), Toshiya Iio, Yudai Miyatani, Akira Tsunoi (Bosch Corporation)

9. Abstract

In this report, the effect of injection specification, such as droplet size, lengths of nozzle tip and spray angle, on the engine performance was investigated using a 1.2 L port fuel injection (PFI) four-cylinder gasoline engine. The experimental conditions were selected to cover the daily operating mode, including the cold start and catalyst heating process. The experiments were conducted by varying not only the injectors but also the injection timing which was shifted from the exhaust to intake stroke. The results were evaluated by the fuel consumption and exhaust gas emissions. When these tests were conducted on a production engine, a carefully designed tumble generator was installed at the intake port to enhance the intake air flow. As a result, the injection specifications showed a potential to obtain less fuel consumption and lower engine-out emissions was evaluated.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Ran 1
3. Time	13：15 - 14：45
4. Session	Materials and Manufacturing
5. Chair (Affiliation),	Aki Kodai (Kawasaki Heavy Industries, Ltd.)
Co-chair (Affiliation)	Christoph von Hiller (Andreas STIHL AG & Co. KG)

6. Paper No.(JSAE/SAE)	20199504 / 2019-32-0504
7. Paper title	Effects of Surface Compound Layer on Bending Fatigue Strength of Nitrided Chromium -Molybdenum Steel
8. Authors (Affiliation)	Tsuyoshi Kubota (Yamaha Motor Co., Ltd.) Osamu Umezawa (Yokohama National University)

9. Abstract

Carburized and quenched materials with high fatigue strength are often used for motorcycle engine parts. Nitrided materials exhibit less deformation during heat treatment than carburized and quenched materials, so if the same or higher fatigue strength can be achieved with nitrided materials as with carburized and quenched materials, the geometric precision of parts can be increased and we can reduce engine noise as well as power loss. When the fatigue strengths of a nitrided material with its compound layer surface put into γ' phase through nitriding potential control (hereafter, G), and a nitrided material put into ε phase (hereafter, E) were measured, the results showed the fatigue strength of the G to be about 11% higher than that of carburized and quenched materials. It was inferred that the strength of the compound layer determines fatigue strength. The reason the fatigue strength of the G is higher is that initial cracks do not readily form, and it can be inferred that when cracks do form, they progress readily and lead to final fracture. In the case of the E, it is thought that when the stress intensity factor, ΔK, due to initial cracks exceeds the threshold of the stress intensity factor range, ΔKth (≃5.9MPa$\sqrt{m}$), it leads to fatigue fractures. While the G has higher fatigue strength than carburized and quenched materials, it is likely to have a big effect on microcrack fatigue strength...

6. Paper No.(JSAE/SAE)	20199516 / 2019-32-0516
7. Paper title	Development of High Productivity and Low Cost Card-Edge Type ECU for Motorcycles
8. Authors (Affiliation)	Yuichi Takeda, Daisuke Sugio, Koji Inose (Honda Motor Co., Ltd.), Syuichi Takioka (Keihin Corporation)

9. Abstract

To reduce global warming, Honda has been worked on emission reduction and fuel efficiency enhancement by applying fuel injection systems. The productivity enhancement and cost reduction are strongly demanded in developing countries as the market is expanding. To enhance productivity and reduce cost of ECU, application of the semiconductor production method has been started for printed circuits with edge connectors. However, products that fully meet the requirements of us have not been realized so far. The ECU developed this time has a structure shielding the whole PCB package except the edge connector terminals. Thus, the waterproofness required for an ECU has realized, as a standalone component, as the first in the world (by Honda survey). To achieve that, we developed transfer molding dies equipped with a unique mechanism never been applied. Moreover, we developed an epoxy resin that eliminates the after cure process. Thus, productivity of 5 times over conventional was realized with a multi-cavity molding capable of moldings more than 10 pieces at a time. Furthermore, a new waterproof card-edge connector was developed, in which a half pipe type terminal providing a stable contact resistance, even with a low contact pressure, and a slider structure that enables reliable coupling operations were adopted...

6. Paper No.(JSAE/SAE)	20199544 / 2019-32-0544
7. Paper title	Development of Laser Welding Pressed-Frame for Small Scooters Considering High Production Efficiency
8. Authors (Affiliation)	Sunao Kawano, Takeru Kobayashi (Honda Motor Co., Ltd.)

9. Abstract

The laser-welded pressed-steel frame made of the high-tensile-strength steel sheet and suitable for high efficiency production has been developed for small scooters. In majority of the conventional designs, the frame of small scooters is composed of a large number of steel pipes and stamped parts complexly welded together, requiring a number of welded joints. As a result, since the welding length increase and the dimensional error of the frame body after welding tends to be large, a correction operation in a post process is required. This has been one of the factors preventing further enhancement of production efficiency. In an attempt to cope with this issue, we have chosen to apply the pressed-steel frame construction using the high-tensile-strength steel sheet, which has been applied to small motorcycles, to small scooters. In addition, we replaced the spot welding with more efficient laser welding to further enhance productivity. The optimum cross section design taking advantages of the pressed-steel frame construction permits more gradual changes of cross sectional area than the conventional steel pipe frame, allowing dispersing of stresses in the frame. Consequently, the frame reinforcement members are reduced while maintaining the same or higher strength as the steel pipe frame, realizing a 39% reduction of number of parts and 10.7 kg reduction of frame weight...

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Ran 2
3. Time	13 : 15 - 14 : 45
4. Session	Alternative Fuels II
5. Chair (Affiliation),	Hiroya Ueda (Honda Motor Co., Ltd.)
Co-chair (Affiliation)	Michael Lang (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199515 / 2019-32-0515
7. Paper title	RANS Simulation of a Multicomponent Underexpanded Gaseous Jet Mixing – Effects of Composition and Injection Conditions
8. Authors (Affiliation)	Andy Thawko , Leonid Tartakovsky (Technion - Israel Institute of Technology)

9. Abstract

Fuel injection and mixing processes determine quality of the subsequent combustion in a DI engine, and description of these processes is vital to optimize the engine performance. Reynolds-averaged Navier–Stokes approach was applied as a cost-effective tool to simulate the mixing process of a multicomponent gaseous fuel jet of various compositions typical for alcohol reformates. To learn about the physics of reformate mixing, a hydrogen-rich multicomponent jet behavior in a constant-volume chamber was investigated at conditions typical for ICE. The CFD model was validated using a reference case from the published literature. Various Impact of the gaseous jet composition, injection pressure and nozzle diameter on its behavior were studied. The important new finding shows that rising the injection pressure or increasing the nozzle diameter won't affect the jet wall impingement timing for bore sizes typical for light-duty vehicle ICEs. Furthermore, it is shown that the integral parameters of a multicomponent gaseous jet in ICE are mainly determined by the molar weight of the injected gas mixture even with high molecular diffusivity species in the mixture like hydrogen.

6. Paper No.(JSAE/SAE)	20199607 / 2019-32-0607
7. Paper title	The Effect of Ethanol Fuels on the Power and Emissions of a Small Mass-Produced Utility Engine
8. Authors (Affiliation)	Saager Paliwal, Glenn Bower (The University of Wisconsin-Madison)

9. Abstract

The effect of low level ethanol fuel on the power and emissions characteristics was studied in a small, mass produced, carbureted, spark-ignited, Briggs and Stratton Vanguard 19L2 engine. Ethanol has been shown to be an attractive renewable fuel by the automotive industry; having anti-knock properties, potential power benefits, and emissions reduction benefits. With increasing availability and the possible mandates of higher ethanol content in pump gasoline, there is interest in exploring the effect of using higher content ethanol fuels in the small utility engine market. The fuels in this study were prepared by gravimetrically mixing 98.7% ethanol with a balance of 87 octane no-ethanol gasoline in approximately 5% increments from pure gasoline to 25% ethanol. Alcor Petrolab performed fuel analysis on the blended fuels and determined the actual volumetric ethanol content was within 2%.

The purpose of this study is to evaluate the performance and emissions of a small utility engine across several load points. Compared to previous works, this study concentrated on engine operation at wide open throttle as any decrease in engine power output due to a fuel's ethanol content would negatively impact an engine's sales potential; small engines developed for this market sector are engineered to meet a certain horsepower rating. For this study, the engine governor was set at 3800 rpm. After the engine governor was adjusted to its maximum position (i.e. 3800 rpm), the engine was loaded by a hydraulic dynamometer. As the load was increased, the engine speed slowly decreased as the dynamometer's torque was increased. Full load engine operation down to an engine speed of approximately 2800 rpm, just higher than the engine's torque peak, was investigated. In addition to engine out emissions and shaft power, exhaust temperatures and cylinder pressure were recorded.

Overall, the experimental results showed increasing ethanol content results in a small gain in power output even though the energy content of the fuel was decreasing. It was found that nitrogen oxides plus hydrocarbons emissions slightly decreased or stayed equivalent while the carbon monoxide emissions were reduced by 10% for the E10 blend and by 20% for the E15 blend. Finally, cylinder pressure and heat release analysis showed that the addition of ethanol increased peak cylinder pressure and advanced the main heat release closer towards top dead center.

6. Paper No.(JSAE/SAE)	20199620 / 2019-32-0620
7. Paper title	Study for Higher Efficiency and Lower Emissions in Turbo Charged Small Gas Engine Using Low Caloric Biomass Model Gas
8. Authors (Affiliation)	Kenta Shiomi, Ryogo Kato, Eriko Matsumura, Jiro Senda (Doshisha University), Ryoichi Hagiwara, Yuta Watanabe, Toru Nakazono (Yanmar Co., Ltd)

9. Abstract

In recent years, depletion of energy resources and increasing CO_2 emission have been concerned. As this solution, the use of biofuels from garbage is focused. In this research, higher efficiency and lower emissions in the gas engine for power generation using biomass gas are aimed. However, the biomass gas is low caloric value and the output is low and the combustion is unstable. Therefore, a turbocharged spark ignition gas engine is used as the test institution. As a result, it is found that combustion stability and high efficiency of biomass gas can be realized.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Cosmos 1
3. Time	13 : 15 - 14 : 45
4. Session	Diesel Engine II
5. Chair (Affiliation),	Tomoaki Yatsufusa (Hiroshima Institute of Technology)
Co-chair (Affiliation)	Giovanni Ferrara (University of Florence)

6. Paper No.(JSAE/SAE)	20199596 / 2019-32-0596
7. Paper title	Effects of Positive or Negative Dwell Times of Split Injection on Diesel Spray Development and Mixture Formation Process
8. Authors (Affiliation)	Jaeheun Kim, Shinichi Kakami, Keiya Nishida, Yoichi Ogata (Hiroshima University)

9. Abstract

An investigation on the effect of dwell time of split injection on a diesel spray evolution and mixture formation process was carried out. A commercial 7-hole injector were used in the experiment to eliminate the possible discrepancies on the spray with single-hole research injector. Laser absorption scattering (LAS) technique was implemented for the measurement of the temporal evolution of fuel evaporation and mixture concentration. The diesel surrogate fuel consists of n-tridecane and 2.5% of 1-methylnaphthalene in volume basis was used. The total amount of fuel injected was initially fixed to 5.0 mg/hole. A split ratio of 9:1 in mass basis was selected according to the results obtained from a previous study. The dwell time was varied from 120 μs to a negative value of -50 μs. The effects of negative dwell time was not ideal for lean mixture formation when compared to zero or positive dwell time conditions. The collision of the spray tail of the first injection and the head of the second injection created locally rich pockets at the vicinity of the nozzle. Finally, injection rate shaping through modulating the pulses consisted of several injections of negative dwell times was investigated. This rate shaping strategy which showed a gradual decrease of the injection rate at the EOI (end-of-injection) timing yielded positive effect on mixture formation. It also exhibited faster lean mixture formation than that of single injection.

6. Paper No.(JSAE/SAE)	20199599 / 2019-32-0599
7. Paper title	Numerical Studies on Temporal and Spatial Distribution of Equivalence Ratio in Diesel Combustion Using Large Eddy Simulation
8. Authors (Affiliation)	Beini Zhou, Shotaro Yamada, Takayuki Adachi, Jin Kusaka (Waseda University)

9. Abstract

To identify ways of achieving good mixture formation and heat release in diesel spray combustion, we have performed Large Eddy Simulation (LES) using a detailed chemical reaction mechanism to study the temporal and spatial distribution of the local equivalence ratios and heat release rate. Here we characterize the effect of the fuel injection rate profile on these processes in the combustion chamber of a diesel engine. Two injection rate profiles are considered: a standard (STD) profile, which is a typical modern common rail injection profile, and the inverse delta (IVD) profile, which has the potential to suppress rich mixture formation in the spray tip region. Experimental data indicate that the formation of such mixtures may extend the duration of the late combustion period and thus reduce thermal efficiency. Analyses of the heat release per unit fuel mass and unit entrained O2 mass under the two injection regimes indicate that IVD injection reduces the density of the fuel-air mixture in the spray tip region, increases the leanness of the spray core region, and enhances O2 entrainment, improving the heat release process.

6. Paper No.(JSAE/SAE)	20199618 / 2019-32-0618
7. Paper title	An Effect of Cooled-EGR on Diesel Engine Performance Fueled with Coconut-oil Methyl Ester
8. Authors (Affiliation)	Koji Yoshida (Nihon University)

9. Abstract

The purpose of this study is to explore an effect of cooled-EGR on the diesel engine performance fueled with coconut-oil methyl ester (CME). The exhaust gas was cooled by the water at room temperature and was fed to the intake manifold, and the EGR rate was changed from 0 % to 30 % at every 10 %. The engine performances were measured at several EGR rates, fuel injection pressures and timings. Test fuels were CME and commercial diesel fuel. In the case of high EGR rate at which the compression ignition was deteriorated, the ignition timing of CME was always earlier than that of diesel fuel, therefore CME had good ignitability as compared with diesel fuel under EGR application. When the fuel injection pressure was increased at high EGR rate, the ignition delay was improved by the fuel atomization and air-fuel mixing effect. The COV of indicated mean effective pressure was not so influenced by the EGR rate for CME and diesel fuel and the brake thermal efficiency of CME was almost the same as that of diesel fuel at any EGR rates. At high EGR rate, NOx emission remarkably decreased and brake thermal efficiency slightly decreased, and THC, CO and smoke emissions were increased for both fuels. In any EGR rates, THC, CO and smoke emissions of CME was slightly lower than those of diesel fuel. Therefore, NOx emission was could be reduced by the cooled EGR when the CME was used, although CO, THC and smoke emissions increased.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Cosmos 2
3. Time	13 : 15 - 14 : 45
4. Session	Measurement and Simulation II
5. Chair (Affiliation),	Tadao Okazaki (LEMA / Kubota Corporation)
Co-chair (Affiliation)	Stephan Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199548 / 2019-32-0548
7. Paper title	Piston Temperature Measurement During Engine Warm-Up and Application for Analysis of Piston Behavior
8. Authors (Affiliation)	Akira Ishibashi, Kunihiko Hiraoka, Masanobu Saito, Shinya Kubota (SUZUKI MOTOR CORPORATION)

9. Abstract

In recent years, internal-combustion engines have been required to satisfy various performance standards against emission regulations and fuel-efficiency targets. To this end, accurate measurement of piston temperature under various engine operating conditions is important. Some studies reported the use of wireless methods to confirm the reliability of the measurement system at the highest engine speed and create a piston temperature map under all operating conditions. However, previous case studies only considered relatively large displacement engines, and the advantage of wireless methods—a high degree of freedom for design—was not used. In terms of engine operating conditions, few cases focus on the piston to cylinder wall clearance during engine warm-up conditions. Thus, wireless methods are still space to use their features. In this study, we develop and implement a telemetry-type method for a motorcycle engine, which has smaller displacement and is therefore more restrictive relative to measurement system design than past case studies. The temperature distribution in the entire piston is measured, considering the temperature distribution of a cylinder bore wall surface during the period between a cold start and the completion of the warm-up. Temperature measurement data are continuously obtained under transient operating conditions. In addition, the measurement results are input to a model that simulates piston behavior to improve the calculation results of piston slap noise.

6. Paper No.(JSAE/SAE)	20199570 / 2019-32-0570
7. Paper title	Study on Oil Consumption in Compact Motorcycle Engines
8. Authors (Affiliation)	Taichi Kohno, Naoyuki Suda, Yoshinari Ninomiya (SUZUKI MOTOR CORPORATION)

9. Abstract

Because the scooter is convenient, the market continues increasing. As a result of market survey, it was revealed that the scooter repeated sudden acceleration and deceleration. Therefore, the oil consumption may occur in special pattern. The oil consumption is an important development target. On the other hand, the oil consumption is complicated phenomenon. In this study, the sulfur trace method was used for measurement of the oil consumption. When a throttle was closed and the intake pipe became the negative pressure, the SO2 emission (oil consumption) increases. Then, using a glass cylinder and a high-speed camera, motion of the engine oil was observed. It was revealed that the engine oil rises to the combustion chamber after stopping at the 4th Land. By a combination of the sulfur trace test and the visualization test, oil consumption phenomenon of the scooter was able to be understood.

6. Paper No.(JSAE/SAE)	20199518 / 2019-32-0518
7. Paper title	Advanced 2-Wheeler Powertrain Test Setup for Dynamic Fuel Consumption Measurement with Increased Accuracy, Repeatability and Data Quality
8. Authors (Affiliation)	Harald Mayrhofer, David Gillespie, Michael Kastner, Karl Köck, Arnold Berger (AVL List GmbH, Croda Europe Ltd.)

9. Abstract

Specific test systems are essential for the development and optimization of powertrains for two-wheeler applications. The World Motorcycle Test Cycle (WMTC) is prevalently used for type approval certification in terms of emissions and fuel consumption. In this respect, decreasing fuel consumption and increasing efficiency within the WMTC is an important development goal. The aim of the development project presented in this paper was to investigate how the robustness and repeatability of the measurement data can be increased by using a specific measurement procedure and test setup. As fuel consumption and emission levels reach ever lower levels, any influencing factors related to performance and emissions are of particular interest within the powertrain development phase. When it comes to the differentiation of specific influencing factors such as lube oil behavior and its contribution to fuel consumption, very high measurement- repeatability and accuracy must be maintained. High measurement repeatability enables the effects resulting from deliberate changes in engineering variabilities to be distinguished from unintended measurement uncertainties. This paper describes a measurement procedure to increase repeatability by using a dedicated test system for full 2-wheeler vehicle applications. This test setup utilizes a virtual driver unit to exclude uncertainties due to variable human driver behavior. ...

Abstracts of Technical Sessions

1. Date Tuesday, November 19
2. Room. Himawari
3. Time 13：15 - 14：45
4. Session Engine Controls
5. Chair (Affiliation), Yutaka Nitta (SUZUKI MOTOR CORPORATION)
   Co-chair (Affiliation) Ken Fosaaen (Kerdea Technologies)

6. Paper No.(JSAE/SAE)	20199511 / 2019-32-0511
7. Paper title	Study of OBD Stage II Misfire Detection System for Small Motorcycles
8. Authors (Affiliation)	Satoshi Miwa, Yuki Iiboshi, Hirotaka Fukuta (Aisan Industry Co., Ltd.)

9. Abstract

In recent years, the shift to Fuel Injection (FI) system for motorcycles has been accelerated in response to the enhancement of exhaust emission regulations and the improvement of fuel efficiency for global environmental protection. In addition, On Board Diagnostics (OBD) was introduced to inform users of vehicle abnormalities and failures and prevent from emission failure in the market. OBD stageII requires enlargement of requirements and threshold detection. Seven items are presented in the EU5, Bharat Stage 6 (BS6). The misfire detection in small motorcycles has several problems. First, for the small motorcycle, a single-cylinder engine is the main and its combustion behavior cannot be compared with other cylinders. Consequently, it is difficult to detect misfire. For misfire detection, we focused on the difference in crank angular velocity during combustion stroke between normal combustion and misfire. The greatest gap was in crank angular velocity occurs at 0-180° crank angle [°CA]. With that, misfire detection control is established. We confirmed from the above control that misfire could be detected in the whole engine speed or load within the regulation. As a countermeasure against erroneous detection at the time of actual running, the rotational fluctuation caused by misfire and the rotational fluctuation caused by disturbance were .....

6. Paper No.(JSAE/SAE)	20199519 / 2019-32-0519
7. Paper title	Sensor Fusion Concept for Improved Rotational Speed Measurement in Small Engines
8. Authors (Affiliation)	Markus Neumayer, Thomas Bretterklieber, Thomas Suppan (Graz University of Technology)

9. Abstract

Future developments for small engines, e.g. engines for handheld working tools, like chain saws require the integration of ECU-systems for engine control. For small engines often only a rotational speed senor is available. The application of additional engine sensors is in many cases unwanted, e.g. due to cost aspects and additional wiring. The lack of sensor data requires tailored control strategies and signal processing techniques to infer information about the engine from the sensor data. E.g. for rotational speed sensors the $\Delta\omega$ method has been proposed, where the load is estimated from the temporal variation of the rotational speed. This approach requires a rotational speed sensor with sufficient angular resolution. In this paper we present a simulation study for a sensor fusion concept to improve the temporal resolution of engine speed measurements for low cost engines by means of an additional vibration sensor. The rotational sensor of the engine is assumed to have insufficient resolution to determine variations of the rotational speed over an engine revolution. However, variations of the rotational speed of the engine also cause vibrations of the engine chassis. A vibration sensor can be used to pick up the vibration signal with high temporal resolution. As the transfer function between the variation of the rotational speed and the .....

6. Paper No.(JSAE/SAE)	20199568 / 2019-32-0568
7. Paper title	Research on Method of Sensor Fault Detection for OBD-II Compliant Motorcycles Based on Temperature Estimation
8. Authors (Affiliation)	Atsushi Watanabe (Keihin Corporation)

9. Abstract

On-Board Diagnostics II (OBD II), which will be to be introduced into motorcycles in Europe and India, requires that the engine oil and cooling water temperatures be monitored in a rational manner. The rationality of the sensors for engine oil and coolant temperatures (TW sensors) is derived from the ability to detect failure modes such as offset or fixation of unintended output voltage in addition to circuit continuity checks such as sensor harness disconnection and short circuit. The OBD II technology for 4-wheeled vehicles cannot be easily converted to motorcycles with their multiple cooling systems (air-cooled and water-cooled) and multiple heat dissipation structures (full fairings, naked structures, etc.). In previous studies, failures of the TW sensor were detected by estimating the water temperature with high accuracy based on the calorific value of the engine and the amount of heat dissipated. However, in studies considering the implementation of electronic control units (ECUs), it has been reported that such estimations are vulnerable to disturbance (especially from a heater or blower) because it was difficult to estimate water temperature based on accurate heat removal. In addition, since the motorcycle has a heat-dissipating structure that facilitates cooling, it is necessary to consider heat removal in any environment.

Abstracts of Technical Sessions

1. Date Tuesday, November 19
2. Room. Ran 2
3. Time 15：15 - 15：45
4. Session Functional Safety
5. Chair (Affiliation), Takashi Mitome (SUZUKI MOTOR CORPORATION)
   Co-chair (Affiliation) Giovanni Ferrara (University of Florence)

6. Paper No.(JSAE/SAE)	20199537 / 2019-32-0537
7. Paper title	Estimating a Rider's Compensatory Control Actions by Vehicle Dynamics Simulation to Evaluate Controllability Class in ISO 26262
8. Authors (Affiliation)	Maki Kawakoshi, Takashi Kobayashi, Makoto Hasegawa (Japan Automobile Research Institute)

9. Abstract

Controllability is defined in ISO 26262 as a driver's ability to avoid a specified harm caused by a malfunction of electrical and electronic systems installed in road vehicles. According to Annex C of Part 12 of ISO 26262, simulation is one of the techniques that the Controllability Classification Panel (CCP) can use to evaluate comprehensively the controllability class (C class) of motorcycles. With outputs of (i) an index for the success of harm avoidance and (ii) the magnitude of the rider's compensatory control action required to avoid harm, the simulation is useful for evaluating the C class of the degrees of malfunction that cannot be implemented in practice for the sake of the test rider's safety.

To aim at supplying data that the CCP can use to judge the C class, we try to estimate the vehicle behavior and a rider's compensatory control actions following a malfunction using vehicle dynamics simulations. The simulated scenario is the occurrence of unintended deceleration during cornering caused by a malfunction of the electronically controlled combined braking system. The parameter values supplied to the simulation model are set based on data obtained from actual riding tests that were performed. Using this model, we extrapolates the vehicle behaviors and the rider's compensatory control actions under conditions that an actual riding test cannot be feasible. Moreover, the estimation results demonstrate the likely magnitude of the steering torque relative to the deceleration due to the malfunction as data that the CCP could use to evaluate the C class.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Cosmos 1
3. Time	15 : 15 - 16 : 45
4. Session	Small & Micro Combined Heat and Power (CHP) Systems
5. Chair (Affiliation),	Toru Nakazono (LEMA / Yanmar Co., Ltd.)
Co-chair (Affiliation)	Alessandro Bellissima (Yanmar R&D Europe)

6. Paper No.(JSAE/SAE)	20199576 / 2019-32-0576
7. Paper title	Impact of Intake Port Water Injection Timing on Mitigating the Tradeoff Between Performance and NOx Emissions for a Naturally Aspired Micro-CHP-Engine
8. Authors (Affiliation)	Youssef Beltaifa, Maurice Kettner (Karlsruhe University of Applied Sciences), Peter Eilts (Technical University of Braunschweig), Markus Klaissle (SenerTec Kraft-Wärme-Energiesysteme GmbH)

9. Abstract

Small natural gas cogeneration engines usually operate with lean mixture and late combustion phasing to comply with NOx emission standards, leading to significant losses in engine efficiency. Owing to water evaporation heat and high specific heat capacity of the water vapor, leads the water injection to cooling the combustion chamber charge, which enables earlier combustion phasing, higher compression ratio and thus higher engine efficiency. Therefore, water injection enables mitigating the tradeoff between NOx emissions and engine performance, without loss in engine efficiency. The intake port injection represents, because of the low required injection pressure and the simple injector integration, a cost-effective way to introduce water into the engine. Hence, the purpose of this work is to adapt the intake port water injection timing to the charge mixture flow conditions in the intake port.

6. Paper No.(JSAE/SAE)	20199588 / 2019-32-0588
7. Paper title	High Efficiency by Miller Valve Timing and Stoichiometric Combustion for a Naturally Aspirated Single Cylinder Gas Engine
8. Authors (Affiliation)	Jörn Judith, Denis Neher, Maurice Kettner (Karlsruhe University of Applied Sciences) Danny Schwarz, Markus Klaissle (SenerTec Kraft-Wärme-Energiesysteme GmbH)

9. Abstract

Small-scale cogeneration units (Pel < 50 kW) frequently use lean mixture and late ignition timing to comply with current NOx emission limits. Future tightened NOx limits might still be met by means of increased dilution, though both indicated and brake efficiency drop due to further retarded combustion phasing and reduced brake power. As an alternative, when changing the combustion process from lean burn to stoichiometric, a three-way-catalyst allows for a significant reduction of NOx emissions. Combustion timing can be advanced, resulting in enhanced heat release and thus increased engine efficiency.
Based on this approach, this work presents the development of a stoichiometric combustion process for a small naturally aspirated single cylinder gas engine (Pel = 5.5 kW) originally operated with lean mixture. To ensure low NOx emissions, a three-way-catalyst is used. In order to achieve high engine efficiency, measures implemented include Miller valve timing, optimized intake system, reduced engine speed and increased compression ratio. In the first step, a detailed 1D engine cycle simulation model was used to investigate the efficiency benefit of Miller valve timing and increased compression ratio.

6. Paper No.(JSAE/SAE)	20199604 / 2019-32-0604
7. Paper title	Effect of Fuel Composition in Bio-Syngas on NOx in Emission with SI-ICE
8. Authors (Affiliation)	Shota Iwai, Hiroshi Enomoto, Kazushi Fukadu (Kanazawa University)

9. Abstract

In recent years, effective methods of utilizing power generation using biomass have been studied a biomass power generation with an internal combustion engines. It is able to be used even on small scale. In addition, by using the ICE, it is possible to make the efficiency relatively high. We manufactured a compact downdraft type gasifier that generates bio-syngas from biomass and drove a small spark ignition ICE (SI-ICE). NO is included in the emission of the ICE. Due to NO is said that it pollute the atmosphere and destroy the ozone layer, it must be reduced. Many researcher study NO in emission with synthetic gas of CH4 mixed with H2. Their result is NO increased as H2 ratio increased. However, experiments with actual syngas is few. And, combustible gases in bio-syngas produced by our equipment are CO, H2 and CH4. Previous studies with synthetic gas of mixed CO, H2 and CH4 is few. Therefore, experiments are performed with actual syngas. Also, H2 and city gas (13 A) is added to syngas for the purpose of changing the combustible gas composition. Also, thermal efficiency and operational stability were compared. COV-IMEP was used for operation stability. H2 and 13A were mixed in 2 inch hose. The experiment was conducted with same IMEP and excess air ratio. The experiment result was compared with syngas, syngas added H2 and syngas added CH4. It was that NO with bio-syngas was higher than 13A. NO in the emission was thermal NO. The maximum in-cylinder temperature and the heat release ratio increased when H2 was added. And initial and main combustion duration decreased. When CH4 was added, the result was the opposite of when H2 was increased. It is expected from this experiment that when bio-syngas is used, there will be the combustion duration in which the balance of NO emission and thermal efficiency is best.

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Cosmos 2
3. Time	15 : 45 - 16 : 45
4. Session	Measurement and Simulation III
5. Chair (Affiliation),	Minoru Iida (Yamaha Motor Co., Ltd.)
Co-chair (Affiliation)	Stephan Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199542 / 2019-32-0542
7. Paper title	Improvement of On-Board In-Cylinder Gas Flow Model and Wall Heat Transfer Prediction Model for CI Engines Using CFD Analysis and PIV Measurements Under Motoring and Firing Conditions
8. Authors (Affiliation)	Mitsuhisa Ichiyanagi, Gerard Ndizeye, Yuji Sawamura, Reina Saito, Kotaro Takahashi, Koki Otsubo, Haoyu Chen, Suzuki Takashi (Sophia University)

9. Abstract

For the improvement of the transient driving performance and the thermal efficiency for diesel engines, it is effective to control the fuel injection by model-based control (MBC) on ECU with cycle-by-cycle calculation, and MBC requires six models; gas flow, spray development, mixture formation, combustion, ignition delay, and heat loss. The authors previously developed on-board in-cylinder gas flow and wall heat transfer prediction models to estimate the heat loss. However, the developed gas flow model has an undetermined coefficient called the turbulence intensity coefficient (TIC), which significantly influences the prediction accuracy of the wall heat transfer prediction model. The present study improved the gas flow model and the wall heat transfer prediction model by applying TICs obtained using the PIV and CFD analysis. In-cylinder gas flow in an optical singlecylinder diesel engine was measured by PIV under both motoring and firing conditions, and TICs were calculated and applied to the wall heat transfer prediction model. The heat flux values obtained from the model were compared with those from the experiments using heat flux sensors. It was made clear that the average heat flux using TIC at 60–80 mm plane (stroke of 96.9 mm) showed the least error of -4.7%, ...

6. Paper No.(JSAE/SAE)	20199543 / 2019-32-0543
7. Paper title	Evaluation of On-Board Heat Loss Prediction Model and Polytropic Index Prediction Model for CI Engines Using Measurements of Combustion Chamber Wall Heat Flux
8. Authors (Affiliation)	Mitsuhisa Ichiyanagi, Zhiyuan Liu, Haoyu Chen, Koki Asano, Koki Otsubo, Emir Yilmaz, Takashi Suzuki (Sophia University)

9. Abstract

Diesel engines need to optimize the fuel injection timing and quantity of each cycle in the transient operation to increase the thermal efficiency and reduce the exhaust gas emissions through the precise combustion control. The heat transfer from the working gas in the combustion chamber to the chamber wall is a crucial factor to predict the gas temperature in the combustion chamber to optimize the timing and quantity of fuel injection. Therefore, the authors developed both the heat loss and the polytropic index prediction models with the low calculation load and high accuracy. In addition, for the calculation of the heat loss and the polytropic index, the wall heat transfer model was also developed, which was derived from the continuity equation and the energy equation. The present study used a single cylinder diesel engine under the condition of engine speed of 1200 and 1500 rpm, and measured the local wall temperature and the local heat flux of the combustion chamber. The measured data were compared with the prediction results of the heat loss and the polytropic index and evaluated the prediction accuracy of those models. ...

Abstracts of Technical Sessions

1. Date	Tuesday, November 19
2. Room.	Himawari
3. Time	15：15 – 16：45
4. Session	Hybrids, Electric Drives & Fuel Cells
5. Chair (Affiliation),	Yasuyuki Muramatsu (Yamaha Motor Co., Ltd.)
Co-chair (Affiliation)	Kai Beck (Andreas STIHL AG & Co. KG)

6. Paper No.(JSAE/SAE)	20199555 / 2019-32-0555
7. Paper title	Development of Hydrogen Powered Fuel Cell e-Snowmobiles
8. Authors (Affiliation)	Patrick Pertl, Martin Aggarwal, Alexander Trattner (HyCentA Research GmbH), Walter Hinterberger, Nigel Foxhall (BRP-Rotax GmbH & Co KG)

9. Abstract

In the highly innovative and holistic flagship project HySnow (Decarbonisation of Winter Tourism by Hydrogen Powered Fuel Cell Snowmobiles), funded by the Austrian Climate and Energy Fund, the decarbonization of winter tourism is being demonstrated. Within this project, two prototype snowmobiles have been developed including the adaption of a Polymer Electrolyte Membrane Fuel Cell (PEM-FC) system for the low temperature and high-performance targets and the integration of the drivetrain into the vehicle.

In this paper the drivetrain development process of the prototype e-snowmobiles will be presented with the aim to derive specifications for the drivetrain components as PEMFC system, hydrogen storage system, electric drive, battery and power electronics. Based on typical use cases for snowmobiles overall vehicle specifications and requirements are defined. Associated driving cycles are investigated and used as input for the development process. Subsequently, analyses regarding possible drivetrain topologies based on technical and economical vehicle requirements are carried out. In parallel, vehicle implementation concepts based on standardized development processes are performed. The development and the design process are verified by verification and optimization loops. The results define...

6. Paper No.(JSAE/SAE)	20199623 / 2019-32-0623
7. Paper title	Replacement of a 50cc Two-stroke Engine with an Electric Powertrain
8. Authors (Affiliation)	Jesse Beeker (TWIG Power)

9. Abstract

As global regulations look to create a dramatic reduction in CO2 emission and other forms of pollution, companies with products that rely on engine technology must be ready to take on the electrification challenge. Applications that remain using two-stroke engine technology continue to exist due to their very high power density requirements. However, their history of higher pollution compared to four-stroke engines makes them a target to be regulated out of existence.

Such high power two-stroke applications include high performance off-road motorcycles. In this type of product, electrification can solve not only pollution challenges but market challenges, such as ridership and public perception. By addressing the core problems presented by the two-stroke engine and turning challenges into opportunity, a strong attraction is created to convert a two-stroke engine motorcycleto an electric vehicle.

With Automotive electric vehicle technology paving the way, the basis for cost effective electric motorcycle powertrain is explored for a 50cc off-road motorcycle application. The 50cc engine and motorcycle represent a special product where size, performance, and cost have a high sensitivity. The 50cc product also represents an area of great opportunity for the product as it is connected to the youth riding segment that establishes the future of motorcycle riding. With both strong opportunity...

6. Paper No.(JSAE/SAE)	20199525 / 2019-32-0525
7. Paper title	Acoustics and Drivability as the Main Drivers for Customer Satisfaction for Electrified 2-Wheeler
8. Authors (Affiliation)	Christian Hubmann, Patrick Falk, Bernhard Graf, Hubert Friedl (AVL List GmbH)

9. Abstract

Along with the global trend for electrification, also motorcycle industry is entering new spheres of highly advanced products and is increasing customer demands for electric mobility. Beside hard facts such as performance, driving range, durability and ease of use, also the brand specific attributes such as styling, driveability and even sound for electrified 2-wheeler are very emotional, unique selling prepositions. To determine the subjective parameters for driveability and acoustics, AVL has developed dedicated tools and methods to quantify these attributes with high maturity. In terms of acoustics and NVH there are several crucial noise sources within electrified powertrains, which have to be treated with high attention from the initial development phase to avoid any kind of unforeseen annoyances: E-motor with inverter, transmission and secondary drive are most relevant. This issue becomes even more important with the ongoing market trend of products featuring increased power.
Electrified motorcycles commonly are expected to offer supreme acceleration performance, but even this attribute may lead into driver´s disappointment if throttle response and overall vehicle driveability parameters are inhomogeneous. The driveability and the corresponding parameters have to be calibrated in perfect match of all powertrain components along with the given vehicle architecture. ...

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Ran 1
3. Time	8 : 30 - 9 : 30
4. Session	Emissions I
5. Chair (Affiliation),	Hiromi Deguchi (SUZUKI MOTOR CORPORATION)
Co-chair (Affiliation)	Mikael Bergman (Husqvarna AB)

6. Paper No.(JSAE/SAE)	20199613/ 2019-32-0613
7. Paper title	Visualization and Analysis of Droplets Behavior in Aftertreatment Systems: I. Experimental Study by Acrylic SCR Dosing Simulator
8. Authors (Affiliation)	Tetsuo Nohara, Naoki Sugiyama, Masayuki Ochiai (Tokai University)

9. Abstract

Diesel engines have been extensively used as a primary power source for off-road applications. Exhaust gas emissions from the engines, in particular Nitrogen oxides (NOx) is reduced using Selective catalytic reduction (SCR) dosing systems in aftertreatment systems. Small off-road diesel engines have also requested SCR dosing systems due to severe worldwide emission regulations. The injection of Urea aqueous solution or Diesel emission fluid (DEF) spray in the exhaust pipe of the small off-road diesel engines significantly eliminate NOx emissions. However, the crystallization of urea from the aqueous solution droplets and wall deposit formation in exhaust pipes are main issues in SCR dosing systems. The issues are critical deterioration of performance in aftertreatment systems. Nevertheless, the visualization study has not been investigated for the inside of exhaust pipes yet. This paper describes visualization experiments of the injected droplets behavior by Acrylic SCR dosing simulator. First visualization technique was applied measuring the gas flow distribution and directions with a smoke generator. Then, the injected spray and droplets behavior are validated with actual application conditions. The details of droplets behavior with gas distributions were confirmed by multiple High-speed video cameras and PIV (Particle Image Velocimetry) analysis. From the visualization results show the details of SCR spray impingement, injected droplet directions and evaporated behavior in the exhaust pipe conditions. The results were clarified complicated gas and droplets flows inside of exhaust pipes. These findings indicate several injected droplets remain the almost same as initial condition in spite of after impingement of mixer. The observations suggest that SCR injected all droplets are not evaporated on the impingement process perfectly. This time, our study has established new visualization experiment methods for the aftertreatment systems, especially Macro-scale of SCR dosing systems. Then, three-dimensional gas flow and droplets behavior have been estimated inside exhaust pipes. As a result, we have found that the visualization study shows effective utilization of SCR dosing systems.

6. Paper No.(JSAE/SAE)	20199612 / 2019-32-0612
7. Paper title	Visualization and Analysis of Droplets Behavior in Aftertreatment Systems: II. Improvement of Vaporization Efficiency by Surface Texturing
8. Authors (Affiliation)	Naoki Sugiyama, Tetsuo Nohara, Masayuki Ochiai (Tokai University)

9. Abstract

Diesel engines contain Nitrogen oxides (NOx) in exhaust gases, and is considered to be problematic in view of the environment. For worldwide NOx emission control, Selective Catalytic Reduction (SCR) dosing systems are widely used in aftertreatment systems. In the urea-SCR system, the urea aqueous solution or Diesel emission fluid (DEF) injected into the exhaust gas by the injector is uniformly dispersed by the mixer and decomposed to ammonia before catalysts for reduction of NOx. A mixer of the urea aqueous solution is placed between the injector and SCR catalysts and is used to provide good ammonia uniformity in SCR catalysts. This is made possible by utilizing fixed metal blades to create turbulence and by promoting evaporation of the urea aqueous solution by improving mixing behavior. It is very important to mix and evaporate the urea aqueous solution at short-distance using the optimum the mixer blade geometry. The vaporization ratio of injected SCR dosing droplets into the exhaust gas are of considerable practical concern. In this paper, the collision behavior of droplets into textured mixer surface materials are investigated by visualization experiment by backlight method. In general, the surface texture is used for controlling the wettability of the wall surface, and there is no document which finds the effect of atomization. Several surface texture types were proposed as a means to improve the atomization performance of droplets by the mixer. In order to verify the performance of droplet atomization by the textures, a visualization experiment of droplet behavior was conducted using a simple experimental device. Furthermore, the droplet diameter distribution before and after collision was calculated using the visualization results. The details of droplets behavior were confirmed by High-speed video camera and Particle viewer systems. Various conditions of droplet diameters were measured and the vaporization performances of the surface textures were studied. According to the results, 30 micron of pitch texture demonstrated good micronizing and evaporating of the droplets. In addition, several types of droplets reactions (Explosion, sticking and rebounds) were observed. This time, our study has established new visualization experiment methods for the aftertreatment systems, especially micro-scale of SCR dosing systems. It was found that improvement of the vaporization efficiency by surface texturing on the mixer or exhaust pipes.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Ran 2
3. Time	8：30 - 9：30
4. Session	Alternative Fuels III
5. Chair (Affiliation),	Toru Nakazono (LEMA / Yanmar Co., Ltd.)
Co-chair (Affiliation)	Kai Beck (Andreas Stihl AG & Co. KG)

6. Paper No.(JSAE/SAE)	20199595 / 2019-32-0595
7. Paper title	The Experimental Investigation of the Performance and Emissions Characteristics of Direct Injection Diesel Engine by Bio-Hydro Fined Oil and Diesel Oil in Different EGR
8. Authors (Affiliation)	Annisa Bhikuning, Xin Li, Shoi Koshikawa, Eriko Matsumura, Jiro Senda(Doshisha University)

9. Abstract

Bio-hydro fined diesel (BHD) oil is known as a second generation oil made from bio hydro finning process. Biodiesel in the first generation is made from transesterification process and it has several disadvantages such as high density and increased the viscosity that can cause operational problems because can make some deposits in the
engine. To overcome this, the second generation process of biodiesel has been modified from the first generation oil.BHD is made from the waste cooking oil by using the hydrofinning process without the trans-esterification process. Theresults of BHD oil has nearly the same with diesel oil. BHD oil has low viscosity and high oxidation stability. Therefore, BHD oil can be used in the diesel engine without making any modifications in the engine.
In this study, the comparison of performance and emissions characteristics from BHD oil, waste cooking oil, and diesel oil are investigated. The experimental conditions are varied for loads (low load and partial load) and exhaust gas circulations (EGR) are zero, 10, and 20%. The engine speed was constant at 2000 rpm. The results show that the BHD oil can be an alternative fuel to replace the diesel oil because the emissions can be reduced from diesel oil, therefore it is friendly to the environment.

6. Paper No.(JSAE/SAE)	20199606 / 2019-32-0606
7. Paper title	Utilization of Castor oil-based Ethyl Ester Biodiesel in a Diesel Engine
8. Authors (Affiliation)	Anupap Pumpuang, Somkiat Maithomklang, Ekarong Sukjit, Disatorn Dejvajara, Phannathon Samaiklang, Somluethai Sanluecha (Suranaree University of Technology), Manida Tongroon (National Metal and Materials Technology Center)

9. Abstract

Biodiesel was prepared through transesterification of castor oil and ethanol. The optimization of parameters related to the yield of transesterification, such as oil to ethanol molar ratio, concentration of catalyst, reaction temperature and reaction time, was investigated. The results indicated that the optimum condition for castor oil ethyl ester (COEE) production was 1:12 oil to ethanol molar ratio, 1.5% catalyst concentration, 40 °C reaction temperature and 150 minutes reaction time. To avoid extremely high viscosity of castor oil which can affect the fuel injection system, COEE was blended with commercial diesel fuel at different concentrations ranged from 5%-15% volume and key properties of fuel blends, mainly focused on fuel lubricity and viscosity were evaluated. The presence of 8% COEE in diesel fuel was concluded as the optimum concentration because the smallest wear scar diameter was obtained after the lubricity test and its viscosity was within acceptable limits prescribed by the standard specification of diesel fuel. Consequently, the blend of 8% COEE and diesel fuel was selected in the engine test. The results showed that the addition of 8% COEE to diesel fuel can improve brake thermal efficiency and brake specific fuel consumption. Moreover, the reduction in carbonaceous gas emissions and oxides of nitrogen was obtained by the combustion of the COEE blend.

Abstracts of Technical Sessions

1. Date — Wednesday, November 20
2. Room. — Cosmos 1
3. Time — 8 : 30 - 9 : 30
4. Session — HCCI I
5. Chair (Affiliation), Co-chair (Affiliation) — Tatsuya Kuboyama (Chiba University), Glenn Bower (The University of Wisconsin-Madison)

6. Paper No.(JSAE/SAE)	20199522 / 2019-32-0522
7. Paper title	Combustion Characteristic of Offset Orifice Nozzle Under Multi Pulse Ultrahigh Pressure Injection and PCCI Combustion Conditions
8. Authors (Affiliation)	Pop-Paul Ewphun, Miku Otake, Tsuyoshi Nagasawa, Hidenori Kosaka, Susumu Sato (Tokyo Institute of Technology)

9. Abstract

CI engines provide higher thermal efficiency compared to other internal combustion engines. On the other hand large amounts of smoke and NOx are produced during combustion. Smoke and NOx can be reduced by applying Premixed Charge Compression Ignition (PCCI) combustion. Unfortunately, the problems of PCCI combustion include unstable start of combustion and limited operating range. The multi-pulse ultrahigh pressure injection allows fuel to control PCCI combustion. The objective of offset orifice nozzle is to improve mixture formation and shorten spray penetration in order to increase thermal efficiency and control PCCI combustion. The offset orifice nozzle was designed by shift orifice aliment from into the sac center to edge of sac follow swirl direction. Counter bore design was applied to offset orifice nozzle in order to keep the constant orifice length as standard nozzle. This paper investigates the effect of nozzle orifice design on combustion characteristics under multi pulse ultra high pressure injection and PCCI combustion conditions. The experiments were carried out on a single cylinder engine at 0.55 MPa gross IMEP at 1,750 rpm. The injection pulses were 3 pulses equally mass main injection at 150, 200, 250, 300 and 350 MPa injection pressure. In case of standard nozzle orifice, 1st, 2nd pulse are PCCI followed by diffusive combustion in every injection pressure. For offset orifice nozzle orifice at 150 and 200 MPa 1st, 2nd pulse are also PCCI combustion. However when injection pressure is over 200 MPa, the 2nd pulse of rate of heat release become diffusive combustion. The offset orifice nozzle resulted in increased thermal efficiency, NOx and smoke. However significant differences between the smoke of offset orifice nozzle and standard nozzle were not found under injection pressure 300 and 350 MPa. The offset orifice nozzle also resulted in decrease CO and THC.

6. Paper No.(JSAE/SAE)	20199608 / 2019-32-0608
7. Paper title	Improvements to a CFR Engine Three Pressure Analysis GT-Power Model for HCCI and SI Conditions
8. Authors (Affiliation)	Jorge Pulpeiro Gonzalez, Muhammad Umer Waqas, Christopher Kolodziej (Argonne National Laboratory), Daniel DelVescovo, Timothy Ross (Oakland University)

9. Abstract

While experimental data measured directly on the engine are very valuable, there is a limitation of what measurements can be made without modifying the engine or the process that is being investigated, such as cylinder temperature. In order to supplement the experimental results, a Three Pressure Analysis (TPA) GT-Power model of the Cooperative Fuel Research (CFR) engine was previously developed and validated for estimating cylinder temperature and residual fraction. However, this model had only been validated for normal and knocking spark ignition (SI) combustion with RON-like intake conditions (naturally aspirated, <52 °C). This work presents improvements made to the GT-Power model and the expansion of its use for HCCI combustion. The burn rate estimation sub-model was modified to allow for low temperature heat release estimation and compression ignition operation. After this, several updates were made in the GT-Power model parameters so that the air and fuel charge mass was correctly predicted under these different combustion (SI vs. HCCI) and intake conditions (boosted or heated). Thermodynamic verifications were made to compensate for uncertainty in some of the measured operating parameters, such as compression ratio, in the CFR engine. The updated CFR model was used to obtain the cylinder pressure-temperature trajectories of both HCCI and SI cases under different levels of intake pressure, intake temperature, and speed. Two additional common cylinder temperature estimation methods were compared to the results of the GT-Power model.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Cosmos 2
3. Time	8 : 30 - 10 : 00
4. Session	Measurement and Simulation IV
5. Chair (Affiliation),	Tadao Okazaki (LEMA / Kubota Corporation)
Co-chair (Affiliation)	Stefan Sturm (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199502 / 2019-32-0502
7. Paper title	Spectroscopy Based Tool for Temperature Evaluation During the Spark Discharge
8. Authors (Affiliation)	Simona Silvia Merola, Adrian Irimescu, Bianca Maria Vaglieco, Silvana Di Iorio, Paolo Sementa (Istituto Motori – CNR)

9. Abstract

In this work, a new tool is proposed and tested to investigate the early phase of spark ignition (SI) processes. The diagnostic tool is based on Spark-Induced Breakdown Spectroscopy (SIBS), a consolidated technique in which the plasma formed by spark generation between two electrodes is used as the excitation source for optical emission spectroscopy (OES). The spark discharge of a commercial ignition system was analyzed through OES to correlate the characteristic evolution of the discharge with the formation of reactive species inside the activated volume. Specifically, an open-source spectrum simulation program (Lifbase) together with the NIST database was used for defining relations between the ultraviolet emission bands of nitrogen first negative system (FNS_N2) in the glow phase for different plasma temperature and pressure values. Besides plasma density and ion energy, electron and gas temperatures are important parameters that govern the reaction rate of active species generation through dissociation, excitation, and ionization processes and thus influence the chemistry of the spark discharge. It is well known that the electrical discharge occurring between the spark plug electrodes can be divided into three phases (breakdown, arc and glow discharge), characterized by different time scales. The breakdown occurrence causes the gas molecules in the ignition area to break into atoms and ions. ...

6. Paper No.(JSAE/SAE)	20199552 / 2019-32-0552
7. Paper title	Analysis of Cycle-to-Cycle Variation in a Port Injection Gasoline Engine by Simultaneous Measurement of Time Resolved PIV and PLIF
8. Authors (Affiliation)	Santa Haramiishi, Takahiro Watanabe, Minoru Iida (Yamaha Motor Co., Ltd.), Satoshi Hokimoto (Sustainable Engine Research Center Co., Ltd.), Tatsuya Kuboyama, Yasuo Moriyoshi (Chiba University)

9. Abstract

Cycle-to-cycle variation (CCV) of combustion in low load operation is a factor that may cause various problems in engine operation. Variable valve timing and variable ignition timing are commonly used as a means to reduce this variation. However, due to mountability and cost constraints, these methods are not feasible for use in motorcycle engines. Therefore, development of an engine with minimal CCV without utilizing complicated mechanisms or electronic control is required. CCV of combustion may be caused by fluctuations in in-cylinder flow, air-fuel mixture, temperature, residual gas and ignition energy. In this study, the relationship between CCV of combustion, in-cylinder flow fluctuation and air-fuel mixture fluctuation was the primary focus. In order to evaluate in-cylinder flow fluctuation, Time Resolved Particle Image Velocimetry (TR-PIV) technique was utilized. In addition, Planar Laser Induced Fluorescence (PLIF) technique was used to measure spatial distribution of the mixture. These two visualization techniques were used together to measure continuous combustion cycles. The fluctuation of net IMEP can be explained by the fluctuation of Turbulence Kinetic Energy (TKE) and fuel concentration. In most cycles, net IMEP was correlated with TKE. In the remaining cycles, net IMEP was correlated with fuel concentration. The contribution of each factor towards net IMEP is to be discussed. ...

6. Paper No.(JSAE/SAE)	20199571 / 2019-32-0571
7. Paper title	Effects of Shape of Ion Probe on Flame Detecting Characteristics in 2-Stroke Gasoline Engine
8. Authors (Affiliation)	Tomoaki Yatsufusa, Rio Kamei, Hu Wentao (Hiroshima Institute of Technology)

9. Abstract

Multiple-ion probe method is one of the beneficial method to obtain the detailed information about explosive combustion such as knocking. Our group has been trying to expand the measurement ability on multiple ion probe method from highly-controlled combustion in combustion test tube studied by previous studies to highly-unstable combustion such in spark ignition engines. The previous studies showed that multiple-ion probe method was able to capture the movement of propagating flame in 2-stroke gasoline engine in limited conditions. It requires that more reliable detection of propagating flame in the engine to capture the flame movement more stably. In the present study, the effects of the shape of the ion probe on flame detection characteristics in 2-stroke gasoline engine was investigated. Tested parameters of the shape in the ion probe were projection length and diameter of an ion probe wire. Projection length was changed as 0, 0.5, 1.0, 1.5mm. Test results say that the projection length has positive effects for flame detection. Longer projection length has a higher sensitivity for flame detection. Diameter of ion probe wire was changed as 0.3, 0.5, 0.7, 1.0mm. Experimental results indicate that the size of diameter has less effect on the mean strength of detected flame signal than the projection length.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Himawari
3. Time	8：30 - 10：00
4. Session	Engine Technology I
5. Chair (Affiliation),	Yuji Araki (Yamaha Motor Co., Ltd.)
Co-chair (Affiliation)	Roland Kirchberger (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199509 / 2019-32-0509
7. Paper title	Tumble Flow Enhancement Applied for Low-Load Condition of Engines by Utilizing Reverse Flow Phenomenon in Intake Port
8. Authors (Affiliation)	Yohei Nakamura, Yosuke Inoue, Makoto Fujikubo (Honda Motor Co., Ltd.)

9. Abstract

We established a technology that can enhance the tumble flow in the cylinder only in a partial load range of the engine without the need to use any intake path switching mechanisms.

Firstly, we attempted to understand the basic phenomena of intake flow by using a CFD model, while using a butterfly throttle valve in a straight pipe. By doing this, we were able to observe the reverse flow of intake air that appears after the intake air has passed the throttle valve when the throttle valve opening is 30% or less. This reverse flow is generated mainly in the flow that has passed the trailing edge of the throttle valve. At both sides of the trailing edge opening, the flow is slowed down by diffusing. The flow is then pulled into the low-pressure zone created behind the throttle valve. In addition, a part of the reverse flow merges with the air flowing on the leading-edge side.

Next, we confirmed that installing a flow separator behind the throttle valve that vertically divides the flow can successfully capture the reverse flow into one of the two flow paths. Furthermore, we confirmed that optimizing the separator position ...

6. Paper No.(JSAE/SAE)	20199591 / 2019-32-0591
7. Paper title	Flexible Valve Timing Strategies for Boosting a Small Four-Stroke Spark Ignition Engine Performance
8. Authors (Affiliation)	Mohd Razali Hanipah, Muhammad Haziq Adham Rosli, Akhtar Razul Razali (Universiti Malaysia Pahang.)

9. Abstract

Variable valve timing (VVT) technology has been successful in enhancing internal combustion (IC) engine performance. VVT offers an additional control on engine breathing so that the engine operating conditions may be tailored more precisely hence, output and performance are amplified. In this paper, an approach of boosting IC engine performance through flexible valve timing (FVT) is presented. A numerical baseline model was developed using one-dimensional numerical simulation tool based on a 65cc four-stroke gasoline engine. The flow coefficient values of intake and exhaust ports were obtained from flow bench experiments. The baseline model was validated against specification from manufacturer and results from previous research. This model undergone performance tuning to obtain the power and torque curves for the whole engine speed range. Next, performance optimization was conducted through design of experiments (DoE) with the target of boosting the torque and power of the baseline model between 5 to 10% for the engine speed from 1,500 until 6,000rpm. This was obtained through the variation of intake and exhaust valves timing as well as maximum lift using a full factorial experiment with three levels. The DoE experiments have identified several optimum FVT profiles. The result has shown an increase of up to 13% in brake power ...

6. Paper No.(JSAE/SAE)	20199580 / 2019-32-0580
7. Paper title	Study on the Decision Process of Basic Specification in Development of General Purpose Engine
8. Authors (Affiliation)	Takayuki Aoki, Takahiro Tsuchiyama (Honda R&D Co., Ltd.)

9. Abstract

Social interest in global environmental issues has remained in the forefront during recent years, and as a result, internal combustion engines are expected to have further improved fuel efficiency and reduced exhaust emissions. General purpose engines are demanded for reduced cost in addition to various types of displacement developments. If optimum specifications are examined for each engine displacement and incorporated in the parts shapes, the number of dedicated parts for each engine displacement would increase, which is not desirable from a development/production cost-wise standpoint. It is considered important during the development of engines to efficiently and economically cope with market needs including improved specific power and fuel consumption. Therefore, it was considered necessary to improve combustion performance by enhanced in-cylinder flow and to commonize parts. Then, this study was designed to establish an approach for decision of engine specifications with the perspective of multiple displacement development after satisfying the target performance by combustion improvement. The long stroke and valve angle were adjusted so as to examine specifications that enable enhanced in-cylinder flow with multiple displacements. By confirming that combustion characteristic and fuel efficiency characteristic are ...

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Ran 1
3. Time	10 : 30 - 11 : 30
4. Session	Emissions II
5. Chair (Affiliation),	Hiromi Deguchi (SUZUKI MOTOR CORPORATION)
Co-chair (Affiliation)	Stefan Sturm (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199513 / 2019-32-0513
7. Paper title	Bosch On Board Diagnostic Solutions for Motorcycles
8. Authors (Affiliation)	Holger Jessen, Agarwal Kushal, Abhijith Sabu, Shreyas Hande, Matthias Tappe (Robert Bosch GmbH)

9. Abstract

EU OBD legislation requirements will bring new challenges for motorcycle engine control from 2020 and 2024 respectively. This paper gives a perspective on the Bosch solutions for On Board Monitoring functions to implement the legislation requirements. Specifically the approach and validation results for the monitor for Secondary Air Injection (SAI) will be highlighted. OBD is well established e.g. for passenger car systems in worldwide markets with Bosch solutions covering different system configurations and legislation requirements. While a large portion of the required OBD monitors for motorcycles can be carried over from passenger car solutions with modifications and enhancements where needed, some specific monitors had to be developed from scratch. These new monitors are required for subsystems and components which do not exist in the passenger car environment, e.g. a controlled valve between the intake manifold and engine outlet of the motorcycle to implement secondary air injection. Special focus of this presentation is on the OBD monitoring of the secondary air injection control valve, where robustness is a challenge given the boundary conditions of only binary lambda sensors available in the systems. Challenges are detection of the actual functioning of the secondary air valve with the binary downstream lambda sensor under real world operating conditions and completion of the diagnostic in the WMTC and on the road. A proof of the chosen conceptual approach is given by the implementation into series software and by validation test results on a 1-cylinder motorcycle. Measurements show, that a malfunction will be detected both in the WMTC and during normal driving.

6. Paper No.(JSAE/SAE)	20199617 / 2019-32-0617
7. Paper title	Sensor Integrated Substrate for Future Exhaust System of Two Wheelers
8. Authors (Affiliation)	Kosaku Ito (Vitesco Technologies Japan. K.K.), Sven Seifert, Francois Jayat, Thomas Cartus (Vitesco Technologies Emitec GmbH)

9. Abstract

By upcoming new global two wheelers emission legislation, it is expected that it will become more and more complicated to control exhaust emissions. Therefore, not only optimized catalyst specifications to meet OBDII or RDE, but also new components will be required for future application in two-wheeler exhaust systems. In such applications, beneath applying new components, it is necessary to ensure mountability while maintaining design but improving function of the exhaust system at the same time. As exhaust system layout of two wheelers is generally strongly limited by many factors, such as steeply bended exhaust pipes and catalysts which are hard to resize, one of the most challenging tasks is the positioning of sensor behind the catalyst, due to two wheelers unique exhaust design. In order to overcome the challenge, this work describes designs like the catalyst with integrated lambda sensor, which was developed to contribute to high efficient future two wheelers exhaust systems. The sensor integrated substrate can be installed without choosing the type of sensor (Lambda, Temperature, Pressure, PM, NOx and so on), position, and size. In addition, the substrate with efficient system as structured foil technology produce significant functional advantages. The two structures have a lower thermal mass, which makes it possible to dispense with the first, smaller substrate in the cascade. The other advantage when installed in a catalyst is no risk of sensors being destroyed by water hammer, and more heating leads to improved management. The sensor integrated substrate in this time was combined with perforated structures and tested. By the result of gas measurement, an imbalance value was observed after substrate without the technologies. In contrast, the difference was improved by using the sensor integrated substrate with perforated stucture. The system was showed the possibility of contributing future two wheelers exhaust systems.

Abstracts of Technical Sessions

1. Date — Wednesday, November 20
2. Room. — Ran 2
3. Time — 10 : 30 - 11 : 30
4. Session — Alternative Fuels IV
5. Chair (Affiliation), Co-chair (Affiliation) — Toru Nakazono (LEMA / Yanmar Co., Ltd.), Ken Fosaaen (Kerdea Technologies)

6. Paper No.(JSAE/SAE)	20199611 / 2019-32-0611
7. Paper title	The Combustion Characteristic of Fuel Additives with Diesel-Ethanol Fuel Blends on Engine Performance
8. Authors (Affiliation)	Kampanart Theinnoi, Boonlue Sawatmongkhon, Thawatchai Wongchang (King Mongkut's University of Technology North Bangkok), Ekarong Sukjit (Suranaree University of Technology) Sathaporn Chuepeng (Kasetsart University)

9. Abstract

Reducing carbon dioxide (greenhouse gas) is one of the most important drivers to promote biofuels. Fuel from biomass has the potential to reduce greenhouse gas emissions and can gradually reduce the dependence on fossil fuels. However, fuel properties can differ significantly from standard diesel fuel and this will affect exhaust emissions and environmental pollution. Diesel – ethanol fuel blends development and specification are currently driven by the engine technology, existing fossil fuel specification and availability of feedstock. Thus, the aims of this study to investigate the effects of fuel additives with diesel-ethanol fuel blend under steady-state conditions. In the present study, the additives were palm diesel, n-butanol, ethyl acetate and di-tert-butyl peroxide (DTBP). The ratio of conventional diesel fuel to ethanol fuel to fuel additive are 80:15:5 by volume of fuel blends. The comparative studies on the effects of fuel additives in the engine performance and phase separation in diesel-ethanol blends. The effects of engine performance included exhaust gas emissions with different fuel additives on small diesel engine are also investigated under different engine conditions in order to considering the engine speed and engine load comparison with conventional diesel. The study found that all the additives are enhanced the stabilities in diesel-ethanol fuel blends and phase separation has not be found under the room temperature. The diesel-ethanol fuel blend with DTBP can improved the highest thermal efficiency with lower exhaust gas emission (e.g. carbon- monoxide, oxides of nitrogen, and soot) compare with conventional diesel with another fuel additives. However, the break specific fuel consumption is higher (>4%) than conventional diesel which could be acceptable range. The results suggest that significant benefits can derive from the use of di-tert-butyl peroxide as fuel additive for diesel and ethanol fuel blends as the alternative fuel for compression ignition engine in terms of engine performance, exhaust gas emissions, aftertreatment system performance and environmental pollution in the near future.

6. Paper No.(JSAE/SAE)	20199614 / 2019-32-0614
7. Paper title	Evaluation of Optimal Water Content on an Emulsified Fuel Droplet for Diesel Engine
8. Authors (Affiliation)	Junichi Aoki, Tomoyuki Kaneko, Junya Tanaka (Kogakuin University)

9. Abstract

It is expected for emulsified fuel to improve performance of Diesel engine as thermal efficiency and emissions. The advantage of emulsified fuel is to use secondary atomization. The secondary atomization occurs, because of difference of boiling point between fuel and water. The water content strongly influence on timing of secondary atomization. However, water content is determined empirically as ever. In previous report, it has been reported an engineering evaluation of emulsified fuel to determine optimal water content. Namely, an emulsified fuel droplet is adopted Weibull pots as a statistical evaluation. The experimental data show optimal water content is extremely difference between diesel fuel and neat bio fuel. This paper focuses on the cause of this difference of optimal water content. About this point in this paper, the remarkable parameter is kinematic viscosity and ingredients in fuel. The 4 kind of test fuels are provided, 2.65[mP•s], 13.30[mP•s], 36.50[mP•s], 75.00[mP•s]. The experimental data show that optimal water content of low kinematic viscosity fuel converges toward a point at 23%, however, higher kinematic viscosity fuel change to wider range of optimal water content gradually. It is suggested that optimal water content of fuel droplet is influenced on internal motion of dispersed water. Moreover, it is investigated that effectiveness of ingredients in fuel on optimal water content. The tested fuels are sunflower oil and bean oil which aim at similar kinematic viscosity and different kind of fatty acid ingredients. The effectiveness of ingredients has been confirmed hardly in this research.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Cosmos 1
3. Time	10 : 30 - 11 : 30
4. Session	HCCI II
5. Chair (Affiliation),	Akira Iijima (Nihon University)
Co-chair (Affiliation)	Glenn Bower (The University of Wisconsin-Madison)

6. Paper No.(JSAE/SAE)	20199528 / 2019-32-0528
7. Paper title	Investigation of the Effect of Enhanced In-Cylinder Flow on HCCI Combustion in a Rapid Compression and Expansion Machine
8. Authors (Affiliation)	Yiwen Zhong, Kazuya Ogawa, Tatsuya Kuboyama, Yasuo Moriyoshi (Chiba University), Kei Yoshimura (SUZUKI MOTOR CORPORATION)

9. Abstract

The purpose of this paper is to find a way to extend the high load limit of homogeneous charge compression ignition (HCCI) combustion. A newly developed rapid compression and expansion machine (RCEM) was employed to reproduce the typical HCCI high load condition. The in-cylinder turbulence was created by the special piston which equipped with a flow guide plate. Meanwhile, the ambient temperature distribution in the cylinder was determined by the wall temperature controlling system which was controlled by the independent coolant passages. In addition, the numerical simulation by using large eddy method coupled with a detailed chemical reaction was conducted as well. The results show that HCCI mode is potential to be improved at high load condition in full consideration

6. Paper No.(JSAE/SAE)	20199573 / 2019-32-0573
7. Paper title	Study on Robust Fuel Performance with Differing Fuel Types in a 2 Stroke CAI Combustion Engine
8. Authors (Affiliation)	Mashu Kurata, Masami Okubo, Yoshikazu Yamada, Sho Kitano (Honda R&D Co., Ltd.)

9. Abstract

This study sought to achieve robust combustion with the differing fuel types and levels of fuel quality that are present in various areas of the world. The tests used the 2-stroke controlled auto ignition (CAI) engine from our earlier report, which was proven to have potential as an efficient, clean engine for diesel fuel. This study verified whether efficient, clean CAI combustion of gasoline fuel could be achieved with the same basic structure and engine system. Diesel and gasoline have very different volatility, viscosity and ignition characteristics, all of which significantly affect combustion in an engine. It is particularly necessary in CAI combustion to adjust the ignition timing according to the fuel used, as the difference in auto-ignition temperature from gasoline and diesel affects the CAI ignition timing. This issue was addressed by conducting experiments with a test engine to determine how the ignition timing is affected by the equivalent ratio, compression ratio and in-cylinder flow, and the ideal solution was verified. The results indicated that the ignition timing for CAI combustion can be effectively adjusted by changing the shape of the scavenging port to alter the in-cylinder flow. Computational fluid dynamics (CFD) analysis confirmed that the change in the scavenging port shape increased the in-cylinder flow velocity and the turbulence kinetic energy at the compression end. This indicates that the in-cylinder flow during the compression stroke affects the ignition timing for CAI combustion. The results produced by this study also indicated that equivalent thermal efficiency and emission levels can be achieved for both diesel and gasoline by setting an appropriate equivalent ratio, compression ratio, in-cylinder flow and exhaust valve lift profile for each type of fuel. In conclusion, this study confirmed that 2-stroke CAI is a combustion process with extremely robust fuel performance and the potential to be suitable for various fuel types with significantly different properties.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Himawari
3. Time	10 : 30 - 11 : 00
4. Session	Engine Technology II
5. Chair (Affiliation),	Yutaka Nitta (SUZUKI MOTOR CORPORATION)
Co-chair (Affiliation)	Roland Kirchberger (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20199582 / 2019-32-0582
7. Paper title	Experimental Investigations on a Novel Expansion Engine for Waste Heat Recovery
8. Authors (Affiliation)	Michael Lang (Graz University of Technology) Christian Bechter, Thomas Amann (Mahle König Kommanditgesellschaft GmbH & Co KG) Sebastian Schurl, Niko Bretterklieber (Graz University of Technology)

9. Abstract

Waste heat recovery in medium-power systems below 400 kW waste heat power asks for a novel expansion engine concept for water-based Rankine steam cycles. The aim is to combine the advantages of reciprocating piston engines and of turbines at reasonable costs. The so-called rotational wingpiston expander uses two pivoting shafts, each holding two wing-like pistons within one housing, that perform a cyclic movement relative to each other. Thus, four working chambers with varying volumes are shaped, each experiencing repetitive compression and expansion. This solution offers the possibility of sealing the lubricated gearbox against the steam-flooded section containing the working chambers with rotational seals.

For the development of the expansion engine, starting with an initial approach for a functional prototype, experimental investigations are carried out. Motored tests are performed in order to scrutinize kinematics and mechanics. Tests with pressurized air for enhanced load on the components - without applying the corrosion and thermal stress of hot steam - are assessed. The structural problems at the piston mount during the test runs reveal improvement potential and lead to its highly effective redesign. The occurring leakage at the rotational and piston seals and the high friction demand for improvements in further investigations.

This paper treats the design and layout of the novel expansion engine concept, the special challenges of test bench investigations, especially concerning measurement equipment and test bench requirements, and shows the most important findings and insights gained during the experimental investigations of the engine, as well as possibilities for improvement.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Ran 1
3. Time	13 : 00 - 14 : 30
4. Session	Lubricants
5. Chair (Affiliation),	Yuji Mihara (Tokyo City University)
Co-chair (Affiliation)	Mikael Bergman (Husqvarna AB)

6. Paper No.(JSAE/SAE)	20199505 / 2019-32-0505
7. Paper title	Developing High-Performance Motorcycle Oils
8. Authors (Affiliation)	Mike Marcella (Maxima Racing Oils), Aaron Johnson (Kawasaki Motors Corp.)

9. Abstract

Published motorcycle lubricant research often focuses on developments to meet certain specifications, regulatory requirements, or a combination of the two. Seemingly missing from the literature is research where the primary goal is development of a lubricant that enables maximum torque, power and acceleration from a machine for the purpose of winning races. The present study combines the two areas of research, where a high-performance motorcycle engine oil platform is developed to be used in competition, while simultaneously meeting the necessary regulations and specifications to be useful for commuters and leisure riders alike. Well-known are the demands on a motorcycle oil, which must lubricate and protect the crankcase, clutch and gears, all of which have competing requirements such that a strategy to improve the performance in one area can cause a detriment in another. Formulating for racing engines that are typically much more powerful than production versions further exacerbates these dichotomies, where the traditional strategies for gaining power through the lubricant of reducing viscosity or adding friction-reducing chemistries can leave the clutch and gears open to severe damage. To meet these competing demands, a novel additive system with unique anti-wear and friction modifier chemistries was introduced to ensure clutch and gear protection while simultaneously improving power output and minimizing deleterious effects to aftertreatment devices. ...

6. Paper No.(JSAE/SAE)	20199510 / 2019-32-0510
7. Paper title	Identifying the Limitations of the Hot Tube Test as a Predictor of Lubricant Performance in Small Engine Applications
8. Authors (Affiliation)	Jason Hanthorn, Jessica Schmiesing (The Lubrizol Corporation)

9. Abstract

The Hot Tube Test is a bench test commonly used by OEMs, Oil Marketers and Lubricant Additive manufacturers within the Small Engines industry. The test uses a glass tube heated in an aluminum block to gauge the degree of lacquer formation when a lubricant is subjected to high temperatures. This test was first published by engineers at Komatsu Ltd. (hence KHT) in 1984 to predict lubricant effects on diesel engine scuffing in response to a field issue where bulldozers were suffering from piston scuffing failures [1]. Nearly 35 years after its development the KHT is still widely used to screen lubricant performance in motorcycle, power tool and recreational marine applications as a predictor of high-temperature piston cleanliness – a far cry from the original intended performance predictor of the test. In this paper we set out to highlight the shortcomings of the KHT as well as to identify areas where it may still be a useful screening tool as it pertains to motorcycle applications.

6. Paper No.(JSAE/SAE)	20199601 / 2019-32-0601
7. Paper title	Impact of Soot and Engine Oil Additive Characteristics on Metallic Wear Using Electron Microscopy and Confocal Microscopy
8. Authors (Affiliation)	Panyakorn Rungsritanapaisan, Preechar Karin, Warawut Amornprapa (King Mongkut's Institute of Technology Ladkrabang), Dhritti Tanprayoon, Ruangdaj Tongsri (National Metal and Material Technology Center), Katsunori Hanamura (Tokyo Institute of Technology)

9. Abstract

Soot particles are produced inside the combustion chamber of the internal combustion engines and will later be exhausted into the thermosphere. Part of these particles will contaminate the engine oil. When this happens, diesel engine abrasion or, in a worst-case scenario, lubricant starvation will occur. This circumstance will eventually cause engine wear. This research uses X-Ray Fluorescence (XRF) technique to analyze the additive element in engine oil. For wear test, this research uses tribology Four ball wear tester to substitute point contact wear mechanism. Then the worn surface is analyzed with Scanning Electron Microscope (SEM). Confocal Microscope are used to study the effect of additive on soot dispersion in engine oil, which affects the metal wear mechanism. This research use Laser Particle Size Analyzer to investigate performance of soot dispersant additive in each engine oil. The results show that, the wear scar diameters significantly increased when the American Petroleum Institute (API) CD standard engine oil is contaminated with soot. On the other hand, American Petroleum Institute (API) CF-4 standard engine oil which contains higher amount of additive has a lower roughness value, because its soot dispersant additive improves the dispersing of carbon black (CB). When the CB is dispersed, it will serve to polish the ball's surface, resulting in a lower roughness value in the CB contaminated high amount of additive engine oil, ...

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Ran 2
3. Time	13 : 00 - 14 : 30
4. Session	Engine Components I
5. Chair (Affiliation), Co-chair (Affiliation)	Takahito Murase (Kawasaki Heavy Industries, Ltd.) Adrian Irimescu (Istituto Motori-CNR)

6. Paper No.(JSAE/SAE)	20199508 / 2019-32-0508
7. Paper title	Development of a Novel Hybrid-Piston for Application in High Performance Two-Stroke Engines
8. Authors (Affiliation)	Christian Bechter (Mahle König KG), Axel Jahn, Frieder Zimmermann, Uwe Stamm (Fraunhofer IWS), Thomas Herb (Mahle König KG)

9. Abstract

The current development trends for high performance two-stroke engines have been identified in raising combustion pressures and therefore higher cylinder temperatures [1] [2]. Thus, the requirements on piston assembly are increased in such a way that pistons based on aluminium-silicon alloys – as most commonly used in high performance two-stroke engines - reach their application limit. A suitable solution has been shown by research work such as that conducted by Mahle König, by using a piston consisting of different materials. With this approach, the higher stressed piston crown consists of steel, while the lower stressed piston skirt is made out from aluminium. Previous basic examinations showed the high potential of the hybrid piston concept in terms of pressure and temperature increase, while also showing the need for a temperature-stable and pressure-tight joint between crown and skirt. This paper will focus on the development of two novel hybrid-piston concepts, where the piston crown and the piston skirt are connected in different ways. The first hybrid concept presented uses the piston pin in order to realize a plug-connection between piston crown and piston skirt (a conjunction hereafter known as plug-connection). A second approach is...

6. Paper No.(JSAE/SAE)	20199523 / 2019-32-0523
7. Paper title	Optimum Design of Assist Mechanism for Motorcycle Multi-Plate Clutch
8. Authors (Affiliation)	Misaki Minoha, Koji Yoneyama, Ryoichi Imai, Hidenori Kitazawa, Osamu Mano, Shinya Miyagawa (EXEDY Corporation)

9. Abstract

In recent years, the popularity of leisure-motivated large motorcycles has increased as the demand for high-added value motorcycles is growing. Therefore, large motorcycle engines have become more powerful. Due to this trend, the capacity of the clutch is also required to increase. Contrary to the demand for high engine power and high clutch capacity, reductions in weight, space, operational load, and shock at deceleration are permanent issues of motorcycle development. The consideration of all these issues are required during development of a clutch for large motorcycles. Considering the above issues, a clutch with an assist cam and slipper cam mechanism is effective for cost and performance. The assist cam mechanism allows the clutch to have a larger transmittable torque without an increase of the clutch lever load. The slipper cam mechanism can automatically reduce the transmitted torque when shock from sudden engine braking happens during downshifting. Therefore, the installation of the clutch with cam mechanism on large motorcycles is becoming standard in the motorcycle industry. Regarding smaller motorcycles, the reduction of the number of clutch discs can be realized by adopting an assist mechanism, which enables reductions in weight, space, and the operational amount of the clutch lever. On the other hand,...

6. Paper No.(JSAE/SAE)	20199541 / 2019-32-0541
7. Paper title	Application of Porous Material as Heat Storage Medium to a Turbocharged Gasoline Engine
8. Authors (Affiliation)	Dongsheng Dong, Yasuo Moriyoshi, Tatsuya Kuboyama, Fuchao Shen, Naohiro Hasegawa (Chiba University)

9. Abstract

Porous materials, which have large surface areas, have been used for heat storage. However, porous Si-SiC material, as heat storage medium to be applied to a turbocharged gasoline engine has not been investigated extensively. In this study, porous Si-SiC material was used in the upstream of the turbine as heat storage medium and a model was thereby developed for further study. Substrate surface area and substrate volume of Si-SiC were calculated for structure model calibration. Following these calculations and test results, the pressure loss and thermal model were validated. Results show that the weaken exhaust gas pulsation amplitude by porous Si-SiC leads to better turbine performance and BSFC in steady engine condition for a turbocharged gasoline engine. In addition, its transient operation response needs to be improved under transient engine conditions. Hence the possibility of improving the transient response is investigated with characteristics of porous Si-SiC material. It was observed that less time was required for the engine to reach the target torque in transient conditions.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Cosmos 1
3. Time	13：00 - 13：30
4. Session	Vehicle Components
5. Chair (Affiliation),	Masayuki Baba (Honda Motor Co., Ltd.)
Co-chair (Affiliation)	Alexander Winkler (University of Applied Sciences Upper Austria)

6. Paper No.(JSAE/SAE)	20199597 / 2019-32-0597
7. Paper title	Effect of Dean Number on Heat TransferCharacteristics for Square Channel Helical Coil Sub-Cooled Condenser
8. Authors (Affiliation)	Hardeep Singh (Sophia University), Junya Washiashi, Jun Liu (Keihin Corporation), Mitsuhisa Ichiyanagi, Takashi Suzuki (Sophia University)

9. Abstract

Attribute to high heat transfer rate and less complexity, the Helical coil sub-cooled condenser (HCSCC) can provide the most innovative and unique application for the air conditioning system. In the case of automobiles, reduction in air-conditioning load may diminish the vehicular emission, and power consumption as the air-conditioning load is the most power-consuming components after the engine load. Moreover, to solve the problem, we focus on the helical type heat exchanger. It may play a vital role in reducing the weight and increase the performance of the small engine because of the compact structure and lighter weight. The compressor unit is the most vital component of the refrigeration cycle, but the condenser unit is also one of the most critical devices, and the author tried to reduce the power consumption by enhancing the performance of the condenser. The crucial point of this study is to use HCSCC, which exemplify the effect of subsequent flow generation inside the fluid, and it is known as the Dean's effect. This effect leads to the heterogenous temperature distribution along the square cross-sectional channel of the HCSCC. Experimentally, two different square cross-section of HCSCC has been analyzed and then compared with CFD investigation. During the analysis, various Dean numbers were evaluated at different flow rates of refrigerant as well as the varying cross-sectional area of the channel. From the result of the study, it is found that the Dean number plays a significant role in enhancing the heat transfer coefficient.

Abstracts of Technical Sessions

1. Date	Wednesday, November 20
2. Room.	Cosmos 2
3. Time	13 : 00 - 14 : 30
4. Session	NVH Technology I
5. Chair (Affiliation),	Chanat Ratanasumawong (Chulalongkorn University)
Co-chair (Affiliation)	TBA

6. Paper No.(JSAE/SAE)	20199512 / 2019-32-0512
7. Paper title	A Study on the Decay Process in the Time-Frequency-Dependent Combustion-Noise-Generation Model for Diesel Engines
8. Authors (Affiliation)	Hitoshi Oguchi, Masato Mikami (Graduate School of Sciences and Technology for Innovation, Yamaguchi University)

9. Abstract

We experimentally investigated the process of decay of engine noise from a single-cylinder diesel engine considering the time-frequency-dependent combustion-noise-generation model. In this model, the vibration energy of each frequency component is assumed to accumulate in the engine structure excited by the combustion impact during the combustion period in a cycle and decay over time, and the combustion noise is assumed to radiate from the engine surface. We used wavelet transform analysis as a time-frequency analysis of the sound pressure to obtain the decay rate, *c*, of the engine noise power. In order to investigate the dependence of the decay rate, *c*, on the sound-source location, we placed eight microphones in different positions near the engine. In order to investigate the dependence of the decay rate on the maximum in-cylinder pressure rise, we conducted experiments under three different operating conditions. The shape of the temporal variation of the engine-noise power depended on the sound-source location while the value of the engine noise power depended on the maximum in-cylinder pressure rise. Based on the time-frequency-dependent combustion-noise-generation model, we obtained the engine-noise decay rate, *c*, as the absolute value of the time differentials of the natural logarithm of the combustion noise power by line approximation. ...

6. Paper No.(JSAE/SAE)	20199593 / 2019-32-0593
7. Paper title	Pass-By Noise Prediction of a Vehicle
8. Authors (Affiliation)	RajaGopal.B, Santosh Gannu, Abhilash M, GS Krishnamurthy, Rod Giles (Royal Enfield)

9. Abstract

The forthcoming pass-by noise regulations have impacted the automotive sector, which further leads to the reduction of noise in the vehicle. The prediction of pass-by noise at an early stage will reduce the overall cost as well as time for an automobile industry and helps to reduce the overall product development life cycle. This supports the design activities of a vehicle. Msc ACTRAN/NASTRAN/ADAMS and GT Suite are major tools used in the present study to develop a simulation method to mimic the predefined testing norms. In Actran interior and exterior noise propagation is performed. Interior noise obtained by compressible flow analysis which uses exhaust/intake line velocity/temperature as boundary condition. The exterior noise propagation obtained by direct frequency response using acoustic duct mode with unit pressure injected into the intake and exhaust system and compressible flow field map results as input, this will take care of both noise propagation. Similarly for engine exterior noise radiation done by Nastran unit frequency response analysis and later actual loads from multi-body dynamics multiplied with direct frequency response analysis in Actran. Finally the python script is developed to find the acoustic transfer function between the unit pressure pulse in Actran/Unit frequency response in Nastran, ...

6. Paper No.(JSAE/SAE)	20199609 / 2019-32-0609
7. Paper title	Performance Evaluation & Optimization Technique for Torsional Vibration Damper System (TVDS) in Multi-Plate Clutches for Improved Drivability
8. Authors (Affiliation)	Girish Kokane, Ashutosh Jahagirdar, Ashish Rahane, Gopal Lahoti, Ravindra Kharul (Endurance Technologies Ltd)

9. Abstract

In recent years with the advent of technological advancements, engine power & torque levels per unit engine displacement volume in motorcycles are showing significant increase. These powertrains however are prone to Torsional Vibration issues. The severity is even more with single cylinder engines. The Torsional Vibration Damper System (TVDS) in clutches has become critical as it plays an important role in isolating these torsional vibrations. Thereby increasing the lifespan of the critical powertrain components. The major challenge with TVDS is, it must transmit the high torques on one hand and effectively keep the high pulsations in torque away from the rest of drive train on the other. These are conflicting requirements & often result in a design compromise. Further this is revealed only at full vehicle testing. Thus it requires the full vehicle functional prototypes to be ready for first level evaluation of TVDS. This reduces the scope available for implementation of all possible design changes. Additionally during this full vehicle testing, very limited amount of information is generated regarding performance behavior such as natural frequency, isolation properties etc. This poses difficulty in optimizing TVDS methodically & restraints designers to opt for trial & error approach. ...

Abstracts of Technical Sessions

1. Date Thursday, November 21
2. Room. Ran 1
3. Time 8 : 30 - 9 : 30
4. Session Advanced Combustion I
5. Chair (Affiliation), Koji Yoshida (Nihon University)
   Co-chair (Affiliation) Simona Silvia Merola (Istituto Motori-CNR)

6. Paper No.(JSAE/SAE)	20199565 / 2019-32-0565
7. Paper title	Design and Development of a High-Efficiency Single Cylinder Natural Gas-Fueled Jet Ignition Engine
8. Authors (Affiliation)	Nathan Peters, Sai Krishna Pothuraju Subramanyam, Michael Bunce, Hugh Blaxill (MAHLE Powertrain), Josh Pihl, Melanie Moses-Debusk (Oak Ridge National Laboratory), Gokul Vishwanathan (Booz Allen Hamilton), David Tew (Advanced Research Projects Agency-Energy)

9. Abstract

The current energy climate has created a push toward reducing consumption of fossil fuels and lowering emissions output in power generation applications. Combined with the desire for a more distributed energy grid, there is currently a need for small displacement, high efficiency engines for use in stationary power generation. An enabling technology for achieving high efficiencies with spark ignited engines for such applications is the use of jet ignition which enables ultra-lean ($\lambda > \sim 1.6$) combustion via air dilution. This paper provides a comprehensive review of the development of a 390cc, high efficiency single cylinder natural gas-fueled jet ignition engine operating ultra-lean. The engine was developed as part of the Department of Energy's Advanced Research Projects Agency–Energy (DOE ARPA-E) GENSETS program. Design choices for minimizing friction are highlighted as well as test results showing further friction reduction through downspeeding. Extensive hardware optimization of the combustion system has been performed and results are presented for air-flow path optimization and the jet igniter. The efficiency benefits related to enleanment and downspeeding are analyzed using an efficiency loss breakdown based on the First Law of Thermodynamics. Through optimization efforts a peak brake thermal efficiency in excess of 34% was achieved, representing an increase of greater than 20% over the current state-of-the-industry for comparably sized CNG engines.

6. Paper No.(JSAE/SAE)	20199551 / 2019-32-0551
7. Paper title	Effects of Sub-Chamber Configuration on Heat Release Rate in a Constant Volume Chamber Simulating Lean-Burn Natural Gas Engines
8. Authors (Affiliation)	Yuzuru Nada, Yoshiyuki Kidoguchi, Yuto Yamashita, Ryo Furukawa (Tokushima University), Ryu Kaya, Hideaki Nakano, Shinichi Kobayashi (Honda R&D Co., Ltd.)

9. Abstract

Sub-chamber is a useful device with regard to sustaining stable operation of compressed natural gas (CNG) engines under lean burn conditions. In our previous studies, we applied a sub-chamber injection system to CNG engines, in which a single injector and a spark plug are mounted in a small sub-chamber. The aim of this study is to investigate the effect of the sub-chamber configuration on heat release in the main combustion chamber. 11 types of sub-chamber with different nozzle number, nozzle diameter, and sub-chamber volume were examined under a condition that pressure is 2.3 MPa, and global equivalence ratio is 0.6. When the subchamber with smaller nozzles are used, the penetration velocity of burned gas jet increases. In addition, the velocity also increases with an increasing sub-chamber volume. The high-speed penetration of burned gas jet shortens the period of initial flame development. This is because the hightemperature burned gas quickly reaches to side wall of main chamber, and immediately ignites lean mixtures existing in the main chamber. Consequently, combustion duration time until heat release reaches 90 % is also shortened. On the other hand, the velocity difference between the jets from subchambers with different nozzle numbers is small. To predict the penetration velocity, we proposed an empirical formula based on the volume, nozzle diameter and nozzle number of sub-chamber. The jet intensity evaluated from the formula shows correlations with duration times of combustion periods as well as penetration velocities of burned gas jets.

Abstracts of Technical Sessions

1. Date Thursday, November 21
2. Room. Ran 2
3. Time 8：30 - 9：30
4. Session Engine Components II
5. Chair (Affiliation), Takahito Murase (Kawasaki Heavy Industries, Ltd.)
   Co-chair (Affiliation) Mike Marcella (Maxima Racing Oils)

6. Paper No.(JSAE/SAE)	20199530/ 2019-32-0530
7. Paper title	Friction Reduction of an All-Aluminum Cylinder for Motorcycles by a Mirror Finished Bore with Dimples.
8. Authors (Affiliation)	Yuta Murase, Hideya Kumagai (Yamaha Motor Co.,Ltd)

9. Abstract

In recent years, the demand for fuel economy of small engines has been increasing for further improvement of product competitiveness. As a solution for this issue, a lot of developments on reduction of friction losses of engine components have been actively performed by engine manufacturers, especially the friction loss between the cylinder bores and pistons or piston rings is main issue to solve because these frictions highly contribute to the fuel economy for the small engines. In this study, focusing on the effect of the texture of the all-aluminum cylinder bore on friction loss, we verified the friction loss of all-aluminum cylinders having several kinds of surface textures by a floating liner method. For the evaluation, we prepared cylinders which have the texture of the following three types, 1) plateau type (having conventional cross-hatches), 2) mirror finished type (having no cross-hatches and no irregular surface characteristics), 3) dimple type (most of part is mirror finished but small dimples are given at a limited part). As a result of the evaluation, it was confirmed that FMEP of mirror type was 14.1% lower and dimple type (optimized for low friction) was 19.5% lower than plateau type. In addition, when comparing FMEP for each crank angle, it was revealed that mirror type was effective evenly in all strokes of intake, compression, expansion, and exhaust, and the dimple showed a large effect particularly on the expansion stroke.

6. Paper No.(JSAE/SAE)	20199610 / 2019-32-0610
7. Paper title	Development of a Method to Predict Performance of Sensing System with Air Mass Flow Sensor by CFD
8. Authors (Affiliation)	Kosuke Suematsu, Kento Nosaka, Tadao Okazaki (Kubota Corporation)

9. Abstract

With the strengthening of exhaust gas regulations such as EU Stage 5 and China's 4th regulation, the engine such as external EGR and aftertreatment device has become complicated. In addition, Kubota's industrial engines are used not only in agricultural and construction machines but also in various machines with different applications around the world, there are many variations of intake and exhaust systems, and the engines are diversified.

For an engine adopting an external EGR and a aftertreatment device, a hot wire type mass air flow rate sensor is widely adopted in an intake piping in order to control the EGR valve appropriately and the regeneration control of the DPF. However, it is known that the sensitivity of this sensing system varies depending on the shape of the intake piping. When the sensitivity varies, the engine is controlled based on the incorrect air mass flow rate, so that the exhaust performance may be deteriorated. It is confirmed that the variation of sensitivity does not exceed the limit value by measuring the sensitivity of this sensing system using the prototype and considering the variation of the assembling error and the like. If the sensitivity variation exceeds the limit value, we must change the shape and mounting position of the intake piping. Therefore development lead time will be prolonged in order to design intake piping, prototype, shipment from overseas and experiment again.

In this paper, we investigate the factors that vary the sensitivity of this sensing system by flow rig test of the intake piping and a CFD focusing on the convective heat transfer amount of the hot wire inside the sensor. It was confirmed that the influence by velocity and turbulent kinetic energy were large. CFD is carried out with various intake piping, limit value are set based on the characteristic of physical quantity with large sensitivity variation, and we developed method to predict the possibility that the sensitivity variation of the air mass flow rate sensor exceed the limit value before prototyping.

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Cosmos 1
3. Time	8：30 - 10：00
4. Session	Vehicle Dynamics
5. Chair (Affiliation),	Hisayuki Sugita (SUZUKI MOTOR CORPORATION)
Co-chair (Affiliation)	Glenn Bower (The University of Wisconsin-Madison)

6. Paper No.(JSAE/SAE)	20199569/2019-32-0569
7. Paper title	A Study of the Control Logic of Electronically Controlled Suspension for Motorcycle
8. Authors (Affiliation)	Takenori Terada, Kazuhiro Ichikawa, Hideyuki Kato, Taro Iwamoto (Kawasaki Heavy Industries, Ltd.)

9. Abstract

Electronically controlled suspensions are expected to improve driving performance as the damping characteristics of the suspension can be adjusted in real time to respond to road conditions. This paper reports the results of testing the suspension control logic for improving ride quality, especially when driving on rough roads, using an internally developed riding simulator.

The skyhook theory is widely known as a control logic for reducing vibration when driving a four-wheeled vehicle on a rough road, which we utilized in our riding simulator to examine the vibration reduction effects when applying control logic for motorcycle suspensions. The test results show that the skyhook theory can be applied in motorcycles.

However, sensors for suspension systems that can be installed in mass-produced motorcycles are severely limited in terms of cost and space. Therefore, we examined a control logic based on skyhook theory that can reduce vibration even with a simple and inexpensive sensor system.

A novel control logic was successfully designed that implements the relationship between the suspension stroke speed and the vertical acceleration of the sprung mass from the dynamics of the vehicle body when driving on rough roads...

6. Paper No.(JSAE/SAE)	20199572 / 2019-32-0572
7. Paper title	Study of Rider Model for Motorcycle Racing Simulation
8. Authors (Affiliation)	Masatsugu Nishimura, Yoshitaka Tezuka (Honda Racing Corporation) Enrico Picotti, Mattia Bruschetta (Università degli Studi di Padova) Francesco Ambrogi (VI-grade s.r.l.), Toru Yoshii (VI-grade Japan Ltd.)

9. Abstract

Various rider models have been proposed that provide control inputs for the simulation of motorcycle dynamics.

However, those models are mostly used to simulate production motorcycles, so they assume that all motions are in the linear region such as those in a constant radius turn. As such, their performance is insufficient for simulating racing motorcycles that experience quick acceleration and braking.

Therefore, this study proposes a new rider model for racing simulation that incorporates Nonlinear Model Predictive Control. In developing this model, it was built on the premise that it can cope with running conditions that lose contact with the front wheels or rear wheels so-called "endo" and "wheelie", which often occur during running with large acceleration or deceleration assuming a race. For the control inputs to the vehicle, we incorporated the lateral shift of the rider's center of gravity in addition to the normally used inputs such as the steering angle, throttle position, and braking force.

We compared the performance of the new model with that of the conventional model under constant radius cornering and straight braking, as well as complex braking and acceleration in a single (hairpin) corner that represented a racing run...

6. Paper No.(JSAE/SAE)	20199578 / 2019-32-0578
7. Paper title	Motorcycle Out-of-Plane Dynamics Estimation: an Approach Based on Sharp 71 Model
8. Authors (Affiliation)	Alexander Winkler, Sandra Haas, Gernot Grabmair (University of Applied Sciences Upper Austria)

9. Abstract

This paper presents a study on the state estimation of out-of-plane dynamics of motorcycles based on the Sharp 71model.

The Sharp 71 model is a linear time-variant systemthat describes the out-of-plane dynamics of a motorcycle.

Comparisons with multi-body simulations and measurement data show that this relatively simple model is capable of adequately representing the lateral dynamics of the motorcycle. Two relevant variables of out-of-plane dynamics are the roll angle and the tire lateral forces. The structure of the Sharp 71 model offers the possibility of estimating these two variables model-based with the aid of corresponding measured output variables. The input variable is the steering torque, which obviously cannot be measured with reasonable effort. Therefore, an unknown-input observer is used to estimate the states. This state estimator allows a systematic consideration of the unknown input variable. The unknown-input observer is designed for different sets of outputs and the corresponding effects on the results are considered. The sensors used include gyroscope, acceleration sensor and steering angle sensor. The longitudinal velocity as time-variant parameter considers the coupling of the out-of-plane model with longitudinal dynamics. The implementation is achieved with gainscheduling of the observer ...

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Cosmos 2
3. Time	8 : 30 - 10 : 00
4. Session	NVH Technology II
5. Chair (Affiliation),	Chanat Ratanasumawong (Chulalongkorn University)
Co-chair (Affiliation)	TBA

6. Paper No.(JSAE/SAE)	20199531 / 2019-32-0531
7. Paper title	Acoustic Study on Motorcycle Helmets with Application of Novel Porous Material
8. Authors (Affiliation)	Jüri Lavrentjev, Hans Rämmal (TalTech)

9. Abstract

A critically high noise level inside protective helmet is a prevalent concern for motorcyclists. Especially at highway speeds where the noise level, regardless of helmet type can exceed 100 dB(A) and approaches threshold of discomfort, often resulting in temporary hearing loss. Despite of large share of persons exposed to such noise disturbance around the world, the in helmet noise levels have not significantly decreased over the last decades. Only few scientific publications can be found to systematically address this issue. Furthermore, in respect of driving safety even moderate noise levels are reported to impair reaction times and reduce attention of motorcyclists. At higher speeds the dominant helmet noise source is linked to aerodynamic turbulence around the helmet shell. The loudness and spectral contents mainly depend on the driving speed, windscreen configuration, riding position and helmet geometry. In this paper a series of on-road tests and laboratory experiments with three main types of helmets (“full face”, “flip up” and “open face” type) have been performed with the focus on in-helmet acoustics. Noise spectra at the location of rider’s ears are measured, the results are analyzed and the noise source mechanisms are studied. ...

6. Paper No.(JSAE/SAE)	20199533 / 2019-32-0533
7. Paper title	Endurance of Micro-Perforated Elements in Unmanned Ground Vechicle’s Small Diesel Engine Silencer Application
8. Authors (Affiliation)	Hans Rämmal, Jüri Lavrentjev (TalTech)

9. Abstract

As a suitable replacement for prevalent but environmentally hazardous fibrous materials used in exhaust system silencers, innovative micro-perforated (MP) elements have been progressively implemented for internal combustion engine noise control during the past decades. Although MP elements are already massproduced for IC engine noise control, surprisingly few scientific publications can still be found on the endurance of these MP elements. Recently the reliability of MP element was studied by the authors for a small four-stroke petrol engine silencer application. The results clearly demonstrated that the performance of the micro-perforated elements is influenced by the contamination of residual combustion products of the exhaust gas. In this paper the endurance of MP element tested in small industrial diesel engine application of a novel unmanned ground vehicle (UGV) has been treated. The MP element has been incorporated into specific exhaust system custom designed for the military UGV. During the test cycle the vehicle has been operated for more than 200 hours including severe off-road conditions. The acoustic performance together with the flow resistance of the silencer unit has been investigated by performing a series of comparative tests before and after the test cycle. ...

6. Paper No.(JSAE/SAE)	20199587 / 2019-32-0587
7. Paper title	Extraction of Modified Parts of Mechanical Structures Based on Mutual Mode Kinetic Energy Distribution for Vibration Reduction
8. Authors (Affiliation)	Masami Matsubara, Koki Morikawa, Kohei Takahashi, Shozo Kawamura (Toyohashi University of Technology), Kohei Furuya (Gifu University), Tomohiko Ise (Kindi University)

9. Abstract

Three-dimensional computer aided design technology has made remarkable advances in the manufacturing industry and has been applied to various products and scopes (e.g., motorcycle manufacturing). In addition, by adopting the finite element method (FEM), we can analyze the dynamic behaviors of products accurately. In the design stage, modal analysis using FEM calculates the natural mode shapes and frequencies of an object or structure during free vibration. To reduce the vibration or noise, natural mode shapes and the kinetic and potential energy distribution are confirmed. However, it is still difficult to design mechanical components for vibration reduction based on this information. This study presents the extraction of mechanical components for vibration reduction and a mechanical design using the tuned frequency of that component. Mechanical components, which are candidates for modified design, are extracted by mutual kinetic modal energy calculated by natural mode shapes and the mass matrix of the element. The natural frequencies of the entire structure without the candidate component and that of the candidate component alone are calculated by component modal analysis. In this case, the natural frequency of the candidate component is very close to that of the main structure, and the height of the resonance peak can be decreased. Finally, the proposed method is verified by application to a finite element model of a motorcycle.

Abstracts of Technical Sessions

1. Date — Thursday, November 21
2. Room. — Himawari
3. Time — 8 : 30 - 10 : 00
4. Session — Two Stroke Engine I
5. Chair (Affiliation), Co-chair (Affiliation) — Tatsuya Kuboyama (Chiba University), Pierre Duret (IFP School)

6. Paper No.(JSAE/SAE)	20199524 / 2019-32-0524
7. Paper title	Intermittent Injection for a Two-Stroke Direct Injection Engine
8. Authors (Affiliation)	Francesco Balduzzi, Luca Romani, Lorenzo Bosi, Giovanni Ferrara (University of Florence)

9. Abstract

Cycle-to-cycle variation is one of the main factors for high fuel consumption and emissions of a two-stroke engine during the low-load and low-speed running. The increase of residual gas ratio due to the lower delivered amount of fresh scavenging air leads to a lower flame front speed and, therefore, to a slow combustion or even misfiring. The consequence is a very high level of unburnt hydrocarbons, since a large amount of fuel does not take part in the combustion process. The use of a direct injection system allows a more flexible management of the injection of fuel over subsequent engine cycles. Under a low-load condition, the low request in terms of brake mean effective pressure (BMEP) can be achieved by performing a load control based on an intermittent injection, thus reducing the need for intake throttling and avoiding the loss of fresh fuel resulting from cycles without combustion. In more detail, the supply of fuel to the combustion chamber can be skipped for one or more cycles, thus performing a number of consecutive scavenging cycles with only fresh air. As a result, the fresh air is less diluted by the residual gas and the combustion efficiency increases. This paper presents the results of a preliminary experimental activity on the use of an intermittent injection strategy with a Low Pressure Direct Injection (LPDI) system. In more detail, the effect of skipping one cycle – thus operating the twostroke engine in a four-stroke-like mode – was investigated at part load conditions by considering four BMEP levels (i.e. from 1.0 bar to 2.5 bar). ...

6. Paper No.(JSAE/SAE)	20199549 / 2019-32-0549
7. Paper title	Simulation Analysis of the Scavenging Process of a Uniflow and Loop Scavenging Concept
8. Authors (Affiliation)	Stefan Sturm, Michael Lang, Stephan Schmidt (Graz University of Technology)

9. Abstract

The two-stroke engine, as a today unconventional concept in automotive applications, has a great potential for a relaunch in the fast-growing market of Plugin Hybrid Electric Vehicle (PHEV) or Range Extender Electric Vehicle (REX) [2, 3, 4, 8, 9]. An efficient scavenging to remove the in-cylinder burnt gases and to fill the cylinder with fresh charge, performed at the same time is one of the major challenges, as losses of fresh air and fuel towards the exhaust line should be avoided when operating a lambda = 1 concept necessary for a 3-way catalyst aftertreatment system. A prior study [1] of different gas exchange designs for two-stroke engines concludes that two possible concepts cover this purpose. In this paper, 3D-CFD simulation is used to compare these two different scavenging concepts, a uniflow and a loop scavenging type with control elements for the gas exchange process. As boundary conditions, it is assumed that both concept types have nearly the same displacement, are used with an external scavenging blower and have a lubrication system like a conventional oil sump similar to a four-stroke engine. Additionally, a high-pressure direct injection fuel system is applied to guarantee oil- and fuel-free air for the scavenging process. To compare these different two-stroke scavenging concepts, this study focuses on the scavenging and compression phase using 3D-CFD simulation in order to evaluate the scavenging characteristics and the in-cylinder charge motion. The goal of this study is to prepare a basis for discussion of the best configuration, which will be designed, built and tested on the engine test-bench.

6. Paper No.(JSAE/SAE)	20199579 / 2019-32-0579
7. Paper title	Calcium in Oil Effects on Pre-Ignition of Two-Stroke Engine
8. Authors (Affiliation)	Kuniyoshi Eto, Masaki Kihara (Yamabiko-Corp.)

9. Abstract

Investigations of the influence of calcium on pre-ignition in a two-stroke engine have shown that the lower the calcium concentration, the lower the frequency of pre-ignition. Pre-ignition problems can occur in small, air-cooled, two-stroke engines such as a chainsaw. In contrast, in a supercharged automobile engine, it has been reported that calcium, which is a detergent component in engine oil, causes low-speed pre-ignition. The oil for two-stroke engines also contains calcium and is mixed with the fuel and lubricated before being supplied to the combustion chamber. This makes, two-stroke engines more likely to be affected by oil components. Based on this, we investigated the influence of calcium on pre-ignition of a two-stroke engine. First, we investigated driving conditions in which pre-ignition is likely to occur, such as warming up the engine. Under this condition, oil with calcium concentrations ranging from 0 ppm to 1,500 ppm were tested at a mixing ratio of 2%. The results show that the lower the calcium concentration, the lower the incidence rate of pre-ignition. Which could also occur at 0 ppm. The incidence rate was 4.6% at 1,500 ppm and 2.3% at 0 ppm.

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Ran 1
3. Time	10 : 30 - 12 : 00
4. Session	Advanced Combustion II
5. Chair (Affiliation),	Akihito Kasai (Honda R&D Co., Ltd.)
Co-chair (Affiliation)	Simona Silvia Merola (Istituto Motori-CNR)

6. Paper No.(JSAE/SAE)	20199586 / 2019-32-0586
7. Paper title	Influence of Zn, Mo, P, S-Contained Engine Oil Additives on Abnormal Combustion in a Spark Ignition Engine
8. Authors (Affiliation)	Takuya Izako, Akira Iijima (Nihon University), Tatsuya Kusumoto, Toshimasa Utaka (Idemitsu Kosan Co.,Ltd.)

9. Abstract

A Spark Ignition Engine has some kinds of problem to be solved over many years, one of them is abnormal combustion; Low-speed pre-ignition (LSPI) under low-speed, high-load driving conditions for vehicle, and pre-ignition under long-term operation without cleaning a combustion chamber for gas cogeneration. As a cause for abnormal combustion, engine oil droplets diluted by liquid fuel and peeled combustion deposits delivered from engine oil are proposed. In this study, experiments were conducted focusing on engine oil additives having different chemical structure and abnormal combustion behavior. A four-stroke side-valve single cylinder engine that allowed in-cylinder visualization of the combustion flame was used in the experiments. The experimental results showed that the influence of DTC additive on abnormal combustion is small and the zinc component contained in the DTP additives had the effect of advancing the autoignition timing.

6. Paper No.(JSAE/SAE)	20199616 / 2019-32-0616
7. Paper title	Numerical Study on Characteristics of Spray Under Air Flow in Gasoline Engine
8. Authors (Affiliation)	Min Guo (Wuhan University of Technology), Keiya Nishida (University of Hiroshima), Chaoqun Wu, Qingrong Fan (Wuhan University of Technology)

9. Abstract

The air flow affects the spray feature and mixture significantly in gasoline engine. The effects of air flow with atmosphere and pressurized ambient pressure were investigated experimentally in the previous work, the gasoline spray characteristics and air flow are analyzed using CFD method in this study. By polishing the model of droplet breakup according to the experimental results, the simulations are taken with various air flow conditions. Modeling of spray injected under typical condition of cross-flow is employed to compare the numerical results with experimental results, using the corrected model the more calculation are carried out simulating the real conditions. With changing the injection and air flow conditions, the spray feature, droplet size, droplet movement, and droplet distribution are calculated by a commercial software. The effects of air flow on spray are clearer by numerical method than that in experimental measurements, the bended spray outline is varied with changing air flow speed, ambient pressure and injection angle, the penetration decreases when the cross-flow speed is increased and better second droplet breakup; Droplet size increases when the ambient pressure is increased, the tiny droplets appears in the area downstream the air flow even after the spray column near nozzle, the coalescence between droplets happens, which case large droplets appear downstream air flow; the small droplets are easy to be mingled with air flow, which is distinct in bottom of spray, the air flow field is also changed by the spray, turbulence appears downstream flow after spray; air flow most enhance the distribution of spray when the spray angle is 90°, decreasing or increasing the spray angle case the more weaken distribution of spray. The numerical results agree with the experimental measurement, it is meaningful to optimize the air flow parameters during design and control.

6. Paper No.(JSAE/SAE)	20199622 / 2019-32-0622
7. Paper title	A Study of Ignition Method for Gas Heat Pump Engine Using Low Temperature Plasma
8. Authors (Affiliation)	Yasuo Moriyoshi, Osamu Matsumoto, Tatsuya Kuboyama, Takahiro Tsukamoto (Chiba University), Yoshiyuki Kinuzawa, Hideaki Maeshima (Sustainable Engine Research Center CO., LTD.)

9. Abstract

Low temperature plasma ignition has been proposed as a new ignition technique as it has features of good wear resistance, low energy release and combustion enhancement. In the authors' previous study, lean burn limit could be extended by low temperature plasma ignition while a voltage drop during discharge, leading to the transition to arc discharge, was found. In this study, the structure of plug and power supply's performance with steep voltage rising with time, dV/dt, are examined to investigate the effects on combustion performance. As a result, comparing three power sources of conventional, IES and steep dV/dt, steep dV/dt showed small cycle-to-cycle variation and shorter combustion period, leading to higher peak value of the rate of heat release and better indicated thermal efficiency by relatively 6% and 4% compared to CIC and IES, respectively.

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Ran 2
3. Time	10 : 30 - 12 : 00
4. Session	Engine Components III
5. Chair (Affiliation),	Naoya Isozaki (Kawasaki Heavy Industries, Ltd.)
Co-chair (Affiliation)	Mike Marcella (Maxima Racing Oils)

6. Paper No.(JSAE/SAE)	20199553 / 2019-32-0553
7. Paper title	Optimized Wet Clutch Design
8. Authors (Affiliation)	Nitin Rajaram Bhone, Sachin Thakare, Ashutosh Jahagirdar (ENDURANCE TECHNOLOGIES LTD)

9. Abstract

Multi-plate wet clutches used in motorbikes transmit the torque by friction under pressure between driving and driven Plates. The life & performance of the clutch for the friction material used, depends on amount of energy generated during clutch slip, amount & uniformity of heat dissipation amongst the plates and surface texture of mating surfaces. Above parameters if not properly considered during design stage may lead to higher temperature of rubbing surfaces. Higher temperature further reduces the friction coefficient and increases the wear rate of friction material leading ultimately to lower torque capacity of clutch. The temperature rise in a wet clutch is the balance between amount of heat generated and the amount of heat dissipated by oil flowing through clutch. The maximum amount of oil is limited by the requirement of clutch drag torque, Which decides the quality of neutral finding and gear shift feel on vehicle. Further, if roughness of rubbing surfaces is not controlled in mass production, it leads to fast wear of friction material during initial operating cycles. The rate of wear is faster if the heights of surface asperities are of high magnitude. This paper explains the design features of clutch developed by Endurance Technologies Ltd., optimized to achieve above aspects, for the engines having clutch cooling oil supply through the gear box input shaft.

I. An innovative oil management concept is incorporated which distributes the oil as per requirement amongst the plates. Adequate distribution of oil facilitates to have optimum oil flow with minimum desired drag torque. It also ensures effective heat dissipation throughout the clutch assembly. A part of oil is directed to cool the clutch clamping springs which reduces the clamping load loss.

II. The validation procedure to confirm the adequacy of oil flow through the plurality of plates is developed.

III. The defined controlled surface texture of steel plates provides consistent and controlled wear rate in mass production. Further, it ensures the dynamic torque capacity within a narrow band over the longer life span. The above two features of multi-plate wet clutch design achieved reduction in wear by 56 % and improved dynamic by 16 % at the end of durability tests.

6. Paper No.(JSAE/SAE)	20199584 / 2019-32-0584
7. Paper title	Dynamic Implicit Analysis of Valve Train with Cylinder Head Assembly
8. Authors (Affiliation)	Prasanth Venkatesan, T Sreenivasulu, S Karthik, Rod Giles (Royal Enfield)

9. Abstract

Transient dynamic behaviour of the valve train system at constant engine speed is simulated with an implicit time integration method. The Interference fit between the valve guide, valve seat to cylinder head and preload between cam housing to cylinder head has been modelled as initial loads in the valve train. The cylinder head and cam housing have been modelled to consider the mounting stiffness on dynamics of the valve train. The temperature from steady-state CFD simulation has been mapped to the valve train, cylinder head and cam housing assembly. The expansion of the whole system has been considered, due to an increase in temperature. The cam has been rotated at specified engine speed for 360 degrees. The change in valve to guide clearance, Contact Pressure and Contact Status between valve to seat for both hot and cold condition has been compared and plotted from the simulation. Valve guide & valve seat distortion have been plotted to compare the cold and hot effects. The stress from the simulation has been used to predict the fatigue life of the valves.

6. Paper No.(JSAE/SAE)	20199585 / 2019-32-0585
7. Paper title	Piston Durability Analysis Including Side-Thrust Loads
8. Authors (Affiliation)	Ashwin Balaji, Sangam Laxman Kute, T Sreenivasulu, Rod Giles (Royal Enfield)

9. Abstract

The Piston is one of the most arduously loaded components in an IC engine. It is subjected to multiple loads simultaneously such as cylinder pressure, temperature loads, inertial loads & side-thrust loads. The durability of the Piston can be modelled accurately, only by accounting all the loads acting on the Piston. The challenge is, this approach requires information from multiple disciplines such as temperatures from CFD, Piston secondary forces from Multi-Body Dynamics (MBD) analysis and P-theta (Pressure vs Crank angle) curve from the experimental measurements. In this study, the life of the Piston and the damage location is predicted by using temperature dependent material properties and the above-mentioned loads.

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Cosmos 2
3. Time	10 : 30 - 11 : 30
4. Session	NVH Technology III
5. Chair (Affiliation),	Tadao Okazaki (LEMA / Kubota Corporation)
Co-chair (Affiliation)	TBA

6. Paper No.(JSAE/SAE)	20199527 / 2019-32-0527
7. Paper title	High Frequency Vibration Transmission Analysis on Agricultural Tractor by Using Combined Dynamical Energy Analysis and Transfer Path Analysis Approach
8. Authors (Affiliation)	Satoshi Morita (Yanmar R&D Europe s.r.l), Gregor Tanner, Martin Richter (University of Nottingham)

9. Abstract

Dynamical Energy Analysis (DEA) has recently been introduced as a mesh-based high frequency method modelling structure borne sound for complex built-up structures. Using DEA, the structure-borne sound of an assembled agricultural tractor was calculated and good agreement between measurement and DEA calculations has been shown. However, it is still difficult to model a solid structure as currently DEA is based on wave-transmission calculations through plates and plate-to-plate junctions. Additionally, it is often difficult to generate accurate FE meshes of assembled complex structures because of welds, bolts, and rubber brushes between components. In this paper, we propose a novel method to generate DEA elements based on measurement data in order to model solid parts of a complex structures. The method of Advanced Transfer Path Analysis (ATPA) is employed to extract energy-transmission characteristics of a structure. Firstly, Frequency Response Functions (FRFs) are measured between interface points on a structure. Then the direct transfer functions between all interface points are calculated using ATPA. Finally, DEA elements connecting interface points are calculated. They are based on the ATPA result and therefore represent energy-transmission characteristics of the structure. The proposed method is applied to an agricultural tractor structure in order to generate DEA-TPA elements of a gear casing demonstrating the effectiveness of the proposed method.

6. Paper No.(JSAE/SAE)	20199594 / 2019-32-0594
7. Paper title	Modeling Subjective Evaluation of Instantaneous Sound Qualities of Motorcycle Exhaust Sound Applying a Highly Efficient Experimental Design
8. Authors (Affiliation)	Kazuhiko Tanaka (Honda Motor Co., Ltd.), Shigeaki Nishina (Honda Research Institute Japan Co., Ltd.), Haruomi Sugita, Takeo Kato, Masahiko Sekita (Honda Motor Co., Ltd.)

9. Abstract

Exhaust sound quality is one of the most important factors for attractive motorcycles. It is desirable to quantitatively and objectively examine the exhaust sound quality during the development process.
In our previous study, we developed evaluation models that could be applied to various exhaust sounds. However, due to the limitation of the model, it could not be applied to varying conditions, such as from acceleration to steady driving and then to deceleration. In this study, we developed more practical evaluation models that can be applied to various driving conditions.
To cover a wide variety of sounds under different driving conditions, we prepared more than 300 sound stimuli and collected subjective evaluation data on those sounds. As the evaluation method, we used a pairwise comparison method to make decision making easy for the participants. However, if the pairwise comparison was simply performed for such sample size, the experiment cannot be done in a realistic experimental scale because the number of evaluation pairs gets very large. To solve this issue, we allocated evaluating pairs among multiple participants and used the Bradley–Terry model for estimation of the subjective quality rate. With these methods, the number of evaluations per participant was reduced to 1/300 of that required with the naive method.
We constructed the models based on a multiple regression analysis on the subjective evaluation data with waveform feature values as independent variables. We confirmed that these models accurately predicted the motorcycle developers' subjective impression of the exhaust sound of actual vehicles under a wide range of driving conditions.

Abstracts of Technical Sessions

1. Date	Thursday, November 21
2. Room.	Himawari
3. Time	10 : 30 - 11 : 00
4. Session	Two Stroke Engine II
5. Chair (Affiliation),	Tatsuya Kuboyama (Chiba University)
Co-chair (Affiliation)	Pierre Duret (IFP School)

6. Paper No.(JSAE/SAE)	20199562 / 2019-32-0562
7. Paper title	Effect of Two-point Ignition on Knocking in Spark-Assisted HCCI Combustion Using an Optically Accessible Engine
8. Authors (Affiliation)	Kojiro Yoshida, Takuma Furusho, Yosuke Abe, Masaya Iimura Takafumi Imai, Kazutoshi Hoshi, Akira Iijima (Nihon University)

9. Abstract

This study investigated the effect of the ignition positions in a two-point ignition system on homogeneous charge compression ignition (HCCI) combustion. Focus was put on controlling the ignition timing, and changes in combustion behavior due to the ignition positions were observed on the basis of in-cylinder combustion visualization and pressure analysis. Experimental results showed that misfire occurred under a condition where the temperature rise time was short and combustion became unstable. In contrast, combustion was stable under a condition where the rise time was sufficiently long and autoignition developed along the cylinder wall. As a result, knocking intensity was reduced by stable combustion.