SETC2022 Session Timetable

			Room 407	Room 408	Room 409	Exhibition Hall C
Monday, October 31st	13:30-15:00		Opening Ceremony & Keynote Addresses (Exhibition Hall C)			
	15:00-15:30		Networking Break			
	15:30-16:30		Advanced Combustion Part 1 of 5	Lubricants and Tribology	Measurement and Simulation Part 1 of 2	New Product Technology Part 1 of 10
		Chair	Akira Iijima	Yuji Mihara	Gaku Naoe	Yuji Araki
		Co-Chair	Roland Kirchberger	Mikael Bergman	Stephan Schmidt	Kai Beck
			20229007/2022-32-0007		20229011/2022-32-0011	NPT2022-024
			20229008/2022-32-0008	20229077/2022-32-0077	20229014/2022-32-0014	NPT2022-028
	16:30-17:00		Networking Break			
	17:00-18:00		Advanced Combustion Part 2 of 5	Emission and Environmental Impacts Part 1 of 3	Renewable Energy and Alternative Fuels Part 1 of 5	New Product Technology Part 2 of 10
		Chair	Koji Yoshida	Tadao Okazaki	Tatsuya Kuboyama	Wataru Yamamoto
		Co-Chair	Roland Kirchberger	Stephan Schmidt	Maurice Kettner	Christoph V. Hiller
			20229038/2022-32-0038	20229004/2022-32-0004	20229021/2022-32-0021	NPT2022-029
			20229081/2022-32-0081	20229026/2022-32-0026	20229061/2022-32-0061	NPT2022-030
Tuesday, November 1st	9:00-10:00		Advanced Combustion Part 3 of 5	Emission and Environmental Impacts Part 2 of 3	Renewable Energy and Alternative Fuels Part 2 of 5	New Product Technology Part 3 of 10
		Chair	Akira Iijima	Tadao Okazaki	Yuji Araki	Wataru Yamamoto
		Co-Chair	Stephan Schmidt	Kai Beck	Maurice Kettner	Sebastian Schurl
			20229015/2022-32-0015	20229005/2022-32-0005	20229067/2022-32-0067	NPT2022-004
			20229044/2022-32-0044	20229050/2022-32-0050	20229001/2022-32-0001	NPT2022-026
	10:00-10:30		Networking Break			
	10:30-12:00		Measurement and Simulation Part 2 of 2	Emission and Environmental Impacts Part 3 of 3	Renewable Energy and Alternative Fuels Part 3 of 5	New Product Technology Part 4 of 10
		Chair	Tadao Okazaki	Wataru Yamamoto	Koji Yoshida	Jun Ishikawa
		Co-Chair	Stephan Schmidt	Christoph V. Hiller	Maurice Kettner	Dominik Gschanes
			20229031/2022-32-0031		20229088/2022-32-0088	NPT2022-031
			20229045/2022-32-0045	20229019/2022-32-0019	20229092/2022-32-0092	NPT2022-003
			20229053/2022-32-0053	20229091/2022-32-0091	20229043/2022-32-0043	NPT2022-021
	12:00-13:00		Lunch & Poster Session (Exhibition Hall C)			
	13:00-14:30		Plenary Session (Exhibition Hall C)			
	14:30-15:00		Networking Break			
	15:00-16:30		Advanced Combustion Part 4 of 5	Engine Components and Fuel Supply Systems Powertrain Controls	Renewable Energy and Alternative Fuels Part 4 of 5	New Product Technology Part 5 of 10
		Chair	Tatsuya Kuboyama	Shigeho Sakoda	Toru Nakazono	Yuji Araki
		Co-Chair	Kai Beck	Mikael Bergman	Maurice Kettner	Dimitrios Vogiatzis
			20229027/2022-32-0027	20229035/2022-32-0035	20229084/2022-32-0084	NPT2022-001
			20229051/2022-32-0051	20229009/2022-32-0009	20229095/2022-32-0095	NPT2022-005
			20229060/2022-32-0060	20229048/2022-32-0048	20229073/2022-32-0073	NPT2022-002
	16:30-17:00		Networking Break			
	17:00-18:00		Advanced Combustion Part 5 of 5	Vehicle Dynamics and Safety Part 1 of 3	Renewable Energy and Alternative Fuels Part 5 of 5	New Product Technology Part 6 of 10
		Chair	Tatsuya Kuboyama	Hisayuki Sugita	Toru Nakazono	Wataru Yamamoto
		Co-Chair	Dimitrios Vogiatzis	Alexander Hagenberger	Maurice Kettner	Sebastian Schurl
			20229070/2022-32-0070	20229086/2022-32-0086	20229023/2022-32-0023	NPT2022-023
			20229089/2022-32-0089	20229082/2022-32-0082	20229074/2022-32-0074	NPT2022-022
Wednesday, November 2nd	9:00-10:00		Engine Technology Part 1 of 2	Vehicle Dynamics and Safety Part 2 of 3	NVH Technology	New Product Technology Part 7 of 10
		Chair	Ken'ichi Ohmori	Jun Ishikawa	Keisuke Namekawa	Takashi Mitome
		Co-Chair	Roland Kirchberger	Alexander Hagenberger	Stephan Schmidt	Mikael Bergman
			20229028/2022-32-0028	20229046/2022-32-0046	20229037/2022-32-0037	NPT2022-008
			20229017/2022-32-0017	20229112/2022-32-0112	20229016/2022-32-0016	NPT2022-009
	10:00-10:30		Networking Break			
	10:30-12:00		Engine Technology Part 2 of 2	Vehicle Dynamics and Safety Part 3 of 3	Materials and Manufacturing Part 1 of 2	New Product Technology Part 8 of 10
		Chair	Masahito Saito	Hisayuki Sugita	Hirotaka Kurita	Takashi Mitome
		Co-Chair	Roland Kirchberger	Dominik Gschanes	Christoph V. Hiller	Mikael Bergman
			20229006/2022-32-0006	20229003/2022-32-0003	20229075/2022-32-0075	NPT2022-010
			20229079/2022-32-0079	20229029/2022-32-0029	20229078/2022-32-0078	NPT2022-012
				20229039/2022-32-0039	20229042/2022-32-0042	NPT2022-014
	12:00-13:00		Lunch & Poster Session (Exhibition Hall C)			
	13:00-15:00		Hybrid and Electric Drives Part 1 of 2	Two Stroke Engine Part 1 of 2	Materials and Manufacturing Part 2 of 2	New Product Technology Part 9 of 10
		Chair	Tasuyuki Muramatsu	Akira Iijima	Hirotaka Kurita	Keisuke Namekawa
		Co-Chair	Kai Beck	Luca Romani	Christoph V. Hiller	Guilherme Batalha
						NPT2022-006
			20229002/2022-32-0002	20229012/2022-32-0012	20229010/2022-32-0010	NPT2022-011
			20229025/2022-32-0025	20229057/2022-32-0057	20229024/2022-32-0024	NPT2022-025
			20229018/2022-32-0018	20229063/2022-32-0063	20229041/2022-32-0041	NPT2022-018
	15:00-15:30		Networking Break			
	15:30-18:00		Plenary Session (Exhibition Hall C)			
Thursday, November 3rd	9:30-11:00		Hybrid and Electric Drives Part 2 of 2	Two Stroke Engine Part 2 of 2	Diesel Engine	New Product Technology Part 10 of 10
		Chair	Yasuyuki Muramatsu	Akira Iijima	Tadao Okazaki	Jun Ishikawa
		Co-Chair	Kai Beck	Luca Romani	Roland Kirchberger	Guilherme Batalha
			20229085/2022-32-0085	20229076/2022-32-0076	20229013/2022-32-0013	NPT2022-017
			20229094/2022-32-0094	20229080/2022-32-0080	20229052/2022-32-0052	NPT2022-019
					20229068/2022-32-0068	NPT2022-027
	11:00-11:30	Lunch box ready at 11:15	Break / Lunch & Poster Session (Exhibition Hall C)			
	11:30-12:30		Award and Closing Ceremony (Exhibition Hall C)			
	12:40-		Optional Tour			

1. Date	Monday, October 31
2. Room	Room 407
3. Time	15:30 - 16:30
4. Session	Adovanced Combustion Part 1 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Akira Iijima (Nihon University) Roland Kirchberger (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229007 / 2022-32-0007
7. Paper title	Effect of Oil Additives and Fuel Concentration in Lubricating Oil on Abnormal Combustion of Supercharged SI Engine
8. Authors (Affiliation)	Yota Nakayama, Junya Tanaka (Kogakuin University)

9. Abstract

The spark ignition engine with supercharger which is supplied the fuel directly in cylinder (SI engine) has a phenomenon of abnormal combustion as called Low Speed Pre-Ignition (LSPI). It has been reported that the LSPI would be related with lubricating oil and the ingredients of fuel and oil additives. The mechanism of LSPI does not clear sufficiently, especially, relation ignition source of LSPI with the lubricating oil additives and the fuel concentration in lubricating oil.
This research focuses on the source of LSPI which is autoignition of a lubricating oil droplet in cylinder. The effect of oil additives as Zn, Mo, Mg, Ca and concentration of fuel on autoignition of a lubricating oil droplet has been investigated. This research has been tried to evaluate the degree of autoignition fundamentally by using of electric furnace which has been heated an oil droplet. The experimental data show oil additives and fuel are strongly effect on autoignition and the data show the synergy effect of the both for autoignition, especially, the concentration of fuel between 20%vol. and 40%vol.
These experimental results have been evaluated by the activation energy E by Livengood-Wu integral. It has been suggested that the Zn and Mo oil additives prevent an oil droplet from igniting spontaneously. The oil additive of Ca and Mg in an oil droplet is little effect on autoignition. The concentration of fuel in an oil droplet is more than 20%vol., the autoignition is accelerated significantly.

6. Paper No.(JSAE/SAE)	20229008 / 2022-32-0008
7. Paper title	Autoignition of Lubricating Oil from Piston Crown and In-Cylinder Condition on Abnormal Combustion of Supercharged SI Engine
8. Authors (Affiliation)	Akira Seto, Yuka Kuwae, Junya Tanaka (Kogakuin University)

9. Abstract

The supercharged spark ignition engine with direct fuel supply system in cylinder (SI engine) has a problem on abnormal combustion at low engine speed. It is called the LSPI (Low Speed Pre-Ignition).
This research focuses on one of the source of abnormal combustion which is the autoignition of lubricating oil from piston crown in cylinder, here especially, frequency of autoignition in cylinder.
In this experiment, the test engine operates without spark ignition as motoring operation. The advantage of this method is to avoid the effect of gasoline dilution. Namely, it is able to reveal the essence of abnormal combustion experimentally. The 2 kinds of lubricating oil are tested.
The measured data show that the frequency of autoignition in this research is 1/10 of that of lubricating oil scattering from piston crown. The abnormal combustion occurs the frequency of 1 time in each 10000 cycles approximately.
The special behavior of the LSPI has been measured. The autoignition timing is ATDC in the initial stage. When the cycle of autoignition proceed, its timing is advance to BTDC.
On the other hand, the time history of pressure and temperature in cylinder are able to evaluate the autoignition by Livengood-Wu integral. The activation energy E which is estimated by the integral means the quantitative evaluation of autoignition in cylinder. The dangerous activation energy E for the LSPI is under 6452 (× 104J/mol) in this research. The activation energy E would be able to tae advantage of the engine design and simulation to prevent from the LSPI.

1. Date	Monday, October 31
2. Room	Room 408
3. Time	16:00 - 16:30
4. Session	Lubricants and Tribology
5. Chair (Affiliation), Co-chair (Affiliation)	Yuji Mihara (Tokyo City University) Mikael Bergman (Orbital Corporation Ltd)

6. Paper No.(JSAE/SAE)	20229077 / 2022-32-0077
7. Paper title	Development of Low Friction Pistons for Small Scooter Engines
8. Authors (Affiliation)	Shinya Kubota, Naoyuki Suda, Yoshinari Ninomiya (SUZUKI MOTOR CORPORATION)

9. Abstract

Small scooters have a large share of the motorcycle market because of their convenience and economy. Therefore, fuel efficiency is an important factor when customers choose products. Urban scooter users frequently use the low to medium speed range. The friction loss of the piston is a large part of the engine loss and affects the fuel consumption. The scooter piston slides horizontally. To improve the fuel consumption of scooters, it is necessary to understand the piston operating environment and improve the lubrication environment. In order to determine the thickness of the oil film required to reduce friction, we investigated the operating environment of the piston sliding horizontally at low and medium speed. As a method to control the oil film thickness, we focused on the shape of the streak. To reduce friction loss in scooters, we improved the lubrication environment of pistons.

1. Date	Monday, October 31
2. Room	Room 409
3. Time	15:30 - 16:30
4. Session	Measurement and Simulation Part 1 of 2
5. Chair (Affiliation), Co-chair (Affiliation)	Gaku Naoe (Honda R&D Co., Ltd.) Stephane Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229011 / 2022-32-0011
7. Paper title	Prediction of Fatigue Strength of Motorcycle Exhaust System in Higher Temperature Range
8. Authors (Affiliation)	Takanori Nagata (Honda Motor Co., Ltd), Jun Mizuno (Honda R&D Co., Ltd.), Shuji Iimura, Michio Ito, Mikihito Masaki (Honda Motor Co., Ltd)

9. Abstract

When developing a motorcycle exhaust system, it is important to predict the fatigue durability of the exhaust system during the design stage. We have been predicting fatigue durability using our own methods [1]. In recent years, however, in order to meet stricter emission regulations, the installation position of a catalyzer has been changed and the temperature of the exhaust system has been increased. Accordingly, the required fatigue durability of mufflers is at higher temperatures than before. With such a change in situation, a prediction method with higher accuracy for fatigue durability that can handle a higher temperature range, was required. The exhaust system temperature distribution and the physical properties of the material change depending on the temperature. Therefore, in the simulation model developed this time, the temperature distribution of the exhaust system is calculated by a heat conduction analysis method applying FEM. Furthermore, based on the temperature distribution, the values of the material properties are set for each element. In order to verify the effectiveness of the constructed model, measurements were performed on a real motorcycle. In the measurement on an actual vehicle in this study, a glass bonding method was developed and adopted for the purpose of bonding the optical fiber strain gauge. The results yielded by using the fatigue durability prediction method, constructed in this study, were in agreement with the results of the actual vehicular tests, confirming the effectiveness of this analysis method.

6. Paper No.(JSAE/SAE)	20229014 / 2022-32-0014
7. Paper title	Application of AI for Predicting Test Cycles of Drivetrain Component
8. Authors (Affiliation)	Gaurav Sirsaj, Vinay Kharche (Dana India Technical Center)

9. Abstract

Industries are currently going through “The Fourth Industrial Revolution,” as professionals have called it “Industry 4.0” (I4.0). Integration of physical and digital systems for the product life cycle mainly concerns Industry 4.0. With the appearance of I4.0, the concept of prediction management has become an unavoidable tendency in the framework of big data and smart manufacturing. At the same time, it offers a reliable solution for handling test fatigue failures. AI and its key technologies play an essential role –

1. to make industrial systems autonomous like predicting test failures
2. to make possible the automatized data collection from industrial machines/components.

Based on these collected data types, machine learning algorithms can be applied for automated failure detection and iagnosis. However, it is a bit difficult to select appropriate machine learning (ML) techniques, type of data, data size, and equipment to apply ML in industrial systems. Selection of inappropriate technique, dataset, and data size may cause time loss and infeasible result prediction. Therefore, this study aims to present a comprehensive case study of predicting the testing failure using ML techniques.

This work presents a novel approach for different parameterbased fatigue failure (rig testing failure) characterization using artificial intelligence (AI). The deep learning algorithm is trained on carefully collected physical testing data (historical data), which helps in predicting the new product development testing failure cycles based on basic design parameters available at the start of the program such as loading, component dimensions, distances, and inclination angle, etc. Rig testing reveals the testing cycles which indicate either failure or non-failure of the component (depending upon the passing criteria). Thus, every driveline component subjected to this research work generates at least one data set (testing values from AI). Based on this study, a conservative failure prediction accuracy of 88% is achieved. So, this methodology is pioneering to predict fatigue failure without -

1. comprehensive expensive physical testing.
2. the need for extensive, error-prone, use of complex assessment methodologies

With expert knowledge of evaluation procedures, the developed AI approach enables quick and reliable prediction of fatigue failure of components based on elementary key design parameters which can reduce the overall design cycle time.

Abstracts of NPT Sessions

1. Date	**Monday, October 31**
2. Room	**Exhibition Hall C**
3. Time	**15:30 - 16:30**
4. Session	**New Product Technology Part 1 of 10**
5. Chair (Affiliation),	**Yuji Araki (Yamaha Motor Co., Ltd.)**
Co-chair (Affiliation)	**Kai Beck (Andreas Stihl AG & Co. KG)**

6. Paper Number	NPT2022-024
7. Paper title	Combined heat and power system using a biomass gas engine
8. Authors (Affiliation)	Hiroyuki Otsubo (YANMAR ENERGY SYSTEM CO., LTD)

9. Abstract

Yanmar Energy System Co., Ltd. is suppling a gas engine combined heat and power (CHP) system that generates electric power and heat to applications such as hot water and air conditioning. This time, the biogas engine CHP system BP25D2 is developed, which has a power generation output of 25kW. This CHP system has the following features.

1. Power generation output 25kW (power generation efficiency 32.0%), recovered heat amount 40.6kW (total efficiency 84.0%)
2. Covers 47-100% methane concentration (specification setting according to methane concentration)
3. 8760h long maintenance interval
4. Efficient unit control operation is possible according to the electricity demand and amount of generated gas (up to 16 units)
5. Support by remote monitoring

6. Paper Number	NPT2022-028
7. Paper title	Rotary valve 4-stroke engines for general purpose power equipment and unmanned systems.
8. Authors (Affiliation)	Brian Richard Mason, Keith Lawes (RCV Engines Limited), Koichi Hirakawa (KAAZ Corporation)

9. Abstract

A rotary valve 4-stroke combustion system has been applied to engines for unmanned air vehicles (UAVs) and general-purpose power equipment. The RCV rotary valve system can operate on a range of fuels and at high levels of power, together with typical 4-stroke exhaust emissions and fuel economy. The DF35 and DF70 engines, for UAVs and unmanned hybrids, are based around a 35 cc cylinder configured as a single or boxer twin, with either air or liquid cooling. The fuel injected DF engines achieve 63 kW/litre on either gasoline or kerosene-based fuels such as JP8. The 25 cc multi-position general purpose CK1 engine is configured into a brushcutter package. CK1 has completed development for volume production, achieves 48 kW/litre.

Recent small engine developments are application specific. Small two wheelers and garden equipment originally used basic 2-stroke engines for cost and power to weight reasons. Exhaust emissions regulations have resulted in new low emissions small engines and a move towards battery/electric systems. However, there are many situations where battery electric systems will not be viable. With a requirement for net-zero carbon emissions in 2050, future small engine will need to achieve: low exhaust emissions, low fuel consumption, high power to weight, and have an ability to run on net-zero carbon fuels, such as synthetic aviation fuel. Combining the multi-fuel capability of the DF engine with volume production technology of the CK1 engine, the RCV rotary valve combustion system provides a viable technology for future small engine applications.

Abstracts of Technical Sessions

1. Date	**Monday, October 31**
2. Room	**Room 407**
3. Time	**17:00 - 18:00**
4. Session	**Adovanced Combustion Part 2 of 5**
5. Chair (Affiliation),	**Koji Yoshida (Nihon University)**
Co-chair (Affiliation)	**Roland Kirchberger (Graz University of Technology)**

6. Paper No.(JSAE/SAE)	20229038 / 2022-32-0038
7. Paper title	Numerical and Experimental Analysis of Abnormal Combustion in a SI Gasoline Engine with a Re-Entrant Piston Bowl and Swirl Flow
8. Authors (Affiliation)	Ayano Matsuoka, Kentaro Shiraishi, Shinji Kishi (Kubota Corporation), Jaeok Bae, Makoto Kaneko, Tatsuya Kuboyama, Yasuo Moriyoshi (Chiba University)

9. Abstract

Some SI (spark-ignition) engines fueled with gasoline for industrial machineries are designed based on the conventional diesel engine in consideration of the compatibility with installation. Such diesel engine-based SI engines secure a combustion chamber by a piston bowl instead of a pent-roof combustion chamber widely applied for SI engines for automobiles.
In the development of SI engines, because knocking deteriorates the power output and the thermal efficiency, it is essential to clarify causes of knocking and predict knocking events. However, there has been little research on knocking in diesel engine-based SI engines. The purpose of this study is to elucidate knocking phenomena in a gasoline engine with a re-entrant piston bowl and swirl flow numerically and experimentally. In-cylinder visualization and pressure analysis of knock onset cycles have been experimentally performed. Locations of autoignition have been predicted by 3D-CFD analysis with detailed chemical reactions. The prediction accuracy of the location of autoignition has been examined by comparing with experimental results. Initial and boundary conditions for 3D-CFD are obtained by TPA (Three Pressure Analysis), which is a 1D engine cycle simulation using measured intake/exhaust and in-cylinder pressures as the input data. Locations and timing of autoignition have been observed through an endoscope attached to the cylinder head. The visualization area through the endscope is determined based on the location of autoignition predicted by 3D-CFD analysis. The in-cylinder pressure is also measured simultaneously, and the maximum amplitude of the pressure oscillations after applying a high-pass filter to the in-cylinder pressure is used as knock intensity (KI) to determine knock onset cycles. From results of the in-cylinder pressure measurements and analysis by TPA, the relationships between in-cylinder conditions and KI are analyzed. The comparison between visualized and calculated location of autoignition have been shown good agreement in the case that both the maximum and the low engine speed conditions.

6. Paper No.(JSAE/SAE)	20229081 / 2022-32-0081
7. Paper title	Use of Narrow Angle Split Injection Strategy for Improving the Performance of a Biogas-diesel RCCI Engine
8. Authors (Affiliation)	Anirudh Koya, Gopa Kumar S, A. Ramesh (Internal Combustion Engine Laboratory, Department of Mechanical Engineering, Indian Institute of Technology, Madras)

9. Abstract

Low temperature combustion technologies like RCCI are gaining popularity because of their potential for good performance while promoting the use of renewable energy sources. Conventionally in a biogas diesel RCCI engine biogas is inducted and compressed along with air while diesel is injected very early in the compression stroke. The early injection of diesel using the conventional wide angle fuel injector that is suitable for conventional diesel combustion leads to wall wetting and hence elevates the HC emissions and also lowers the efficiency. The present work is an attempt to address these issues with the use of a narrow angle injector for the biogas diesel RCCI mode of operation. The conventional Wide angle injector which is located at the center of the combustion chamber needs to be retained because the engine has to be operated in the conventional mode at low and high loads. Thus, the Narrow angle injector is an additional injector which has to be located at the available space in an offset manner from the Wide injector. The role of the Narrow angle injector is to ensure that the fuel hits the piston surface rather than the liner during early injections in the RCCI mode. A CFD model of the engine that was validated using experimental data was used for the parametric studies reported in this work. The Narrow injector has been first located and oriented in the combustion geometry based on the space constraints in the cylinder head. The number of holes in the injector were fixed as three and their orientations were then determined based on the simulations taking into consideration the benefits of spray targeting. The importance of spray targeting the piston bowl periphery was first established by a comparative study. Two injectors with different spray angles were then designed based on two chosen injection timings namely 900 bTDC and 700 bTDC and their performances were compared to select the better configuration. A timing sweep was done to analyze the performance of each of the injectors based on fuel vaporization, film mass and the homogeneity of the mixture at different injection timings. It was found that the injector designed for SOI-900 bTDC gave the best results. The performance of the chosen Narrow injector was then compared against that of the wide angle injector and the potential for a significant improvement in efficiency was observed. However, this was at the cost of high NOx and HC emissions. In order to reduce the emissions, split injection strategy was then considered with the Narrow angle injector. The results showed further improvement, but the emission values were still higher than that of wide angle injection. Thus, the use of Narrow angle injector is beneficial in improving the efficiency of an RCCI engine. However, steps need to be taken to reduce the NOx and HC emissions.

1. Date	Monday, October 31
2. Room	Room 408
3. Time	17:00 - 18:00
4. Session	Emission and Environmental Impacts Part 1 of 3
5. Chair (Affiliation), Co-chair (Affiliation)	Tadao Okazaki (LEMA/ Kubota corporation) Stephane Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229004 / 2022-32-0004
7. Paper title	Impact of 3 way catalytic converters on particulate emission of MPFI motorcycle engines
8. Authors (Affiliation)	Sebastian Schurl, Stephan Schmidt, Marcus Bonifer (Graz University of Technology)

9. Abstract

Due to climatic movements and politics, there is no doubt that a stricter emission legislation will soon face the two-wheeler sector and their manufacturers with new challenges. Additional to the already limited pollutants, a limitation of particulate number will probably also be introduced, which means that there is an urgent need for action in exhaust gas aftertreatment and particulate reduction systems. For natural aspirated, port injected engines, as used in two-wheeler-technologies, conventional systems already established in passenger cars are not necessarily applicable. Moreover, the emission spectrum is fundamentally different from passenger car engines due to the better homogenization of they typically used MPFI engine types. Adapting conventional particulate filter technologies to the finer particles of MPFI engines would result in a disproportionately larger exhaust backpressure. For this reason, we are investigating the effects of 3-way catalytic converters on particulate number emissions from MPFI engines in the two-wheeler sector and possible modifications to increase filtration and particulate burn-off. The characteristic properties of the catalyst investigated in this context relate to cell density, honeycomb construction, foil technologies and coatings and their effect on the emission behaviour of particles of different size classes. Initial investigations showed that the 3-way catalyst has significant influence on particle emission due to its design and exothermic reactions. An adjustment of the already mentioned characteristics of the catalyst shows further reduction possibilities especially for ultrafine particles smaller than 10 nm. With increasing size and the accompanying bigger thermal inertia of the particles, the reduction potential decreases sharply within a few nanometres. …

6. Paper No.(JSAE/SAE)	20229026 / 2022-32-0026
7. Paper title	Carbon Footprint Calculation of Catalytic Converter Production - an Industrial Case Study
8. Authors (Affiliation)	Simon Merschak, Peter Hehenberger (University of Applied Sciences Upper Austria), Marcus Bonifer (Heraeus Deutschland GmbH & Co. KG)

9. Abstract

The carbon footprint calculation of a catalytic converter coating process at Heraeus Precious Metals is presented in this publication. The emission hot spots are identified and discussed. Heraeus Precious Metals is a German world - wide leading company in the field of precious metal products and Tier - 1 Supplier of emission catalytic converter coatings.
In the first step of the carbon footprint calculation, all relevant raw materials and production process steps of the coating process are collected and modelled by use of a flowchart. In this case study the manufacturing of the metal honeycomb carrier is not included in the calculation.
Transport emissions from the origin of the raw materials to the manufacturing plant of Heraeus Precious Metals in Germany are also considered in the carbon footprint calculation. Included activities for the production of the washcoat dispersion are the mixing of all components by use of an electric agitator and the grinding of the mixture by use of an electric mill. Further, multiple coating processes of the honeycomb carrier and the subsequent drying in a belt drier are considered. Finally, the catalytic converter is tempered in an electric oven.
The calculation results are analyzed, and emission hotspots are identified. The calculated carbon footprint reveals several optimization potentials for carbon emission reduction in the catalytic converter production. It can be concluded that the main source of carbon dioxide emission are the raw material extraction emissions of the precious metals platinum and rhodium. Regarding the production processes, the thermal processes provide the highest potential for optimization.

1. Date	Monday, October 31
2. Room	Room 409
3. Time	17:00 - 18:00
4. Session	Renewable Energy and Alternative Fuels 1 of 5
5. Chair (Affiliation),	Tasuya Kuboyama (Chiba University)
Co-chair (Affiliation)	Maurice Kettner (Hochschuhe Karlsruhe University of Applied Sciences)

6. Paper No.(JSAE/SAE)	20229021/2022-32-0021
7. Paper title	Impacts of methanol blended fuels on emissions and operating performance of two-wheelers
8. Authors (Affiliation)	Guilherme Pellizzaro Batalha, Stephan Schmidt, Roland Kirchberger, (Graz University of Technology)

9. Abstract

Aiming to investigate the influence of methanol blends on the combustion process of a PFI four-stroke boxer engine, four mixtures of pure methanol and oxygen-free gasoline (M0) are prepared. The fuels tested are labelled by M15, M25, M35 and M50, where the number represents the percentual in volume of methanol within the mixture. In order to establish a base for comparisons, standard gas-station gasoline (S95) is also tested. Backwards compatibility is evaluated through test-bed measurements, when the engine operates without any modifications in the ECU. Over the whole operational area of the engine map, M15 and M25 can be used in the motorcycle application. Raw emissions of THC, CO2, CO and NOx decrease with the increase of methanol for almost all the conditions tested. It is observed that knock resistance is higher for higher methanol contents. At WOT, power is increased with the methanol proportion, being M50 and M35 more powerful than standard gasoline. Indicated efficiency also increases with methanol percentage, all the mixtures show a higher efficiency than standard gasoline. The most common WMTC load points are studied in order to evaluate the after-catalyst emissions. Compared to gasoline and oxygen-free gasoline, a significant reduction of NOx is observed. As the combustion temperature of M15 and M25 drops and no optimization of the exhaust aftertreatment was performed, this results in an excess of THC and CO when compared to gasoline.

6. Paper No.(JSAE/SAE)	20229061/2022-32-0061
7. Paper title	Impact of Zero CO2 Fuels on Engine Behaviour of Two-Stroke Engines in Hand-Held Powertools
8. Authors (Affiliation)	Dominik Gschanes (Institut for Thermodynamics and Propulsion Systems)

9. Abstract

One possible path to reduce the CO2 emissions of hand-held power tools are fuels with different amount of renewable content. Within this paper test bench measurements on a small two-stroke engine were carried out. We are trying to reduce CO2 emissions by using fuels which absorbed CO2 from the air during its lifetime or production, so called Zero CO2 fuels The focus was set on the investigation of combustion behaviour, performance and emissions of Zero CO2 fuels in comparison to commonly available fuels. For our measurements we chose a 46 cc serial engine, which was slightly modified for scientific research. This paper shows findings on effects of renewable fuels on engine characteristics. Additionally, the chemical properties of each fuel were investigated in order to form a comprehensive picture, together with the performed dyno measurements. Requirements to future internal combustion engines (ICEs) regarding sustainability and efficiency are continuing to rise while on the other hand, pollutant emission regulations are continuously tightened. Dual-fuel combustion (DFC) of diesel and natural gas is an approach to reduce soot emissions while still profiting from the high efficiency of the diesel combustion process. Using natural gas as the main fuel also helps to reduce carbon dioxide (CO2) emissions due to the favorable C/H-ratio of methane (CH4) as its primary constituent. To reduce both pollutant and greenhouse gas emissions further, diesel can be replaced by an e-fuel. The use of C1-oxygenates – such as polyoxymethylene dimethyl ether (POMDME or “OME”) – as pilot fuel promises to reduce both soot and nitrogen oxide (NOx) emissions. For the present investigation, a 4.5l tractor diesel engine has been converted to a biogas-OME dual-fuel engine. A fully variable valve train has been integrated into the cylinder head. A second exhaust valve lift during aspiration is used to vary the internal exhaust gas recirculation (EGR) rate, while an EGR valve controls the cooled external EGR introduced into the intake runner. This study investigates the influence of external and internal EGR on equivalence ratio and the maximum substitution rate for stable combustion, as well as the resulting engine efficiency and raw emissions. Internal EGR was adjusted by varying the second exhaust valve lift in several discrete steps from 0 to 1.9 mm, while the external EGR rate was varied between 0 and 30 %. The investigations show that CH4 and carbon monoxide (CO) emissions rise with increasing substitution rate, whereas NOx and CO2 emissions are reduced. Soot emissions are well below the EU stage V emission limit throughout the entire measuring range. As the soot-NOx trade-off is no longer an issue, NOx emissions can be reduced by up to 88 % by increasing the EGR rate. Combining internal and external EGR also showed a positive effect on both unburnt CH4 (up to -62 %) and CO emissions (up to -87 %).

Abstracts of NPT Sessions

1. Date	**Monday, October 31**
2. Room	**Exhibition Hall C**
3. Time	**17:00 - 18:00**
4. Session	**New Product Technology Part 2 of 10**
5. Chair (Affiliation),	**Wataru Yamamoto (Kawasaki Motors, Ltd.)**
Co-chair (Affiliation)	**Sebastian Schurl (Graz University of Technology)**

6. Paper Number	NPT2022-029
7. Paper title	Innovative Exhaust Measurement Systems for Lab and RDE
8. Authors (Affiliation)	Benedikt Grob, Roman Felder, Christian Hafenmayer, Marco Miller, Matthias Steffen (AIP GmbH & Co. KG)

9. Abstract

The ever-increasing legal requirements related to the reduction of exhaust emissions are not limited to internal combustion engines of light and heavy duty vehicles, but also to small engines of off-road vehicles, motorcycles, scooters, etc.. This requires high-precision measurement technology in order to achieve reliable measurement results on the engine or vehicle test bench, but also under real driving conditions. AIP offers its customers new, innovative solutions in addition to conventional exhaust gas measurement technology. A portable emission measurement system (PEMS) that can be used flexibly was developed for real driving emissions and can be easily mounted on small vehicles such as motorcycles. The PEMS includes very compact analysers to measures the concentration of CO2, CO, NO, NO2 and particle number. To determine the exhaust mass flow a low flow Exhaust Mass Flow Meter (EFM) based on the pitot tube working principle was developed. The EFM has three cascaded pressure transmitters to cover a wide measurement range. The control board processes the measured values with a very high sampling rate in order to record pulsations in the exhaust system and to avoid measurement errors.
In addition, AIP developed new raw exhaust gas measurement system for additional pollutants like ammonia, N2O and formaldehyde based on the laser absorption spectroscopy technique. The analysers have a wide dynamic range with a ultra low detection limit of < 0,1 ppm and no cross sensitivity to other components in the exhaust gas, such as water. The innovative sampling system with heated filters and minimized dead volumes avoids hang ups and enables full automated quality checks. In addition it can handle very large inlet pressures at the sampling probe up to 4 bar relative. The analysers can be used in a wide temperature range from -30°C to 45°C. They are also insensitive to changes in ambient pressure in the range between 700 hPa abs. – 1.100 hPa abs.

6. Paper Number	NPT2022-030
7. Paper title	Model Based Development with PRUFREX MMS AL
8. Authors (Affiliation)	Bahattin Öztürk, Marius Albert, Thorsten Stoffregen (PRÜFREX Engineering e Motion GmbH & Co. KG)

9. Abstract

The market for small engine applications has always been cost-driven. In addition, depending on the target application, high demands regarding packaging dimensions, robustness in general, electromagnetic compatibility (EMC), and extreme ambient conditions must be met. For this reason, simple and proven carburetor systems have long prevailed.
However, as a result of stricter emission regulations, fuel injection systems are becoming more and more prevalent. This opens new possibilities for combustion and application control, which require corresponding electronic control units.
In parallel to electronic hardware, function development and software implementation also play a major role. Model-Based Development processes offer a variety of advantages here to reduce costs and shorten development times.
This article describes the advantages of such a system and its development processes using the PRUFREX MMS-AL (Motor Management System Advanced Level) with its associated development tools, see Figure 2.
The focus here is on the fact that the key element of the MMS-AL platform is a microcontroller with a floating-point unit (FPU), which introduces on target rapid control prototyping (OTRCP) capabilities into a mass production control unit.

Abstracts of Technical Sessions

1. Date	Tuesday, November 1
2. Room	Room 407
3. Time	9:00 - 10:00
4. Session	Adovanced Combustion Part 3 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Akira Iijima (Nihon University) Stephane Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229015 / 2022-32-0015
7. Paper title	Study on Influence of Tailored In-cylinder Flow on HCCI Combustion in a Rapid Compression and Expansion Machine
8. Authors (Affiliation)	Yiwen Zhong, Tatsuya Kuboyama, Yasuo Moriyoshi (Chiba University), Kei Yoshimura (SUZUKI MOTOR CORPORATION)

9. Abstract

The purpose of this paper is to investigate the mechanism of tailored in-cylinder flow on mitigation of heat release by optical experiments to find a way to extend the high load limit of homogeneous charge compression ignition (HCCI) combustion. We constructed an experimental system that can generate various temperature distributions and airflow patterns in the cylinder (based on a rapid compression expansion machine). The effects of tumble flow on the heat release rate and the pressure rise rate of HCCI were investigated experimentally by combustion analysis and direct photography of combustion. The in-cylinder appropriate turbulence was created by the special piston which was equipped with a flow guide plate that could change the intensity and scale of the flow by special settings. Meanwhile, the ambient temperature distribution in the cylinder was determined by the wall temperature controlling system. The direct photographs show that with enhanced incylinder flow, multiple ignition points are formed in the combustion chamber, the heat release rate is relatively small, and the increase in the pressure rise rate is suppressed. The pressure rise rate varies with variations in the turbulence intensity.

6. Paper No.(JSAE/SAE)	20229044 / 2022-32-0044
7. Paper title	Analysis of Cylinder to Cylinder Variations in a Turbocharged Spark Ignition Engine at Lean Burn Operations
8. Authors (Affiliation)	Ryo Yamaizumi, Haoyun Shi, Tatsuya Kuboyama, Yasuo Moriyoshi (Chiba University)

9. Abstract

In recent years, the improvement in the fuel efficiency and reduction in CO2 emission from internal combustion engines has been an urgent issue. The lean burn technology is one of the key technologies to improve thermal efficiency of SI engines. However, combustion stability deteriorates at lean burn operations. The reduction in cycle-to-cycle and cylinder-tocylinder variations is one of the major issues to adapt the lean burn technique for production engines. However, the details of the causes and mechanisms for the combustion variations under the lean burn operations have not been cleared yet. The purpose of this study is to control cylinder to cylinder combustion variation. A conventional turbocharged direct injection SI engine was used as the test engine to investigate the effect of engine control parameters on the cylinder to cylinder variations. The engine speed is set at 2200 rpm and the intake pressure is set at 58, 78, 98 kPa respectively. In-cylinder pressure, intake pressure, and exhaust pressure are measured in each cylinder by the piezoelectric and piezo-resistive pressure transducers. The ignition timing and fuel injection timing is varied as experimental parameters to investigate the effects of the combustion phase and the fuel distribution on combustion stability. At 78 kPa condition, it was seen that the tendency of COV of IMEP was slightly different in each cylinder Also, it was seen a few cycles of sudden decline IMEP in the third cylinder at lean burn operation. So, COV of IMEP was different in each cylinder and COV of IMEP of first cylinder lower than the third cylinder. Moreover, combustion phase was different in each cylinder when ignition timing was same. Therefore, it is considered that optimized ignition timing and fuel injection timing is different in each cylinder.

1. Date	Tuesday, November 1
2. Room	Room 408
3. Time	9:00 - 10:00
4. Session	Emission and Environmental Impacts Part 2 of 3
5. Chair (Affiliation), Co-chair (Affiliation)	Tadao Okazaki (LEMA/ Kubota corporation) Kai Beck (Andreas Stihl AG & Co. KG)

6. Paper No.(JSAE/SAE)	20229005 / 2022-32-0005
7. Paper title	Design and Implementation of An Oxidation Catalyst for A Spark Ignited Two Stroke Snowmobile Engine
8. Authors (Affiliation)	Noah Squires (Polaris Industries, Inc.), Scott A. Miers (Michigan Technological University)

9. Abstract

The primary goal of this project was to design and implement an oxidation catalyst specific to a high-performance spark ignited two stroke engines to reduce vehicle-out emissions. The primary challenges of two stroke catalysis at high loads include controlling the catalytic reaction temperature as well as minimizing the increase in exhaust back pressure due to the addition of a catalyst. Reaction temperature is difficult to control due to high HC and CO concentrations paired with an excess of oxygen in the exhaust stream. By limiting catalyst conversion efficiency, the reaction temperatures were controlled. Two stroke engines are also inherently sensitive to changes in exhaust back pressure and therefore location and sizing of the catalyst are key design considerations. Because of these challenges significant effort was directed toward developing the two-stroke specific catalyst design process. Through these efforts several key outcomes were reached including a better understanding of how to size and locate a catalyst in an existing two stroke exhaust system while maintaining minimal performance losses as well as insight into the wash coat development process and methods to promote catalyst durability. In total three actively coated catalyst samples were successfully tested over a range of engine speeds and loads. The catalyst samples showed significant HC reductions ranging from 30 to 96 percent across the engine operating range and CO reductions ranging from 10 to 97 percent in a significant portion of the operating range. Peak power loss also remained less than 1.5 percent for all catalyst samples.

6. Paper No.(JSAE/SAE)	20229050 / 2022-32-0050
7. Paper title	Development of DPF regeneration system under all operating conditions for generators
8. Authors (Affiliation)	Daichi Kato, Hiroaki Okano, Katsushi Inoue, Kota Nakano (KUBOTA Corporation)

9. Abstract

In order to resolve global atmospheric environmental issues, latest diesel engines for industrial machinery are required to reduce the emission of harmful gases such as carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx), and particulate matter (PM). For this reason, it is essential to mount exhaust gas after treatment devices such as diesel particulate filter (DPF) and diesel oxidation catalyst (DOC) on diesel engine. Engines mounted DPF must carry out DPF regeneration that burns and removes PM. Generator engine has characteristic of being operated for a long time under light load condition with low exhaust temperature which is difficult for DPF regeneration. In addition, generating white smoke and inlet face clogging of DOC are caused by accumulated soot containing HC at the DOC when operating engine continuously under light load condition.
In this study, DPF regeneration system suitable for generator engine and method for preventing white smoke and inlet face clogging of DOC is proposed by installing Pre-heating catalyst and exhaust throttle valve on upstream of DOC. Exhaust heating control using Pre-heating catalyst and exhaust throttle valve enables DPF regeneration in all cases of operating conditions including operation without load. In addition, HC accumulation that causes white smoke is prevented by periodically raising temperature of DOC by exhaust heating control. Furthermore, method for burning and removing clogging matter on DOC inlet face caused by light load operation is developed, making it possible to prevent inlet face clogging of DOC.

1. Date	Tuesday, November 1
2. Room	Room 409
3. Time	9:00 - 10:00
4. Session	Renewable Energy and Alternative Fuels 2 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Yuji Araki (Yamaha Motor Co., LTD) Maurice Kettner (Hochschule Karlsruhe University of Applied Scieneces)

6. Paper No.(JSAE/SAE)	20229067/2022-32-0067
7. Paper title	Investigation of an Engine Concept for CNG-OME Dual Fuel Operation Using External and Internal EGR
8. Authors (Affiliation)	Ann-Kathrin Jost, Michael Günthnerm, Florian Müller, Alexander Weigel, (TUK Technische Universität Kaiserslautern)

9. Abstract

Requirements to future internal combustion engines (ICEs) regarding sustainability and efficiency are continuing to rise while on the other hand, pollutant emission regulations are continuously tightened. Dual-fuel combustion (DFC) of diesel and natural gas is an approach to reduce soot emissions while still profiting from the high efficiency of the diesel combustion process. Using natural gas as the main fuel also helps to reduce carbon dioxide (CO2) emissions due to the favorable C/H-ratio of methane (CH4) as its primary constituent. To reduce both pollutant and greenhouse gas emissions further, diesel can be replaced by an e-fuel. The use of C1-oxygenates – such as polyoxymethylene dimethyl ether (POMDME or "OME") – as pilot fuel promises to reduce both soot and nitrogen oxide (NOx) emissions. For the present investigation, a 4.5l tractor diesel engine has been converted to a biogas-OME dual-fuel engine. A fully variable valve train has been integrated into the cylinder head. A second exhaust valve lift during aspiration is used to vary the internal exhaust gas recirculation (EGR) rate, while an EGR valve controls the cooled external EGR introduced into the intake runner. This study investigates the influence of external and internal EGR on equivalence ratio and the maximum substitution rate for stable combustion, as well as the resulting engine efficiency and raw emissions. Internal EGR was adjusted by varying the second exhaust valve lift in several discrete steps from 0 to 1.9 mm, while the external EGR rate was varied between 0 and 30 %. The investigations show that CH4 and carbon monoxide (CO) emissions rise with increasing substitution rate, whereas NOx and CO2 emissions are reduced. Soot emissions are well below the EU stage V emission limit throughout the entire measuring range. As the soot-NOx trade-off is no longer an issue, NOx emissions can be reduced by up to 88 % by increasing the EGR rate. Combining internal and external EGR also showed a positive effect on both unburnt CH4 (up to -62 %) and CO emissions (up to -87 %). Operating an Otto-Engine with hydrogen as fuel the probability of combustion anomalies like knocking, preignition and backfiring increases significantly. Knocking is strongly dependent on the operating point, while the cause for preignition is still investigated. Literature as well as preliminary investigations to this work suggest that especially the spark plug has a significant influence on the occurrence of preignition and backfiring. Hence, the scope of this paper is to identify and understand the influence of the spark plug on preignition in order to reduce their occurrence and receive more mechanical power from the engine. In the first step, the operating conditions leading to preignition and backfiring are determined experimentally using a naturally aspirated single cylinder gas engine and a state-of-the-art prechamber spark plug. Afterwards, different prechamber designs of the spark plug, including a variation of the cap volume, thickness and the orifices diameter, are investigated with respect to their tendency to cause preignition. Additionally, measurements are done with a spark plug in which the electrode material has been changed. 3D-CFD simulations with the aim of visualizing the flow processes in the prechamber support the analysis of the experimental results and are the base for new prechamber designs.

6. Paper No.(JSAE/SAE)	20229001/2022-32-0001
7. Paper title	CO2 and H2 effects on lean limits and combustion characteristics of ethanol flame
8. Authors (Affiliation)	M. Zuhaib Akram (Naval Architecture and Ocean Engineering College, Dalian Maritime University, State Key Laboratory of Automobile Safety and Energy, SVM, Tsinghua University), Fanhua Ma (State Key Laboratory of Automobile Safety and Energy, SVM, Tsinghua University), Umair Sultan (Department of Agricultural Engineering, ABE&T Faculty, MNS University of Agriculture), M. Waqar Akram (Department of Farm Machinery and Power, AE Faculty, University of Agriculture Faisalabad), Tahir Rashid (Pakistan Institute of Engineering and Applied Sciences (PIEAS))

9. Abstract

High efficiency can be achieved by running the IC engines under lean conditions. Besides, ethanol known as a renewable fuel is used in combustion engines due to its low carbon emission compared to liquid hydrocarbon fuels. However, the carbon emission from ethanol combustion is still an environmental issue, and the lean flammability limits are also not wider compared to zero-carbon fuel. Besides, the EGR impact on the lean limits of ethanol is still unclear. Currently, the effects of CO2 and H2 on the lean limits and burning characteristics of ethanol flame were studied by using the spherical combustion chamber and Arrhenius model at 373- 473 K and 100 kPa. The hydrodynamic and thermal instabilities were induced under the addition of H2 while CO2 impeded diffusional-thermal and hydrodynamic instability. The lean limits of ethanol increased from λ = 2.1 to λ = 2.6, λ = 3.2, λ = 4.3, and λ = 6.8 at 30%, 50%, 70%, and 90% H2 addition in ethanol/air mixture, respectively. In contrast, CO2 is inflammable gas, which decreased the lean limits of ethanol from λ = 2.1 to λ = 1.9, λ = 1.6, and λ = 1.2 under 5%, 10% and 15% enrichment, respectively. CH3CHO, CH4, CH2O, O2CHO, CH3 and CO species were found correlated to the hydrogen-ethanol and CO2-ethanol flames. Hydrogen significantly increased the combustion process thru CH4 and O2CHO species, whereas the flame propagation deteriorated by a decrement in peak molar fractions of CH3CHO, CH4, CH2O, CH3 and CO species thru CO2 dilution.

Abstracts of NPT Sessions

1. Date	Tuesday, November 1
2. Room	Exhibition Hall C
3. Time	9:00 - 10:00
4. Session	New Product Technology Part 3 of 10
5. Chair (Affiliation), Co-chair (Affiliation)	Wataru Yamamoto (Kawasaki Motors, Ltd.) Christoph V. Hiller (Stihl AG)

6. Paper Number	NPT2022-004
7. Paper title	Unique Theory of the Operating Engine Simulation to Investigate the Noise/Vibration Mechanism
8. Authors (Affiliation)	Arata Miyauchi, Masanori Ogawa, Kanno Masatoshi, Taigo Yukisawa (ESTECH Corp.)

9. Abstract

When an engine is running, a rotating crankshaft and non-rotating (stationary) engine housing are coupled dynamically. To predict such dynamical phenomenon, CAE simulation with using a time domain kinematic mechanism software is commonly used. However, estimating engine noise and vibration takes long computational time.
We proposed a unique frequency domain simulation theory which solves an elastic vibration of both a rotating crankshaft and a stationary engine housing simultaneously. Coupling crankshaft and engine housing in frequency domain enables to analyze an operating engine elastic vibration in a short time.
Our benchmark test found this new analysis method is 100+ times faster than the legacy time domain method. Furthermore, the proposed method has the similar prediction accuracy of the engine vibration and radiation noise compared with the legacy simulation solver. The method is patented with #5352026 in Japan and implemented as a commercial software named 'ESTECH.PS-X'.
This paper briefly reports followings; (1) a new theory of frequency domain solution with large scale finite element engine model to simulate operating engine vibrations, (2) unique modal base analysis methods to easily clarify a vibration mechanism, and (3) applications and use cases of proposed theory.

6. Paper Number	NPT2022-026
7. Paper title	Additively manufactured thermal solutions for small energy systems
8. Authors (Affiliation)	Jason Velardo, Glenn Rees, Gabrian Balelang, Dan Woodford, Michael Fuller (Conflux Technology)

9. Abstract

Thermal technology plays an important role in the performance, safety, reliability and cost of many small powertrain and energy systems. Conflux Technology is an Australian based manufacturer of additively manufactured thermal solutions. We have developed several solutions for application in motorsport, automotive, aviation and aerospace industries. Here we discuss our additively manufactured “cartridge” heat exchanger. We highlight the development of this product, from the initial stages of thermal-hydraulic design using computational modelling techniques to the eventual additive manufacture of the cartridge on a direct metal laser sintering system. The detailed design process followed in this work produced an additively manufactured cartridge heat exchanger that could transfer 5.7kW of heat while maintaining acceptable fluid pressure drops for the given boundary conditions. The heat exchange rate of 5.7kW measured through experimentation agreed very well with the value of 5.6kW expected from the computational modelling. The oil side pressure drop value was also measured to be within 1kPa of the expected value from the computational work. The water side pressure drop was larger experimentally than expected from the modelling, and some possible causes of this are discussed in the work. The cartridge had an overall size of 30mm × 30mm × 30mm and weight of 40g and 60g when empty and charged with fluid, respectively. It could safely operate leak free at the design pressure, and was also easily serviceable, interchangeable, and customizable. These cartridge heat exchangers thus offer a low cost and highly compact solution compared to traditionally manufactured heat exchangers. The design methodology followed was also robust and agile such that a cartridge could be designed with different boundary conditions, constraints and geometry. These are currently being used in engine and gearbox oil cooling applications but are not limited to these applications. They are highly customizable and adaptable to other small powertrain and energy systems.

Abstracts of Technical Sessions

1. Date	**Tuesday, November 1**
2. Room	**Room 407**
3. Time	**10:30 - 12:30**
4. Session	**Measurement and Simulation Part2 of 2**
5. Chair (Affiliation),	**Tadao Okazaki (LEMA/ Kubota corporation)**
Co-chair (Affiliation)	**Stephan Schmidt (Graz University of Technology)**

6. Paper No.(JSAE/SAE)	20229031 / 2022-32-0031
7. Paper title	An estimation method of blended fuel contents by data assimilation for carbon neutral powertrain
8. Authors (Affiliation)	Naoki Yoneya (Hitachi, Ltd.,), Kenji Amaya (Tokyo Institute of Technology)

9. Abstract

For achieving decarbonization in internal combustion engines, a utilization of carbon neutral fuels from renewable energies (e-fuel) could be one option. E-fuel is expected to be implemented as blended fuels with conventional fuels, which results in more uncertainties of the fuel properties. To cope with a larger number of blended fuels compared to the existing alcohol-fuel blends, fuel aging effects resulting from longer refueling intervals in hybrid engines, and fuel blend variations in each refueling station, an optimized engine control and energy management depending on the fuel blend contents will be required. In this study, a new fuel contents estimation method for the engine control based on the external refueling information and the signals of the existing engine sensors is developed, by utilizing data assimilation. With the non-linear ensemble Kalman filter, the prediction model which predicts changes of the fuel blending rate in the tank considering the refueling and fuel aging and their uncertainties was created. Also, the compensation filter which modifies the predicted value based on the engine component signals including measurement noises during engine operations was developed. For the fuel blend prediction model, the relative increase of the heavy components of gasoline, the hydrolysis of dimethyl carbonate (DMC) as one of e-fuels, and the fuel evaporation were considered. The compensation filter is composed of the fuel observation matrix which describes the relationship between the fuel blend rate and the fuel properties, and the engine observation matrix which modelled the signals of the engine components to those fuel properties. The numerical experiment with the repetition of operation and refueling was conducted, considering the 4 fuel blends (Gasoline, Ethanol, Methanol, and DMC) and the fuel aging. The accuracy improvement of the fuel blend estimation with data assimilation was confirmed.

6. Paper No.(JSAE/SAE)	20229045 / 2022-32-0045
7. Paper title	Measurement of propagating flame in a gasoline engine under transient operating conditions using a multiple-ion probe
8. Authors (Affiliation)	Tomoaki Yatsufusa, Yuki Goto, Shota Hiroi (Hiroshima Institute of Technology)

9. Abstract

The propagating flame in a 2-stroke gasoline engine under WOT or transient operating conditions was measured with up to 12 ion probes. Flame arrival time data obtained from multiple-ion probes were statistically compared between arrival time data obtained by different ion probes or between data obtained by the same ion probe for different cycles to investigate the spatial and temporal characteristics of flame propagation behavior. Spatial statistical data analysis revealed that the propagating flame is strongly influenced by the in-cylinder flow prior to ignition. Temporal statistical data analysis revealed that the state of flame propagation, starting from any given cycle and continuing in subsequent cycles, shows a tendency similar to that of the initial cycle for some time, and that the original tendency is completely lost after about 50 cycles.

6. Paper No.(JSAE/SAE)	20229053 / 2022-32-0053
7. Paper title	Local change of PV value on end faces of rocker pins of chain type CVT (Continuously Variable Transmission) under transmitting condition
8. Authors (Affiliation)	Ryunosuke Kikui (Graduate School of Doshisha University), Kiyotaka Obunai, Kazuya Okubo (Department of Mechanical Engineering, Doshisha University), Kouhei Toyohara, Kyohei Watanabe, Hui Jin (Hardware System Development Department, JATCO Ltd)

9. Abstract

The objective of this study was to investigate the local change of PV value on the end faces of rocker pins driven by a high-performance chain under transmitting torque conditions. A test bench system was prepared to evaluate the behavior of the chain belt under driven state. Local contact force of the pin was measured by strain gauges attached to a specific modified pin for which the thickness was partly reduced by machine work. Change of PV value on the end face of the pin was also calculated by considering the change of pressure generated by contact force and sliding velocity of rocker pin. Autorotation angles of the rocker pins in the groove of driving and driven sheaves were investigated by replacing the normal pulleys with visibly transparent sheaves made with acrylic resin. The representative loading points were also calculated assuming that the pin was regarded as a simple beam where an eccentric compressive load was applied. Test results showed that slight bending deformations of the pins were observed when severe contact force was applied between pin and sheave. The observations also revealed that the angles of following pins of the chain belts rapidly changed at entrance and exit of the groove of driving pulley when the wrapping radius of the chain belts was relatively small. This study found that local change of PV value was increased by off-setting of the representative loading position where contact force between pin and sheave was regarded to be applied at the point during autorotation of the pin.

Abstracts of Technical Sessions

1. Date	**Tuesday, November 1**
2. Room	**Room 408**
3. Time	**11:00 - 12:00**
4. Session	**Emission and Environmental Impacts**
5. Chair (Affiliation),	**Wataru Yamamoto (Kawasaki Motors, Ltd.)**
Co-chair (Affiliation)	**Christoph V. Hiller (Andreas Stihl AG & Co. KG)**

6. Paper No.(JSAE/SAE)	20229019 / 2022-32-0019
7. Paper title	Research for "Trap Catalyst" located on upper stream of main catalyst for suppressing the catalyst deterioration of internal combustion engine
8. Authors (Affiliation)	Daisuke MATSUKAWA, Akihito KASAI, Kiichi SHIMAMURA, Shuto SATO (Honda R&D Co., Ltd.)

9. Abstract

As strengthening environmental regulations, exhaust gas emission regulation for internal combustion engines used for Small Off-Road Engines is increasingly strict. The decrease in "the initial exhaust emissions before durability test" and in "the deterioration of exhaust emissions after durability test" is important to meet the strict regulation. In this report, electrical power generator EU7000is using a general purpose engine was investigated and the catalyst deterioration was focused on for the deterioration of exhaust emissions after durability test. It was turned out that the main factor for the deterioration of exhaust emissions after durability test was the catalyst deterioration by the investigation of Deterioration Factor (DF) durability test. The causes of the catalyst deterioration are roughly classified into two types, "Thermal Deterioration" and "Poisoning Deterioration". The thermal deterioration is that precious metal specific surface area decreases by heat affect. The poisoning deterioration is that the catalyst is covered by the poisoning components derived from the engine oil or the engine fuel. The catalysts were analyzed about the poisoning components quantitative analysis by X - ray Fluorescence (XRF). The results showed that the phosphate amount is highly correlated with the purification rate decreasing. Therefore, the catalyst without precious metals which has same structure as main catalyst, (hereinafter referred as Trap Catalyst), was located on upper stream of main catalyst. The phosphate amount of poisoned catalyst decreased by the Trap Catalyst taking on the phosphate. These results implies that this technology contributes to reduce the environmental impact.

6. Paper No.(JSAE/SAE)	20229091/ 2022-32-0091
7. Paper title	Observation / PIV-DDM Analysis of Spray and Liquid Film Behaviors in Visualized Pipe for Urea-SCR dosing system: Confirmation of Physical Phenomena without Thermal Evaporation
8. Authors (Affiliation)	Naoki SUGIYAMA, Shotaro NARA, Yuki KAWAMOTO, Rina OSADA, Hiroki ONOUE , Tetsuo NOHARA, Shun TAKAHASHI, Masayuki OCHIAI (Tokai University, Japan), Kazuo OSUMI, Hisashi OZAWA, Naoya ISHIKAWA (ISUZU Advanced Engineering Center, Japan)

9. Abstract

Diesel engines as power sources ranging in size from small to large have been extensively used worldwide. However, further improvement in the complicated urea-SCR systems is required to meet the stricter NOx regulations on exhaust gas.
This study shows that the behavior of the entire gas/injected droplet can be verified using visualization equipment.
Valuable gas-liquid multiphase flow PIV results using the DDM were obtained. In addition, the detachment droplet behavior from the liquid film was visualized as unknown droplet behavior. These validations are considered to be useful for establishing the PIV-DDM for the flow characteristic estimation in the exhaust pipe of the urea-SCR system.

Abstracts of Technical Sessions

1. Date	**Tuesday, November 1**
2. Room	**Room 409**
3. Time	**10:30 - 12:00**
4. Session	**Renewable Energy and Alternative fuels 3 of 5**
5. Chair (Affiliation),	**Koji Yoshida (Nihon University)**
Co-chair (Affiliation)	**Maurice Kettner (Hochschule Karlsruhe University of Applied Sciences)**

6. Paper No.(JSAE/SAE)	20229088/2022-32-0088
7. Paper title	Verification of New Hydrogen Refueling Method for Fuel Cell Motorcycles
8. Authors (Affiliation)	Fumiaki Baba, Takeru Wakiya, Toru Ota, (SUZUKI MOTOR CORPORATION)

9. Abstract

For FCV, hydrogen refueling protocol is standardized in SAE J2601 and JPEC-S 0003.And, tank gas is required not to exceed 85°C at any case. Therefore, supply hydrogen gas is precooled from -33°C to -40°C, and look-up table(L/T) determines a pressure ramp rate and a target pressure, based on ambient temperature and CHSS initial pressure.
Suzuki have conducted public road trials for FC motorcycles named "Burgman Fuel Cell", which got Japanese type approval, from March, 2017 to March, 2019. Burgman Fuel Cell storages 0.4kg hydrogen at 70MPa. As CHSS capacity is categorized only over 2kg in JPEC-S 0003(2016), we refueled them by JPEC-S 0003(2012), which has no CHSS capacity categories. And it sometimes happened to terminate the fueling before reaching target pressure, around 70MPa.
This termination happens because mass flow to Motorcycle is much smaller than that to Automobile, therefore precooled supply gas temperature is easier to rise until reaching breakaway, where delivery gas temperature is measured at station. MC Formula is the derivative fueling protocol from L/T protocol in SAE J2601, and it changes Pressure Ramp Rate continuously according to supply gas temperature at breakaway. Therefore, it is expected to execute more flexible refueling. Then MC Formula Moto was developed based on MC Formula under JARI hydrogen refueling interface standardization WG from the year 2013 to 2017. ...

6. Paper No.(JSAE/SAE)	20229092/2022-32-0092
7. Paper title	Effect of Different Fuel Supply System on Combustion Characteristics in Hydrogen SI Engine
8. Authors (Affiliation)	Shoi Koshikawa, Yuki Matsuy, Tsukasa Sekine, Eriko Matsumura, Jiro Senda (Department of Science and Mechanical Engineering, Doshisha University) Gin Morita, Toru Nakazono (Yanmar Holdings Co., Ltd)

9. Abstract

In recent years, power generation systems using hydrogen gas, has attracted attention as one solution to the problem of global warming. Different from hydrocarbon fuels, hydrogen gas is a carbon-free fuel that emits only water on combustion. Japanese government declared reduction of greenhouse gas emissions 46% by FY2030 compared to FY2013 and carbon neutral by FY2050. Hydrogen gas is regarded as a key technology for carbon neutral, because it can be produced in a variety of ways. Among them, green hydrogen is produced by electrolysis of water using surplus electricity from renewable energy sources. Therefore, it is a clean fuel that does not emit carbon dioxide on well-to-wheel. By using green hydrogen to generate electricity, the power of variable renewable energy can be maximized. For this reason, the use of hydrogen is expected to increase in the future.
Hydrogen gas has excellent combustion characteristics such as wide combustible range and fast burning velocity because of high diffusion rate. ...

6. Paper No.(JSAE/SAE)	20229043/2022-32-0043
7. Paper title	Combustion Performance of Methane Fermentation Gas with Hydrogen Addition under Various Ignition Timings
8. Authors (Affiliation)	Hongliang LUO (Graduate School of Science and Engineering, Hiroshima University), Yu Jin (Institute of Energy Research, Jiangsu University), Yanzhao An (State Key Laboratory of Engine, Tianjin University), Yukihiko Matsumura, Takayuki Ichikawa, Wookyung Kim, Yutaka Nakashimada, Keiya Nishida (Graduate School of Science and Engineering, Hiroshima University)

9. Abstract

Natural gas with H2 is widely used for lean-burn combustion, which leads to NOx emission as the main problem for it. For decreasing NOx emission and increasing thermal efficiency, the investigation on seeking the influence of H2 fractions on the mixture of CH4 and CO2 was conducted. Firstly, the ignition timing was decided through thermal efficiency and brake mean effective pressure (BMEP) for CH4 only. Then, combustion characteristics of CH4, CH4+CO2 and CH4+CO2+H2 were compared with volume percentage of H2 changing from 5% to 30%. Finally, the H2 injection strategy was checked between closed and open valve injections. Among these discussions, thermal efficiency, power output, BMEP and fuel consumption were evaluated. Results show that CO2 addition decreases power output and BMEP, leading to much more fuel consumption and lower thermal efficiency. When H2 is added, at the rich mixture conditions ($\lambda<1.0$), power output and thermal efficiency decrease sharply as the mixture is enriched. However, at the lean-burn conditions ($\lambda>1.0$), the decrease in flow rate of lower heating value (LHV) and increase in power output finally result in the higher efficiency with H2 addition. ...

Abstracts of NPT Sessions

1. Date	**Tuesday, November 1**
2. Room	**Exhibition Hall C**
3. Time	**10:30 - 12:00**
4. Session	**New Product Technology Part 4 of 10**
5. Chair (Affiliation),	**Jun Ishikawa (Honda Motor Co., Ltd.)**
Co-chair (Affiliation)	**Dominik Gschanes (Graz University of Technology)**

6. Paper Number	NPT2022-031
7. Paper title	Chassis development of Motorcycle with integrated aerodynamic devices
8. Authors (Affiliation)	Tomo Yamamoto, Takashi Nishiyama, Yosuke Takeda, Manabu Morikawa, Masaki Segawa (Kawasaki Motors, Ltd.)

9. Abstract

In recent years, motorcycles equipped with high-power engines exceed the acceleration limit of the vehicle due to their great power, and wheelies are easily generated. This acceleration limit is also called the Willie limit. Although it is possible to suppress the wheelie by reducing engine power through electronic control, it is not possible to exceed the wheelie limit determined by the vehicle's basic performance.
On the other hand, increasing the downforce increases the force pushing the vehicle to the ground, thus increasing the wheelie limit itself. The ability to suppress wheelies without suppressing engine power, which contributes to the improvement of acceleration and lap time, has been a trend in the development of racing vehicles since the late 2010s, with the development of vehicles in which the cowling is fitted with aerodynamic devices with a cross-section of wings. There is also a similar trend in the commercial vehicles to which the technology feedback is directed.
However, it is difficult to apply aerodynamic devices for racing vehicles directly to commercial vehicles because of compliance with laws and regulations and poor productivity. In addition, there are safety issues unique to commercial vehicles, such as increased aggressiveness toward opponents in traffic accidents.
In this paper, by developing a cowling-integrated aerodynamic device that solved these problems, we were able to achieve a significant reduction in lift. First, the design concept of lift/drag reduction for the development is explained. Next, the peripheral technology to realize it and its component details are explained.

6. Paper Number	NPT2022-003
7. Paper title	2021 Model ROV WOLVERINE RMAX2/RMAX4
8. Authors (Affiliation)	Toshikazu Sugiura, Hiro Noguchi, Makoto Eshima, Shinichiro Nakamura, Fumihiro Hidaka (Yamaha Motor Co., Ltd.)

9. Abstract

Principally in North America, the ROV (Recreational OffHighway Vehicle) market enjoys high demand with its wide range of uses from agricultural and dairy farming work to recreational uses such as hunting and trail driving, as well as for sports driving and racing. Demand is expected to increase further in the future. To cover this wide range of uses, since 2013 Yamaha Motor has developed and launched the VIKING, the WOLVERINE, and the YXZ series of models.
The WOLVERINE, which is a model mainly targeted for recreational use, follows the 4-seater WOLVERINE X4 equipped with a 2-cylinder 847 cm3 engine. The model lineup has been expanded by introducing the two-seater 2019 model WOLVERINE X2 with a dump bed structure.
Here, as a high-end model, we introduce the simultaneously developed WOLVERINE RMAX2/RMAX4 (hereinafter referred to as this model) equipped with a 2-cylinder 999 cm3 engine for enjoyment driving in a range of areas more comfortably and with greater confidence.

6. Paper Number	NPT2022-021
7. Paper title	Styling Design for Gold Wing - Clay Model –
8. Authors (Affiliation)	Hidekazu Iwata (Honda R&D Co., Ltd.)

9. Abstract

Seventeen years post its debut, the 2018 Gold Wing was developed in the pursuit of transforming its brand. In this study, we aimed to realize advanced design, functionality, and performance that reflect various changes in the markets, including environmental concerns and transitions in people's values, experienced during those 17 years. A high-quality design that meets every aspect of the requirements was envisioned. To achieve this, design models were fabricated for three individual stages of the design process. The styling theme was determined as “styling with refined sharpness and tension.” Based on this theme, we selected the Japanese sword, katana, that symbolizes the culmination of functional beauty, and a track and field athlete, who represents power and muscularity; we set them as the symbolic images for the design. By implementing these image motifs on to the design models, the exterior design aimed for was harmoniously fulfilled with functional requirements, design evolution was achieved, and a design appropriate to representing the developed Gold Wing was established.

1. Date	Tuesday, Novenber 1
2. Room	Room 407
3. Time	15:00 - 16:30
4. Session	Adovanced Combustion Part 4 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Tatsuya Kuboyama (Chiba University) Kai Beck (Andreas Stihl AG & Co. KG)

6. Paper No.(JSAE/SAE)	20229027 / 2022-32-0027
7. Paper title	Hot Surface Assisted Compression Ignition (HSACI) as an Approach to Extend the Operating Limits of a Natural Gas Fueled HCCI Engine
8. Authors (Affiliation)	Joern Alexander Judith, Maurice Kettner (Karlsruhe University of Applied Sciences), Danny Schwarz, Markus Klaissle (SenerTec Kraft-Wärme-Energiesysteme GmbH), Thomas Koch (Karlsruhe Institute of Technology)

9. Abstract

The concept of hot surface assisted compression ignition (HSACI) was previously shown to allow for control of combustion timing and to enable combustion beyond the limits of pure homogeneous charge compression ignition (HCCI) combustion. This work investigates the potential of HSACI to extend the operating limits of a naturally aspirated single-cylinder natural gas fueled HCCI engine. A zero-dimensional (0D) thermo-kinetic modeling framework was set up and coupled with the chemical reaction mechanism AramcoMech 1.3. The results of the 0D study show that reasonable ignition timings in the range 0-12°CA after top dead center (TDC) in HCCI can be expressed by constant volume ignition delays at TDC conditions of 9-15°CA. Simulations featuring the two-stage combustion in HSACI point out the capability of the initial heat release as a means to shorten bulk-gas ignition delay. Engine trials were conducted to map the operating limits in HCCI and HSACI mode for an engine speed of 1400 1/min as a function of intake air temperature (148-173°C) and relative air-fuel ratio (l = 2.0-3.0). Results show that HSACI extends the lean limit by more than Δl = 0.4 and reduces the minimum required intake temperature by at least 5 K compared to HCCI. Comparative experiments of HCCI and HSACI reveal that HSACI benefits from higher engine load, …

6. Paper No.(JSAE/SAE)	20229051 / 2022-32-0051
7. Paper title	Extension of the Lean Limit of Gasoline Engines Under Part Load by Using Hot Surface Assisted Spark Ignition (HSASI)
8. Authors (Affiliation)	Sascha Holzberger, Maurice Kettner (University of Applied Sciences Karlsruhe), Roland Kirchberger (Graz University of Technology)

9. Abstract

Charge dilution by lean-burn is one way to increase the efficiency of spark ignition engines while reducing NOx emissions. This work focuses on increasing the flammability of lean mixtures inside a passive pre-chamber spark plug by elevating its temperature with the help of a controllable hot surface integrated into the pre-chamber. Thus, an extension of the lean limit under part load is aimed for. A pre-chamber spark plug prototype with an integrated, controllable glow plug was developed, called Hot Surface Assisted Spark Ignition (HSASI). Experimental investigations were conducted on a single-cylinder engine at the Karlsruhe University of Applied Sciences. Operating modes with an active glow plug (HSASI) and a non-active glow plug were compared. The lean limit for both operation modes were determined under part load. NOx, CO and THC emissions were measured for different air-fuel equivalence ratios λ. The lean limit is extended by more than 0.1 in λ at low loads with HSASI operation. At constant λ, lower CO and THC emissions are achieved under HSASI operation than in operation with a non-active glow plug. NOx-emissions are higher with an active glow plug at lower λ and align with higher λ…

6. Paper No.(JSAE/SAE)	20229060 / 2022-32-0060
7. Paper title	Experimental Assessment of the Heat Losses Due to the Adoption of a Passive Prechamber in a Jet Ignition 4-Stroke Engine
8. Authors (Affiliation)	Luca Romani, Lorenzo Bosi, Marco Ciampolini, Sandro Raspanti, Francesco Balduzzi, Giovanni Ferrara (Università degli Studi di Firenze), Paolo Trassi, Jacopo Fiaschi (Betamotor s.p.a.), Davide Carpentiero, Alessandro Fabbri (HPE s.r.l.)

9. Abstract

The passive prechamber concept, known as jet ignition (JI), represents an effective way to promote mixture ignitability, reduce combustion duration and extend knock limits in spark ignition engines. These aspects allow the adoption of a higher compression ratio and the operation in lean conditions, thus increasing thermal efficiency. Despite the potential benefits, the literature typically shows that in port fuel injection (PFI) engines at full load a shorter combustion duration does not necessarily translate in a growth of IMEP. Despite this issue has been frequently observed, the causes have not been fully explained. In previous works some of the authors supposed that the gain in indicated efficiency could be counterbalanced by the lower adiabatic efficiency, as a result of the higher heat exchange coefficient and the additional heat transfer from the prechamber surface. This paper thus aims at explaining the thermal losses of a single-cylinder four-stroke PFI engine, both in baseline and passive JI configurations, by means of the experimental measurement of the thermal power released to cooling system and exhaust gas. Results show a decrease of IMEP in the JI engine at low and medium speed, caused by the high heat transfer to the cooling medium which prevailson the lower heat flux released to the surrounding ambient…

Abstracts of Technical Sessions

1. Date	Tuesday, November 1
2. Room	Room 408
3. Time	15:00 - 16:30
4. Session	Engine Components and Fuel Supply Systems Powertrain Controls
5. Chair (Affiliation), Co-chair (Affiliation)	Shigeho Sakoda (Yamaha Motor CO., LTD) Mikael Bergman (Orbital Corporation Ltd)

6. Paper No.(JSAE/SAE)	20229035 / 2022-32-0035
7. Paper title	A Novel Direct Gaseous Reformate Injector Design and Experimental Study
8. Authors (Affiliation)	Asher Netzer-Lichinitzer, Leonid Tartakovsky (Technion – Israel Institute of Technology)

9. Abstract

Recent developments in High-Pressure Thermochemical Recuperation technology in the Technion – Israel institute of Technology, were first to allow engines to work on a hydrogen-rich reformate as a stand-alone fuel by its direct injection (DI) to the combustion chamber. This was achieved by using a Magneti Marelli gasoline direct injector, IHP072, modified to enable the gaseous reformate injection. However, this injector, under the used working conditions, suffered from a low flow cross section, non-reliable closure and a non-optimized jet structure, which had a detrimental effect on engine performance. In order to optimize engine performance, i.e. to achieve higher flow rate, shorter open-close timing and higher backward pressure resistance (in the cylinder), an improved injector is needed. In the present work, a novel DI injector was designed producing over expanded reformate jet.
One of the main features of the new injector is an outward-opening valve)POPPET valve) with a relatively high flow cross section. Furthermore, a number of elements have been incorporated in the injector design to allow rapid and convenient calibration of the valve lift, sealing force and the magnetic force. Those in turn, enable optimized injector configuration that is well-suited for different working conditions (such as different in-line pressure or flow rates).
In this work, the direct-gaseous-injector design process is reported, and its operation is optimized and investigated.

6. Paper No.(JSAE/SAE)	20229009/2022-32-0009
7. Paper title	Wasted spark duration measurement as a method for firing TDC identification in small engines
8. Authors (Affiliation)	Adrian Irimescu (Consiglio Nazionale delle Ricerche Science and Technology Institute for Sustainable Energy and Mobility), Giovanni Cecere (CNR STEMS), Simona Silvia Merola (Consiglio Nazionale delle Ricerche)

9. Abstract

Distributed generation is one effective option for reducing transmission losses and reducing overall power system complexity. Backup power is another option that can serve as a balancing power source, providing a valuable safety margin in the event of widespread renewable energy deployment. Spark-ignition (SI) engines are often used in such applications, but fixed ignition timing with the so-called wasted spark method, in which the engine is ignited twice, once at compression and once at exhaust, is more common.
Against this background, we developed a method to identify the TDC phase based on current measurements of the engine's secondary ignition circuit to create a system that does not generate wasted sparks. The only modification to this ignition system was to change the coil to an automotive one. The duration of the actual spark event was found to be the parameter that distinguishes whether the ignition occurred during the compression stroke or the exhaust. The statistical distribution during a sequence of 200 cycles was also utilized to make the determination. This paper discusses the limitations of the method and the possibilities for improving its application.

6. Paper No.(JSAE/SAE)	20229048/2022-32-0048
7. Paper title	Increased Reliability and Usability through the Introduction of a User Interface Module for Hand-Held Small Engines
8. Authors (Affiliation)	Bahattin Öztürk, Thorsten Stoffregen (PRUFREX Engineering e Motion GmbH & Co. KG)

9. Abstract

Mobile hand-held or back-carried small engines must be weight-optimized due to their operability. At the same time there is enormous cost pressure within this market segment. As a result, not all of the convenience and additional features for increasing user-friendliness can be taken over from the stationary applications. These include, for example, electrical starting devices or additional sensors and actuators that take over extended control processes in order to avoid or detect and report user or system errors.
In the area of critical applications there are tougher requirements for the reliability and operability, where the above mentioned conditions can lead to catastrophic consequences.
This article describes a possibility to extend a mobile, back-carried engine, which is used as a wildfire water pump by fire brigades, with an additional user interface to minimize the demands on the user and to ensure immediate feedback in case of a failure, so that measures can be initiated as quickly as possible without the need for extensive troubleshooting.

Abstracts of Technical Sessions

1. Date	Tuesday, November 1
2. Room	Room 409
3. Time	15:00 - 16:30
4. Session	Renewable Energy and Alternative Fuels 4 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Toru Nakazono (Yanmar Holdings/LEMA) Maurice Kettener (Hochschule Karlsruhe University of Applied Sciences)

6. Paper No.(JSAE/SAE)	20229084/2022-32-0084
7. Paper title	Effect of Gaseous Fuels with Different Carbon Numbers on Autoignition Properties
8. Authors (Affiliation)	Shinji Mito (Graduate School of Science and Technology, Nihon University), Akira Iijima (College of Science and Technology, Nihon University), Yusuke Manabe (Graduate School of Science and Technology, Nihon University), Shintaro Yoshihara, Takahiro Yamaguchi, Sekai Miyamoto (Thermal System Research Department, Technical Institute, Corporate Technology Division Kawsaki Heavy)

9. Abstract

Internal combustion engines have been required to achieve even higher thermal efficiency and cleaner exhaust emissions in recent years in order to comply with increasingly tighter environmental regulations every year owing to global warming and other environmental issues. Another factor involved here is that global energy demands have prompted a quest for alternatives to liquid fuels such as gasoline, diesel fuel and other petroleum-derived fuels. Homogeneous Charge Compression Ignition (HCCI) engines, featuring higher compression ratios and uniform, lean combustion, are a promising technology for improving the efficiency and reducing the emissions of internal combustion engines. However, it is difficult to control the ignition timing of HCCI engines [1],[2] because they lack any physical means of controlling ignition. This study focused on gaseous fuels that can be used as alternatives to petroleum-based ones. Gaseous fuels like natural gas are a mixture of component gases so changes in their composition influence autoignition characteristics. However, the detailed mechanism by which gas mixture components influence the HCCI ignition process is not known. The purpose of this study was to obtain valuable knowledge for achieving high-efficiency HCCI engine operation on gaseous fuels by making clear HCCI ignition and combustion properties for gaseous fuel blends. …

6. Paper No.(JSAE/SAE)	20229095/2022-32-0095
7. Paper title	Improvements of Combustion and Emissions in a Natural Gas Fueled Engine with Hydrogen Enrichment and Optimized Injection Timings of the Diesel Fuel
8. Authors (Affiliation)	Yoshimitsu Kobashi (Okayama University), Ryuya Inagaki, Gen Shibata, Hideyuki Ogawa (Hokkaido University)

9. Abstract

In a natural gas fueled engine ignited by diesel fuel, the addition of hydrogen to the engine could be a possible way to improve thermal efficiency and reduce unburned methane which has a warming potential many times that of carbon dioxide as it promotes a more rapid and complete combustion. This study carried out engine experiments using a single cylinder engine with natural gas and hydrogen delivered separately into the intake pipe, and with pilot-injection of diesel fuel. The percentages of hydrogen in the natural gashydrogen mixtures were varied from 0% to 50% of the heat value. The results showed that the hydrogen addition has an insignificant effect on the ignition delay of the diesel fuel and that it shortens the combustion duration. The increase in the hydrogen ratio decreased the unburned hydrocarbon emissions more than the reduction of the amount of natural gas that was replaced by the hydrogen. Further, the direct injection timing of the diesel fuel was varied from early in the compression stroke to near top dead center to determine the optimum combinations of the hydrogen ratio and direct injection timing. …

6. Paper No.(JSAE/SAE)	20229073/2022-32-0073
7. Paper title	Effect of Blended Fuel of Hydrotreated Vegetable Oil and Fatty Acid Methyl Ester on Spray and Combustion Characteristics
8. Authors (Affiliation)	Shoi Koshikawa, Eriko Matsumura, Jiro Senda, (Department of Mechanical Engineering, Doshisha University)

9. Abstract

Research on alternative fuels is necessary to reduce CO2 emissions. Hydrotreated Vegetable Oil (HVO) of light fuel physically improves spray and combustion characteristics. Fatty Acid Methyl Ester (FAME) is an oxygenated fuel and its combustion characteristics are chemically improved, although its spray characteristics such as penetration and atomization are deteriorated. The purpose of this study is to understand the effects of blending HVO, which has carbon neutral (CN) characteristics, with FAME, which also has CN characteristics, on spray and combustion characteristics, and to further improve emission such as THC and Smoke. This report presents the effect of the combination of improved spray characteristics and oxygenated fuel on emissions. Spray characteristics such as penetration, spray angle and spray volume were investigated by shadowgraph photography. Also, combustion characteristics such as heat release rate and emission were investigated using a single-cylinder diesel engine. As a result, with blending of HVO and FAME, by increasing the percentage of HVO, lower the fuel density and kinematic viscosity, forming a low penetration and high dispersion spray. In addition, entrainment is promoted and the spray volume tends to increase. The emission performance was found to be significantly affected by chemical effects. Furthermore, blended fuel can reduce THC and Smoke emissions compared to gas oil, while keeping the same NOx levels. …

Abstracts of NPT Sessions

1. Date	**Tuesday, November 1**
2. Room	**Exhibition Hall C**
3. Time	**15:00 - 16:30**
4. Session	**New Product Technology Part 5 of 10**
5. Chair (Affiliation),	**Yuji Araki (Yamaha Motor Co., Ltd.)**
Co-chair (Affiliation)	**Dimitrios Vogiatzis (Graz University of Tecnology)**

6. Paper Number	NPT2022-001
7. Paper title	Development of generator EU3200i equipped with new engine GX130
8. Authors (Affiliation)	Hiroshi Koyama, Mitsutoshi Hirata (Honda R&D Co., Ltd.)

9. Abstract

The North American inverter–generator market is continually expanding because of the high demand for camper-van power sources and other leisure-sector applications. The most widely-used generators are in the 2-kVA class; however, in recent years, the market for the 3-kVA class has increased. Portability is important in the leisure market because generators are often carried to and from vehicles by hand. We have developed a new 3-kVAclass inverter–generator, the EU3200i that is portable and can be used to power various home appliances for leisure use. This generator adds several new technologies to the existing 2-kVA-class EU2200i and has limited increase in size and mass while achieving high output and enhanced usability. First, the alternator contains a neodymium bond magnet, and the dedicated GX130 engine has small displacement, high rotation, and a high compression ratio; both alternator and engine are compact and powerful.
Second, the generator features Honda Power Products' first battery-free fuel-injection system, realizing easy start-up while suppressing fuel consumption by stoichiometric feedback operation. Finally, the packaging has a resin monocoque structure instead of reinforcing frame members; this achieves the same noise level as in earlier models but with less mass. Owing to these innovations, the EU3200i, with a power-to-mass ratio enhanced by 15% compared to the previous model, outperforms other models in the 3-kVA class in terms of compactness (79 L) and mass (26.8 kg).

6. Paper Number	NPT2022-005
7. Paper title	Development of the FX820V air-cooled V-Twin engine for lawn mowers
8. Authors (Affiliation)	Yasutaka Kobayashi (Kawasaki Motors, LTD)

9. Abstract

Mainly vertical air-cooled V-Twin engines have been used for lawn mowers. In recent years, in the field of lawn mowers, there has been a demand for environmentally friendly products while electric powered products have gradually started to be marketed mainly for residential lawn mowers. However, unlike residential lawn mowers that have small deck-size chassis and short operating times, it is difficult to electrify commercial lawn mower products that are mounted on large deck-size chassis and require high output performance and long operating times. Internal combustion engines will continuously be used for this category.
Our company has already developed two generations of aircooled V-Twin engines and in those developments the reliability of the engines has been improved. However, in order to meet and comply with severe environmental regulations expected in the future, it was considered necessary to develop a third-generation engine with a significantly revised intake and combustion systems.
Therefore, the development of the new engine focused on the reduction of intake air loss related to intake air restrictions, the improvement of thermal efficiency by a high compression ratio, and the improvement of combustion with the enhancing of tumble flow of the intake air in the cylinder and combustion chamber.
This paper will introduce the newly developed thirdgeneration "FX820V" engine, which has a high compression ratio, 3 valves per cylinder (Intake 2, Exhaust 1), and small throttle body, to improving output performance, fuel economy, and exhaust gas emission values.

6. Paper Number	NPT2022-002
7. Paper title	Development of Titanium-Oxide Heated Exhaust Gas Oxygen Sensor for Advanced Engine Management system in Small Motorcycles Applications
8. Authors (Affiliation)	Akhilesh Jain, Rajesh Pandian (Napino Auto & Electronics Limited), Ken Ervin Fosaaen (Kerdea Technologies)

9. Abstract

With the growing need for reduction in greenhouse gas emissions through vehicular tailpipe emission, it is required to optimize internal combustion engine technology & its supportive components and increase the fuel efficiency to the maximum possible.
Although many developing countries like India have switched from carburetors to electronic fuel injection (EFI) systems in two-wheelers, there are more that can be achieved for the reduction of tailpipe emissions.
An oxygen sensor is a necessary component in an electronic fuel injection system to have closed-loop engine control.
Currently, automotive oxygen sensors are big, require too much power for heater control, and are far too expensive to be suitable for most global small engine applications.
To keep costs down, many motorcycle applications are using unheated sensors. Additionally, these small motorcycles have a low exhaust temperature after starting, so it takes time even for the zirconia-oxide HEGO sensor to stabilize. Also, the convergence of λ control may be delayed due to the reactivity in the close vicinity of stoichiometry. Whereas the resistivebased Titanium-Oxide HEGO sensor, which is very sensitive to oxygen concentration and has shown fast response time, allows utilizing this advantage for finer lambda control, improving the tailpipe emissions. It can also be expected to improve fuel efficiency.
Authors developed a Titania HEGO Sensor design to make it cost-effective, robust, compact, and able to customize considering small engine applications. The authors have also validated the vehicle performance of this technology in terms of Emission, Response time by benchmarking the Zirconia HEGO Sensor.
For the sensor design, the gas-sensitive metal-oxidesemiconductor (MOS) layer thickness is optimized using rigorous and diverse trials. It possesses good resistance against water splash and its sensitivity enables the engine management system for detecting misfires. The heater design is optimized to achieve the optimum temperature required for the activation of the sensor hence, power consumption is minimal, and the mechanical design is optimized to fit in the compact mounting.

1. **Date** **Tuesday, November 1**
2. **Room** **Room 407**
3. **Time** **17:00 - 18:00**
4. **Session** **Advanced Combustion Part 5 of 5**
5. **Chair (Affiliation),** **Tatsuya Kuboyama (Chiba University)**
   Co-chair (Affiliation) **Dimitrios Vogiatzis (Graz University of Technology)**

6. Paper No.(JSAE/SAE)	20229070 / 2022-32-0070
7. Paper title	Effects of Ignition Timing and Fuel Chemical Composition on Autoignition Behavior and Knocking Characteristics under Lean Conditions
8. Authors (Affiliation)	Kaede Shirane, Toshiki Kimura, Sota Nakamura (Graduate School of Science and Technology, Nihon University), Karin Furusyo, Akira Iijima (Nihon University)

9. Abstract

This study focused on autoignition behavior and knocking characteristics. Using an optically accessible engine, autoignition behavior was observed over the entire bore area, and the relationship between autoignition behavior and knocking characteristics was clarified on the basis of visualized combustion images and frequency analysis of the in-cylinder pressure waveform. In addition, chemical kinetic simulations were used to investigate the effects of different fuel chemical compositions on combustion and autoignition characteristics under equivalent octane ratings. The results showed that the rate of autoignition development has a significant effect on knocking intensity. In addition, the ρ1,0 mode is the dominant vibration mode caused by knocking, regardless of the location of autoignition. It can be inferred that strong knocking is caused by multiple vibration modes. Furthermore, chemical kinetic simulation results and experimental data show that different fuel chemical compositions affect the onset of autoignition.

6. Paper No.(JSAE/SAE)	20229089 / 2022-32-0089
7. Paper title	Chemical Kinetic Analysis with Two-Zone Model on Spark Knock Suppression Effects with Hydrogen Addition at Low and High Engine Speeds
8. Authors (Affiliation)	Jun Goto (Yamaha Motor Co., Ltd, Hokkaido University), Yoshimitsu Kobashi, Yoshito Ueno, Gen Shibata, Hideyuki Ogawa (Hokkaido University), Minoru Yamamoto (Yamaha Motor Co., Ltd)

9. Abstract

Spark knock suppression with hydrogen addition was investigated at two engine speeds (2000 rpm and 4800 rpm). The experimental results showed that the spark knock is strongly suppressed with increasing hydrogen fraction at 2000 rpm while the effect is much smaller at 4800 rpm. To explain these results, chemical kinetic analyses with a twozone combustion model were performed. The calculated results showed that the heat release in the end gas zone rises in two stages with a remarkable appearance of low temperature oxidation (LTO) at 2000 rpm, while a single stage heat release without apparent LTO process is presented at 4800 rpm due to the shorter residence time in the low temperature region. The mechanism of the spark knock suppression with hydrogen addition can be explained by inhibition of the LTO reactions and H2O2 loop reactions by the OH radical consuming reaction with hydrogen, leading to a reduction in the heat release from hydrocarbon fuel at the initial stage of the ignition process. However, the OH radical is simultaneously produced from H radical with hydrogen addition at the later stage of the ignition process. The reduction in the heat release with hydrogen addition can only be obtained at the initial stage of the ignition process, and the differences in spark knock suppression with hydrogen addition under low and high engine speeds are due to absence or appearance of LTO at the initial stage of the ignition process.

Abstracts of Technical Sessions

1. Date	Thursday, November 1
2. Room	Room 408
3. Time	17:00 - 18:00
4. Session	Vehicle Dynamics and Safety part 1 of 3
5. Chair (Affiliation), Co-chair (Affiliation)	Hisayuki Sugita (SUZUKI MOTOR CORPORATION) Alexander Hagenberger (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229086 / 2022-32-0086
7. Paper title	One Systematic Design Method and Control PerformanceEvaluation of Heading Control System in Pleasure Boats
8. Authors (Affiliation)	Naoki Imamura (Advanced Technology R&D Center, Mitsubishi Electric Corporation), Ryo Sakaguchi (Mitsubishi Electric Corporation)

9. Abstract

The pleasure boat intended in this paper is an outboard motorboat equipped with an outboard motor operating a propeller thrust and a steering angle. Outboard motor boats have a wide variation in the number of outboard motors to be equipped with depending on the size and a shape of the boat itself, and the environmental disturbances peculiar to a boat such as tidal currents and winds greatly influences the heading control performance. Therefore, it is necessary to realize a robust heading control response to environmental disturbances regardless of the variation of boats. There are two challenges for realizing such heading control response. One challenge is ensuring the stability of the control system in the entire speed region from the low-speed region for fishing applications to the high-speed region for mobile applications to which the autopilot function is applied. The other one is the suppression of the deviation in the response time of the heading control response. In response to these challenges, the authors proposed one systematic design method of heading control system to stabilize the control response in the entire vessel speed region to which the autopilot function is applied. We proved the validity of the proposed design method through the cruising test on the boats equipped with the designed heading control system and the numerical simulation.

6. Paper No.(JSAE/SAE)	20229082/2022-32-0082
7. Paper title	Estimation of Vehicle Attitude of Off-road Motorcycles Integrating Small and Lightweight On-board Equipment in Motocross and Cross-country
8. Authors (Affiliation)	Yuki Uto, Shinichi Inoue, Kazuto Yano (Kawasaki Motors, Ltd)

9. Abstract

Among others, off-road motorcycles are subject to changes in road surface conditions depending on weather conditions, and the influence of riding operation on their behavior is significant. Therefore, for consistent evaluation of handling stability, it is effective to quantitatively understand the amount of riding operation and vehicle behavior through data measurement. However, when riding off-road motorcycles, the impact on the vehicle is large, and there are problems with the impact resistance of the measurement equipment. There is also a high risk of damage to sensors due to entrapment of mud or stones, etc. Therefore, when using high-precision sensors, it is necessary to proceed with careful operational verification. In particular, since off-road motorcycles are designed to be lightweight, measurement equipment for them must be lightweight as well and compact enough to avoid possible large impact on the vehicle's dynamic characteristics. Due to such strict requirements for data measurement, there have been few reports on vehicle behavior because measurement and analysis have not been sufficiently conducted. Therefore, in this study, we focused on the measurement and analysis of vehicle attitude caused by riding operation, which is a typical vehicle behavior, with the measurement equipment mounted in such a way that it does not interfere with riding operation while meeting the measurement requirements. Because straight driving is relatively common on the course in general and the influence of riding operation is relatively small during straight driving, we focused on the pitch angle as the vehicle attitude. The pitch angle is estimated by using (1) suspension deformation using a potentiometer and (2) an inertial sensor. First, we decided to use the inexpensive method (1), which is also used in the study by Yagi et al (1). Next, we conducted (2). As a result, we were able to estimate the pitch angle, which is the vehicle attitude due to riding operation on motocross and cross-country courses, and confirm the vehicle behavior. From these results, it was found that the vehicle behavior caused by riding operation during off-road motorcycle driving can be quantitatively demonstrated.

1. Date	Tuesday, November 1
2. Room	Room 409
3. Time	17:00 - 18:00
4. Session	Renewable Energy and Alternative fuels 5 of 5
5. Chair (Affiliation), Co-chair (Affiliation)	Toru Nakazono(Yanmar Holdings/LEMA) Maurice Kettner (Hochschuhe Karlsruhe University of Applied Sciences)

6. Paper No.(JSAE/SAE)	20229023/2022-32-0023
7. Paper title	Effects of different prechamber spark plug geometries on combustion anomalies of an internal combustion engine
8. Authors (Affiliation)	Sebastian Oswald Söhnlein, Jörn Alexander Judith, Sascha Holzberger, Marco Taschek, Maurice Kettner, Markus Klaissle, Danny Schwarz, (Ostbayerische Technische Hochschule Amberg-Weiden, Karlsruhe University of Applied Sciences, Ostbayerische Technische Hochschule Amberg-Weiden, SenerTec Kraft-Wärme-Energiesysteme GmbH)

9. Abstract

Operating an Otto-Engine with hydrogen as fuel the probability of combustion anomalies like knocking, preignition and backfiring increases significantly. Knocking is strongly dependent on the operating point, while the cause for preignition is still investigated. Literature as well as preliminary investigations to this work suggest that especially the spark plug has a significant influence on the occurrence of preignition and backfiring. Hence, the scope of this paper is to identify and understand the influence of the spark plug on preignition in order to reduce their occurrence and receive more mechanical power from the engine. In the first step, the operating conditions leading to preignition and backfiring are determined experimentally using a naturally aspirated single cylinder gas engine and a state-of-the-art prechamber spark plug. Afterwards, different prechamber designs of the spark plug, including a variation of the cap volume, thickness and the orifices diameter, are investigated with respect to their tendency to cause preignition. Additionally, measurements are done with a spark plug in which the electrode material has been changed. 3D-CFD simulations with the aim of visualizing the flow processes in the prechamber support the analysis of the experimental results and are the base for new prechamber designs.

6. Paper No.(JSAE/SAE)	20229074/2022-32-0074
7. Paper title	E-Fuel applications in Non Road Mobile Machinery
8. Authors (Affiliation)	Armin Kölmel, Christoph Hiller von Gaertringen, René Schwerin, Stefan Schweiger, Holger Lochmann (ANDREAS STIHL AG & Co. KG), Stephan Schmidt,Christian Zinner, Dominik Gschanes, Roland Kirchberger (Institute Of Thermodynamics and sustainable Propupulsion Systems Graz University of Technology)

9. Abstract

Professional users in particular will continue to rely on internal combustion engine drives in the future due to high power requirements and high daily energy consumption. Especially if they have to work in rural areas without the possibility of recharging batteries, such as in forestry or maintenance of road verges or railway lines. For these applications, it must be possible to run sustainable fuels for defossilization and drastically reduced CO2 emissions. This paper provides insights into a possible future fuel market and describes its evolution towards a more sustainable future from the perspective of a handheld equipment manufacturer. As developments in the fuel market are currently difficult to predict, manufacturers of hand-held power tools with combustion engines need to be prepared for changes in the composition of fuels that might become available on the market. This paper presents the engine performance results of both a 2-stroke engine and a 4-stroke engine, each with spark ignition, for typical handheld applications operating on a fuel blend of dimethyl carbonate, methyl formate and ethanol (DMC+) compared to commercially available fuels. Since DMC+ fuel differs significantly in its chemical properties in terms of material compatibility, air demand and energy content compared to regular fuels, changes to the hardware and engine calibration are necessary. In addition, a common 2-stroke engine oil is not miscible with DMC+. Thus, a special newly developed oil had to be used to lubricate the engine. The investigations will show the influence of this fuel and the engine oil on the mixture preparation, the combustion behavior as well as the resulting exhaust emissions.

Abstracts of NPT Sessions

1. Date	**Tuesday, November 1**
2. Room	**Exhibition Hall C**
3. Time	**17:00 - 18:00**
4. Session	**New Product Technology Part 6 of 10**
5. Chair (Affiliation),	**Wataru Yamamoto (Kawasaki Motors, Ltd.)**
Co-chair (Affiliation)	**Sebastian Schurl (Graz University of Technology)**

6. Paper Number	NPT2022-023
7. Paper title	Development of High-Speed, High-Accuracy Tool Runout Detector
8. Authors (Affiliation)	Takuya Kido (Honda Motor Co., Ltd.)

9. Abstract

What is important to maintain quality of machining in the machining center is how to control chips. In particular, the chips caught in the spindle tapered section at the time of automatic tool change cause tool runout and affect machining precision. Although various measures are taken to deal with this issue, a fundamental solution is yet to be found. To address this issue, we have recently developed a chip detector that measures tool runout. Used for the measurement is the non-contact, eddy current sensor, which allows measurement in the unit of micrometers in an environment wet with coolant. In the measurement by the sensor, however, errors occur due to a variety of reasons. It is also necessary to take into account dimensional variations due to runout of the spindle itself and individual differences in tools. Accordingly, we measure runout accurately when chips are caught by calculating the location of the center of the tool using the least-square method and filtering. Thus the high-speed, high-precision tool runout detection system is develop, enabling automatic operation to be stop before machining begins. In the future, it is anticipated to help eliminate 100% inspection by assuring of quality in the machining process.

6. Paper Number	NPT2022-022
7. Paper title	Energy conservation by use of two heat sources for heat treatment
8. Authors (Affiliation)	Tsubasa Mori, Akihiko Babazono (Honda Motor Co., Ltd.)

9. Abstract

Recognizing “climate change”, “energy issues” and “efficient use of resources” as key issues and setting a target at zero environmental burdens on society, Honda is striving toward reduction of all kinds of environmental burdens with a slogan “Triple ZERO” to cope with the said three issues. We at the motorcycle manufacturing plant, Kumamoto Factory, set a focus on the gas (LNG 13A) consumed for heating purposes and decided to take actions for reduction of gas consumption. To match up the energy saving goals in Honda’s manufacturing sector announced in 2016, we set a target at a reduction of energy consumption in the heat treatment shop by more than 30%. Aluminum motorcycle parts such as frame bodies and the swingarms are produced here. After molding by the gravity die casting method, the aluminum products undergo T6 heat treatment to enhance mechanical properties. The T6 heat treatment is composed of three processes: the solution treatment, the quenching, and the aging, using gas burning furnaces. The gas consumption was as high as 36% of the total amount consumed in the production sector. Upon calculation of the necessary amount of heat in each process and studies on the characteristics of electric furnace, it has been revealed that electric heating is more efficient in some of the processes. Based on the said findings, we have realized the “hybrid heat treatment” which uses gas in the solution treatment furnace and electric heating for the quenching tank as well as in the aging furnace. With these measures taken, we have achieved higher-than-target 38% reduction of energy consumption.

Abstracts of Technical Sessions

1. Date	Wednesday, November 2
2. Room	Room 407
3. Time	9:00 - 10:00
4. Session	Engine Technology Part 1 of 2
5. Chair (Affiliation), Co-chair (Affiliation)	Ken'ichi Ohmori (Honda R&D Co., Ltd.) Roland Kirchberger (Graz University of Technolpgy)

6. Paper No.(JSAE/SAE)	20229028 / 2022-32-0028
7. Paper title	Development of a Rotary Valve Engine for Handheld Equipment
8. Authors (Affiliation)	Norman H. Garrett, Mesbah Uddin (University of North Carolina - Charlotte), Mikael Bergman, Garrett Purvis (Husqvarna AB), Darrick Vaseleniuck, Dan Cordier (Vaztec)

9. Abstract

A multi-position 4-Stroke piston engine utilizing a novel rotary valve system was developed for handheld outdoor power equipment applications such as chainsaws, brush cutters, leaf blowers, and string trimmers. The intent of the project was to create a low-emission 4-Stroke engine with 2-Stroke performance levels including high RPM limits and power output. This was accomplished using a rotary valve system in lieu of the typical poppet valves of traditional 4-Stroke engines. The prototype was then incorporated into a functional product for field testing and performance evaluations.
Three prototype 45cc rotary valve engines were developed and tested in both real-world usage and on laboratory engine dynamometers to measure power output and emissions levels. The rotary valve system provided the ability to achieve high RPM limits without the risk of valve float, delivered improved volumetric efficiency, and exhibited lower vibration and noise levels with improved power density over traditional 4-Stroke valvetrains. Additionally, the total valvetrain part count and complexity was greatly reduced over poppet valve cylinder head designs.
This paper will discuss the goals of this exercise and the relative performance of the final prototypes.

6. Paper No.(JSAE/SAE)	20229017 / 2022-32-0017
7. Paper title	Effects of Engine Cooling System on Engine Performance: Balancing Engine Power and Fuel Consumption
8. Authors (Affiliation)	Yota Sakurai, Yoshinori Nakao, Atsushi Hisano (Kawasaki Heavy Industries, Ltd.), Kunihiro Tanaka, Michihisa Nakagawa (Kawasaki Motors, Ltd.)

9. Abstract

During high engine load, adequate engine cooling is necessary to prevent irregularly highly machine temperatures and spark knock that are issues affecting high power from being achieved. However, excessive cooling during low engine load or cooling locations that do not require cooling relatively exacerbates fuel consumption. Therefore, optimization of the engine cooling system is needed to achieve higher performance of motorcycle engines.
First of all, in water-cooled engines, conventional water cooling system adjusts the cooling amount via flow channel switching with a thermostat, which is opened in high water temperature. However, with the bypass channel, water may bypass the radiator but still continues to circulate, thereby leading to loss arising from heat transfer from the cylinders. Moreover, use of a thermostat allows water to flow through the radiator even during low engine loads under high water temperature operation, thereby resulting in further heat transfer from the cylinders. In order to solve this issue, we consider that an electromagnetic valve installed in a single path cooling circuit without bypass channel blocks water circulation and creates zero flow without depending on engine operation condition. As a result, we achieved early engine warming, loss reduction, and fuel consumption improvement.
Next, with respect to the optimization of cooling distribution, we found it desirable to concentrate cooling near the spark knock spots and hot spots and to warm the cylinder block for loss reduction simultaneously. As a specific method, water inflow from the cylinder head instead of from the cylinder block can reduce knock strength.

1. Date	Wednesday, November 2
2. Room	Room 408
3. Time	9:00 - 10:00
4. Session	Vehicle Dynamics and Safety Part 2 of 3
5. Chair (Affiliation), Co-chair (Affiliation)	Jun Ishikawa (Honda Motor Co., Ltd.) Alexander Hagenberger (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229046/ 2022-32-0046
7. Paper title	Development of Simulation Model for Estimating Loads Applied to Scooter Frame when Traveling on Rough Roads
8. Authors (Affiliation)	Tetsuharu Maruyama, Shinya Takahashi (Honda Motor Co., Ltd.)

9. Abstract

In motorcycle development, weight reduction is important for save resources and reduce environmental impact. On the other hand, it is important to verify the strength and durability of structural materials, such as the frame body, and it is especially important to estimate the loads applied to individual parts when traveling on rough roads at the initial stage of the design. Regarding motorcycle models, a simulation technique for running on rough roads has already been proposed. However, when this simulation technique, as it is, was applied to scooters, a large error occurred in the estimated load values. This was thought to be due to insufficient modeling of the structures and characteristics specific to scooters. Therefore, in this study, in order to develop a simulation model to estimate the loads on the frame body of a scooter, we considered it necessary to obtain these load transmission characteristics and attempted to model them specifically for the scooter. Based on the simulation model for motorcycle type vehicles, components models of the rubber parts, the luggage box including the seat bottom plate, and the cushions were newly built and incorporated into the vehicle simulation model for running when traveling on rough roads. As a result, through the verifications of the estimation errors when loads are applied to individual parts of the frame body when traveling on rough roads, it was confirmed that the vehicle running model for scooters achieved the same level as that for the motorcycles, and the effectiveness of developed modeling technology was confirmed.

6. Paper No.(JSAE/SAE)	20229112 / 2022-32-0112
7. Paper title	Simulation-Driven Aerodynamic Development of a HighPerformance Motorcycle
8. Authors (Affiliation)	Manish Garg, N. Jayaram (TVS Motor Company)

9. Abstract

Aerodynamics is of vital importance in the development of a high-performance super-sports motorcycle. It directly links with the product's performance in terms of top speed, handling dynamics and user experience. The objective of this work is to achieve the best-in-class aerodynamic performance of a motorcycle using a comprehensive method, involving wind tunnel testing and CFD (computational fluid dynamics) modelling. Focus of the study is to understand the impact of aerodynamic forces on the ride comfort and handling (safety), in case of high-speed operation. In this work, a comprehensive CFD model is developed to assess the aerodynamic performance of a motorcycle. The model is validated with wind tunnel measurements – both for integral parameters, namely, coefficient-of-drag (CD) and coefficientof-pitching moment (CM) and for a discrete parameter, which is coefficient-of-pressure (CP) , measured at 30 different locations on the motorcycle fairing. The coefficient-ofpressure is measured using pressure taps. A good agreement between the CFD model and wind tunnel measurement is observed. The results for integral quantities are within 5% error band, and for discrete parameters (CP), the correlation is of the order of 98% between the measurement and model. We have analyzed about 150 design variations to achieve the best in class aerodynamic performance. Further, the CFD model is used to understand the transient forces experienced by rider head, because of vortex shedding from the wind shield (visor), head and its interaction. The study is conducted at two different heights of the rider head, with respect to wind shield, and at three different vehicle speeds. The results of this study, in terms of flow visualization and dynamic forces on the rider head and its frequency analysis are discussed. A vortex shedding from the helmet is observed at all speeds. Results are presented for two different position of the helmet with respect to visor.

Abstracts of Technical Sessions

1. Date	Wednesday, November 2
2. Room	Room 409
3. Time	9:00 - 10:00
4. Session	NVH Technology
5. Chair (Affiliation), Co-chair (Affiliation)	Keisuke Namekawa (SUZUKI MOTOR CORPORATION) Stephan Schmidt (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229037 / 2022-32-0037
7. Paper title	Application of Participation Factor Focusing on Response at Specific Part for Vibration Evaluation of Motorcycle Frame
8. Authors (Affiliation)	Masashi Michiue, Takeyuki Sakai (Kawasaki Heavy Industries, Ltd.) Manabu Morikawa, Naoki Arino (Kawasaki Motors, Ltd.)

9. Abstract

In this study, we efficiently predict the vibration response of a design shape at a low computational cost in the early development stage, select design proposals with good characteristics from many proposals devised by the designer at the early stage, and forward them to the next stage to achieve the front-loading of development while increasing product value.
The application of participation factor (PF) focusing on the response at a specific part for vibration evaluation of a motorcycle frame is described. To reduce the motorcycle frame vibration, an eigenvalue analysis was performed, and appropriate design change proposals were efficiently selected using partial participation factor (PPF), an index showing the relevance of vibration of specific parts or positions.
Using the PPF, we extracted which vibration modes considerably contribute to the vibration response of the part of interest.
The mode shapes of the extracted vibration modes were all those in which the rear frame part was torsionally deformed. Therefore, the torsional vibration was considered a cause of the vibration evaluation to be insufficient, and some frame design change proposals for suppressing the torsion were proposed. In addition, the effect of the design change proposals on the selected shape was verified.

6. Paper No.(JSAE/SAE)	20229016 / 2022-32-0016
7. Paper title	Developmen of Light-weight, Low-noise Exhaust Muffler Using a Laminated Structure for the Muffler Shell
8. Authors (Affiliation)	Junichiro Suzuki, Yuji Kurasawa, Satoru Maki, Kazuyuki Oda (Honda Motor Co., Ltd)

9. Abstract

For motorcycles, the exhaust system is one of the major contributors to the overall acoustic performance. Above all, the radiated noise from the muffler surface needs to be considered sufficiently for rider acoustical comfort. In many cases, countermeasure parts need to be applied to reduce the radiated noise, which, consequently, hinders weight and cost reduction. This paper reports our study on reducing the radiated noise from the muffler surface by applying to the muffler shell a laminated panel structure in which two steel sheets contact each other. We identified the major factors affecting noise radiation from the muffler surface and used the dynamic stiffness of the outer body surface as a physical quantity to evaluate the damping effect of the laminated steel plate. Based on the idea that the damping effect of laminated steel plates mainly depends on the friction force generated by fine relative displacement between the layers, the surface dynamic stiffness was evaluated with various thickness combinations of the square plate, and it was found that the surface dynamic stiffness was maximized when the thickness ratio was about 2:1. In light of this finding, we produced two prototypes of laminated shell mufflers with circular and non-circular cross-sections, and evaluated their noise reduction performance on actual motorcycles. The results showed that the radiated noise reduction performance of the new mufflers was equivalent to that of a conventional structure muffler. Using the laminated muffler shell of the proposed thickness ratio, we achieved 13% weight reduction in a newly developed muffler.

Abstracts of NPT Sessions

1. Date	**Wednesday, November 2**
2. Room	**Exhibition Hall C**
3. Time	**9:00 - 10:00**
4. Session	**New Product Technology Part 7 of 10**
5. Chair (Affiliation),	**Takashi Mitome (SUZUKI MOTOR CORPORATION)**
Co-chair (Affiliation)	**Mikael Bergman (Orbital Corporation Ltd)**

6. Paper Number	NPT2022-008
7. Paper title	New electric propulsion system “HARMO” creates new marine experience
8. Authors (Affiliation)	Maejima Masaki (Yamaha Motor Co., Ltd.)

9. Abstract

As environmental interest increases, social demands for marine electrification go up significantly for this several years. Our company has been studying how to provide low environmental footprint solution in marine pleasure industry.
Since marine vehicle typically requires more energy consumption compare to land mobility, it makes us difficult to provide realistic solution for marine users. One of our answers for this is to maximize customer value by integrating our boat control technologies and electric advantages into one system as “HARMO” system. “HARMO” provides not only eco-friendly operation, but also unmatched silence and revolutionary intuitiveness that marine users have ever experienced.

6. Paper Number	NPT2022-009
7. Paper title	Introduce of eGX, 2-kW-class packaged multipurpose electric power unit powered by removable lithium-ion battery
8. Authors (Affiliation)	Shunsuke Sawasaki (Honda R&D Co., Ltd.)

9. Abstract

We’ve developed eGX, a multipurpose electric power unit designed to be incorporated into commercial OEM power equipment machines. The eGX unit consists of an easily exchangeable lithium-ion battery, reliable power drive unit and a 2-kW-class motor. Concept of eGX is that:

- Easy install by providing hole package (minimum electric development and installing is needed for machine maker)
- Inherit toughness and reliability from GX engine, a world popular multipurpose gasoline engine

As a multipurpose power unit eGX has a diverse range of applications, including machines used in construction, agriculture, the gardening industry and so forth. As benefits of electric power, eGX expand usage area of machine to indoor as a benefit of zero emission (air pollutant HC /NOx and greenhouse effect gas CO2 exhaust is zero). Additional merit is that:

- Easy usage as only two buttons push to start
- Low-vibration, low-noise and low-heat
- No oil maintenance and air cleaner maintenance

To provide continuous operation for users, battery can be replaced easily and charged quickly (60 minutes for 80%). To charge quickly, forced cooling for battery and charger has been adopted with fan inside charger. To install easily, eGX has two type, integrated type and separate type. Both of two types has same PTO (Power take off) shaft position from GX engine. Integrated type only needs same mount position from GX engine. Separate type can be placed more freely with additional mount. To install easily, eGX has both packaged control box and bare cable connector for install optimum switches for machine. To optimize for various machines, machine makers can rewrite software easily and select best parameters include revolution speed. To perform well for heavy vibrations, stator fastening structure, rotor shaft support structure are enhanced and rubbers installed to protect electrical parts for integrated type. For cooling with closed package, both an outside fan and an inside fan are installed to the motor.

Abstracts of Technical Sessions

1. Date	**Wednesday, November 2**
2. Room	**Room 407**
3. Time	**10:30 - 11:30**
4. Session	**Engine Technology Part 2 of 2**
5. Chair (Affiliation),	**Masahito Saito (Kawasaki Heavy Industries, Ltd.)**
Co-chair (Affiliation)	**Roland Kirchberger (Graz University of Technology)**

6. Paper No.(JSAE/SAE)	20229006 / 2022-32-0006
7. Paper title	Distribution of Friction and Moment of Inertia in Start of SI Engine
8. Authors (Affiliation)	Naoki Miyaoka, Hirotaka Sato, Masato Shimizu, and Junya Tanaka (Kogakuin University)

9. Abstract

In a general-purpose small SI engine, it is required to reduce fuel consumption under the operating conditions of repeated start and stop. In other words, the energy distribution during engine start is an important indicator of 0 rpm until idling speed. The SI engine needs to be driven by the motor at startup, and its electrical energy must be minimized. However, the internal parts of the engine need to accelerate during startup, and its electrical energy is affected by both friction and moment of inertia with the internal parts of engine. The objective of this experimental research are two points. First, it is to determine the friction mean effective pressure (FMEP) under idling speed of the engine. It is important for the finding of the minimum demanded energy in startup to investigate the friction loss of each engine part. Second, it is to find the minimum demand for energy from 0 rpm until idling speed. The minimum demand for energy ought to be determined by the balance of FMEP and moment of inertia.
This research has made it possible to divide and measure the frictional loss and the loss due to the moment of inertia during engine acceleration. To achieve the objective, it is proposed to use the experimental set up that combines the high-speed camera with the engine. The acceleration time in this research, which is the minimum energy in the start of the SI engine, is 2.07s.

6. Paper No.(JSAE/SAE)	20229079 / 2022-32-0079
7. Paper title	Feasibility study of boosted DI technology for sport motorcycle
8. Authors (Affiliation)	Hayatoshi Sato, Masaki Torigoshi, Hiroki Takase, Naoki Makita (Yamaha Motor CO., LTD.)

9. Abstract

The sport motorcycles continue to provide riders with the riding pleasure by the excellent potential of mobility performance brought by lightweight, compactness and high-performance powertrains.
However, we are in a situation where we need to make efforts to reduce CO2 emission as much as possible on a global scale, and we also need to make serious efforts to reduce CO2 emission for sport motorcycles. The challenge for sport motorcycles from this perspective is a drastic improvement in fuel efficiency while maintaining the “vehicle dynamic performance”, “drivability performance” and “to meet the latest exhaust emission regulation”, and Yamaha has been proceeding the several feasibility studies aiming for realizing this challenge as advanced development.
In one of the feasibility studies, “Downsizing Concept with boosted DI technology,” we developed a research motorcycle equipped with a powertrain that achieved a specific output of 156kW / L (133kW / 0.85L) on a sport motorcycle. As a result of the development, we were able to obtain 92g / km-CO2 in WMTC which is equivalent to about 30% improvement in fuel efficiency compared to the best FE model in 2017, while keeping excellent drivability.
In this report, we will introduce the development of this powertrain “Internal Combustion Engine (ICE) with turbocharger (TC)” for motorcycle especially following two (2) viewpoints.
1) To balance engine performance, emissions, and fuel economy.
2) Drivability development to obtain linear throttle response or the required drivability.

Abstracts of Technical Sessions

1. Date	Wednesday, November 2
2. Room	Room 408
3. Time	10:30 - 12:00
4. Session	Vehicle Dynamics and Safety Part 3 of 3
5. Chair (Affiliation), Co-chair (Affiliation)	Hisayuki Sugita (SUZUKI MOTOR CORPORATION) Dominik Gschanes (Graz University of Technology)

6. Paper No.(JSAE/SAE)	20229003/2022-32-0003
7. Paper title	Application of a Road Simulator to Efficient Fatigue Reliability Evaluation of an Off road Motorcycle
8. Authors (Affiliation)	Hideki Makida, (Kawasaki Motors, Ltd.)

9. Abstract

Recently, application of a Multi-axis road simulator has been studied to improve reproducibility of vehicle running, however the system is complicated and expensive due to the large number of vibration axis. Therefore, it is necessary to clarify the evaluation object and balance the evaluation accuracy with the test efficiency appropriately.
In this study, we have developed a method for efficient fatigue reliability evaluation of an off-road motorcycle with the road simulator. We focused on the simulation of a jump section of a track because it had been clarified that the fatigue damage in the jump section accounts for the most of the fatigue damage to the vehicle in one lap on the track.

6. Paper No.(JSAE/SAE)	20229029/SAE 2022-32-0029
7. Paper title	Development of evaluation technology for motorcycle advanced rider assistance systems
8. Authors (Affiliation)	Shohei Hosokawa, Kazuya Nagasaka (Kawasaki Heavy Industries, Ltd), Hiroyuki Watanabe (Kawasaki Motors, Ltd.)

9. Abstract

The Kawasaki Heavy Industries Group established its Group's new vision statement, describing what the Group envisions becoming in 10 years — "Group Vision 2030: Trustworthy Solutions for the Future." In order to provide solutions for social issues and create a hopeful future, we will transform our business structure into a form which promises faster growth in line with environmental changes. In the field of "Near-Future Mobility," which is one of the fields we are focusing on, we are the first Japanese motorcycle manufacturer to adopt the Advanced Rider Assistance System (ARAS), with the aim of transforming the movement of people and goods. We began selling models equipped with this system in early 2022. ARAS, which is an advanced rider assistance function for motorcycles, is just a rider assistance function, and the rider is ultimately responsible for properly operating the vehicle. Therefore, even if this system malfunctions, that must not interfere with the safe operation of the rider. To install ARAS in a mass-produced vehicle, we must clarify the impact of ARAS malfunction on the rider's driving, that is, whether the rider is able to make appropriate decisions and operate the vehicle, even during a malfunction. However, it is difficult to create the same malfunction situation and evaluate this system safely in actual driving tests by general riders with different riding skills. In addition, no existing evaluation method exists because this is the first time this system was applied to motorcycles. Therefore, we utilized our previously developed motorcycle riding simulator to conduct a riding test on a digital space to safely confirm the impact of an ARAS malfunction on the rider's riding. The types of malfunctions that could cause harm to the rider were extracted from the risk assessments. By reproducing the high-risk situation from situations in which each malfunction could cause danger to the rider, the rider's decision and action during such situations were efficiently evaluated. A situation in which both the frequency of occurrence and the magnitude of harm to the rider are high is defined as a high-risk situation. The evaluation results confirmed that the rider can safely operate the vehicle, even if it undergoes a malfunction.

6. Paper No.(JSAE/SAE)	20229039/2022-32-0039
7. Paper title	Development of Tire Force Estimation Logic for Off-road Four-wheelers
8. Authors (Affiliation)	Taichi Inaba, Takenori Terada, Atsushi Sano (Kawasaki Heavy Industries, Ltd.), Hideyuki Kato (Kawasaki Motors, Ltd.)

9. Abstract

Recently, off-road four-wheelers are used in various situation. To develop future models that matches the users' demands, collecting data about how vehicles are actually used in market is effective. In this paper, we proposed a method to estimate tire forces using formula derived from simple equation of motion of a vehicle. This method is constructed to be suitable for massproduces vehicles, since only inexpensive sensors are needed. In order to verify the estimation accuracy of the proposed method, another method that can measure the tire forces more directly and to be compared with the proposed method is necessary. In research and development in the field of automobiles running on the paved surfaces, tire force is often measured using a six-component force sensors mounted on the wheels. However, these sensors are basically intended for vehicles driving on the paved surfaces, and are not considered for measurement in situations such as unpaved off-road surfaces. Therefore, we applied another method to calculate the tire force based on the measurement results of strain gage attached on vehicle frame. Strain values are pre-calibrated by simulation and driving tests of basic driving patterns. The estimated tire forces by the proposed methods are compared with those calculated by strain gages measurement of vehicle frame, and the good agreement has been obtained.

Abstracts of Technical Sessions

1. Date	**Wednesday, November 2**
2. Room	**Room 409**
3. Time	**10:30 - 12:00**
4. Session	**Materials & Manufacturing**
5. Chair (Affiliation),	**Hirotaka Kurita (Yamaha Motor Co., Ltd.)**
Co-chair (Affiliation)	**Christoph V. Hiller (ANDREAS STIHL AG & Co. KG)**

6. Paper No.(JSAE/SAE)	20229075 / 2022-32-0075
7. Paper title	The Effect of Welding Conditions on the Bonding Strength for Resistance Welding of Steel and Aluminum Casting
8. Authors (Affiliation)	Takaharu Suzuki (Yamaha Motor Co., Ltd., Nagoya Institute of Technology), Hidenori Wakuda, Hisashi Harada (Yamaha Motor Co., Ltd.)

9. Abstract

Aluminum castings are widely used in transportation equipment because of their high strength to weight ratio, heat conductivity, and corrosion resistance. In the past, heattreated steel and cast iron were used for engine parts that required wear resistance, but the demand for weight reduction has gradually increased, and nowadays most of the large parts that make up an engine are made with Aluminum. If the large aluminum casting parts requires wear resistance, the steel parts may be partially included. The method is to wrap it at the time of casting or to accurately press it in. However, in order to achieve functionality, it may be better to partially bond the steel. Therefore, for the purpose of bonding a wearresistant steel to the cast aluminum AC4C alloy, the influence of the bonding conditions and the shape of the joint was investigated in this study. This time, using the resistance welding method, we focused on the reactions and microstructural changes that occur near the interface between steel and aluminum. In order to obtain a large bonding strength, it is important to remove the oxide film on the aluminum surface, control the influence of the intermetallic compound layer generated at the interface between steel and aluminum, and increase the amount of plastic flow on the joint surface. But, in bonding by resistance welding, each process of energization, heating, deformation, and joining is performed in a very short time, and it is difficult to understand the effects and interrelationships between each factor. It has also become clear that as the target area to be bonded becomes larger, it becomes more difficult to bond under the same conditions at all interfaces of steel and aluminum. For this reason, we decided to start with a simple shape and then join test pieces that are gradually complicated and have a large area shape. In addition, considering that a partial difference in adhesive strength will occur, an undercut groove has been added as a countermeasure.

6. Paper No.(JSAE/SAE)	20229078 / 2022-32-0078
7. Paper title	Stiffness optimization process using topology optimization techniques and lattice structures
8. Authors (Affiliation)	Hiroyuki NAGAMOTO, Koji KOBAYASHI, Hideyuki FUJITA (Yamaha Motor Co., Ltd.)

9. Abstract

In recent years, topology optimization technology has been widely applied as a means of achieving weight reduction. On the other hand, the development of additive manufacturing technology (3D printing) is making it possible to manufacture structures called lattices. In this paper, we show that it is possible to create even stiffer structures by combining both technologies, and we develop a design process that includes optimization calculations.

6. Paper No.(JSAE/SAE)	20229042 / 2022-32-0042
7. Paper title	Structural Optimization of Motorcycle Top Bridge
8. Authors (Affiliation)	Riku MITSUI, Hirotaka KURITA, Hiroyuki NAGAMOTO (Yamaha Motor Co., Ltd.)

9. Abstract

The role of design in merchantability has become increasingly important in recent years. In this context, there is a need to establish a design-oriented design method for structural components. Topology optimization is a method that can create shapes beyond human knowledge, and its applicability as a design feature is expected. However, the objective function cannot be set freely at present, and optimization of strength requirements is a particular challenge. In this paper, a case study is conducted on a steering wheel bridge to apply topology-optimized geometry, which has design potential, to a structural member by conducting two-step optimization of topology and geometry.

Abstracts of NPT Sessions

1. Date	**Wednesday, November 2**
2. Room	**Exhibition Hall C**
3. Time	**10:30 - 12:00**
4. Session	**New Product Technology Part 8 of 10**
5. Chair (Affiliation),	**Takashi Mitome (SUZUKI MOTOR CORPORATION)**
Co-chair (Affiliation)	**Mikael Bergman (Orbital Corporation Ltd)**

6. Paper Number	NPT2022-010
7. Paper title	New possibility of motorcycles, ships and other applications using new SCiB™ rechargeable lithium-ion battery
8. Authors (Affiliation)	Kazuhiro Namba, Atsushi Inamura, Morio Suzuki, Koji Ishiwa, Masahiro Sekino (Battery Division, Toshiba Corporation)

9. Abstract

As the world moves toward carbon neutrality, the global society is more dependent on electrical energy, especially among them, lithium-ion batteries are expected to play a key role in supporting a decarbonized society as safe, clean, and efficient energy storage device. In recent years, the requirements for batteries have diversified as a result of expanding in a variety of applications. High power, long life, and safety are increasingly important, in addition to high energy.
Toshiba rechargeable lithium-ion battery “SCiBTM” offers features such as rapid charging, high power, long life and safety. In particular, the newly commercialized combination type cell has both high energy density and high power density while offering excellent features as the existing SCiBTM cells.
In this paper, overviews of the new SCiBTM and expected applications are provided. Applications for new SCiBTM are proposed based on the results of the lifetime analysis of existing SCiBTM. The new SCiBTM enables high-performance electric boats, electric/hybrid motorcycles and etc.

6. Paper Number	NPT2022-012
7. Paper title	2.5 kW class NEO'S Electric Scooter with Removable Battery
8. Authors (Affiliation)	Yamasaki Ryosuke (Yamaha Motor Co., Ltd.)

9. Abstract

European demand for electric scooters is expected to increase as new customers switch from commuting by car to commuting with two-wheeled vehicles, due to prohibitions on entering urban areas, parking shortages, and traffic congestion. Also, increased taxes, fees and fuel costs for internal combustion engine vehicles are incentivizing consumers to switch from conventional 50cc scooters to electric scooters. This is expected to lead to an increase in demand for electric scooters. In response, Yamaha has developed a new zero-emission EV version of the popular NEO'S 50cc scooter.

6. Paper Number	NPT2022-014
7. Paper title	The Cost Effective 48V Inverter
8. Authors (Affiliation)	Shigeru Saito, Kazuki Harada (Nidec Elesys Corporation)

9. Abstract

Nidec-Elyesy can provide highly reliable and low cost inverters for small power applications.
The low cost can be achieved by the base platform design system, power switch adjustment for required power level and detailed specification consultation with customers.

Abstracts of Technical Sessions

1. Date	Wednesday, November 2
2. Room	Room 407
3. Time	13:30 - 15:00
4. Session	Hybrid and Electric Drives Part 1 of 2
5. Chair (Affiliation), Co-chair (Affiliation)	Yasuyuki Muramatsu (Yamaha Motor CO.,ltd.) Kai Beck (Andreas Stihl AG & Co. KG)

6. Paper No.(JSAE/SAE)	20229002 / 2022-32-0002
7. Paper title	Development of Smart Drive 48V e-Motorcycle
8. Authors (Affiliation)	Michael Kastner, Hubert Friedl, Christian Hubmann, Patrick Falk, Bernhard Graf (AVL List GmbH, Austria)

9. Abstract

The electrification of two-wheelers is advancing significantly faster than that of the automobile, especially in Asia [1]. Along with this global trend for electrification, especially motorcycle industry is entering new spheres of highly advanced products and has to meet the 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, dedicated tools and methods have been developed and used to quantify these attributes with high maturity.
A battery-electric motorcycle has been developed to experimentally prove the achievement of premium subjective attributes. Commercially available products have been taken as benchmark reference. With maximum output of up to 20kW, a maximum speed of 100 km / h and a range of more than 100 km (with 4 kWh battery capacity), this actual demonstrator vehicle delivers highly appealing driving performance and impresses in particular with its excellent drivability. Furthermore, this vehicle demonstrates lowest in-class noise radiation and delighting sound quality.
Besides attractive subjective attributes all kinds of electric motorcycles (same as automobiles) have to meet all the stringent safety regulations (eg. ISO 26262) and environmental standards.

6. Paper No.(JSAE/SAE)	20229025 / 2022-32-0025
7. Paper title	Experimental and simulative transient behavior investigation of a hybrid powertrain handheld tool
8. Authors (Affiliation)	Dimitrios Vogiatzis, Stephan Schmidt , Hans Juergen Schacht, Roland Kirchberger (Graz University of Technology), Martin Arenz (Andreas Stihl AG & Co. KG)

9. Abstract

A transient behavior investigation of a hybrid hand-held tool is carried out on near real load conditions, through a hybrid experimental and simulative study. As this study focuses on handheld tools with a varied or transient load operation like chainsaws and brush cutters, a use of a blower tool as a test-carrier and a throttle body implementation on its blower air pipe adds a controllable braking mechanism. This allows for driving varied load cycles without the need of a testbench. Experimental investigation takes place at both start-up, shut-down and load conditions and for different drive control and commutation modes of electric motor. The controller characterization and parameter selection are done. After the load cycles are driven on the test-carrier, the characterizing data are transferred to the MATLAB and Simulink simulation model to correct and calibrate its transient behavior. After proving the concept of a hybrid tool, different load cycles are examined for defining the energy management strategy. Finally, the energy storage system is characterized for the hybrid tool and the application-attached simulation model compares the reference tool with the hybrid one in terms of efficiency.

6. Paper No.(JSAE/SAE)	20229018 / 2022-32-0018
7. Paper title	Efficiency Increase of a Conventional ICE Powertrain with CVT by 48V Hybridization with Focus on L Category Powersport Applications
8. Authors (Affiliation)	Alexander Hagenberger, Hans-Juergen Schacht, Stephan Schmidt, Roland Kirchberger (Institute of Thermodynamics and Sustainable Propulsion Systems Graz University of Technology)

9. Abstract

In recent years, E-mobility relevance has increased in the automotive sector, yet pure electric vehicles struggle to establish themselves in the still internal combustion engine (ICE) dominated sector of L-category and powersport applications. Battery electric hybrid L-category vehicles, as considered in this paper, combine both ICE and electric powertrains. Nowadays, numerous ICE L-category vehicles use rubber V-belt continuous variable transmissions (CVT) due to their reliability and user-friendliness, which often outweighs the drawback of relatively low efficiency. This paper not only aims to show, with the help of longitudinal dynamic simulation (LDS), how a state-of-the-art L-category ICE powertrain with special focus on the CVT can benefit from hybridization in terms of overall efficiency, but furthermore points out where the efficiency increase actually comes from and how this new knowledge can be implemented intelligently into a hybrid strategy. For this purpose, a Matlab/Simulink forward LDS model of the vehicle including all its powertrain components is built up. The research vehicle uses an uncontrolled centrifugal clutch (CC) located on the input shaft of the CVT. The hybrid module, consisting of a 48V E-motor, inverter and a battery, is added in parallel hybrid architecture (P3 configuration) between the CVT output and the driven wheel. In this study, load on the CVT is increased during ICE driving by using the E-motor as a generator, while charging the battery at the same time and using this energy for pure electric driving afterwards. This load point shifting strategy (LPS) proves to be especially beneficial during low vehicle speed driving, when both the ICE as well as the CVT load and thus their efficiency is low. The study shows fuel consumption benefits of 43% in the WMTC for the considered vehicle, calculated according to the legislative requirements. Furthermore, the final LPS hybrid strategy is also tested in other, real-world driving scenarios to prove its real-world applicability.

Abstracts of Technical Sessions

1. Date	Wednesday, November 2
2. Room	Room 408
3. Time	13:30 - 15:00
4. Session	Two Stroke Engine Part 1 of 2
5. Chair (Affiliation), Co-chair (Affiliation)	Akira Iijima (Nihon University) Luca Romani (University of Florence)

6. Paper No.(JSAE/SAE)	20229012 / 2022-32-0012
7. Paper title	Experimental Analysis of a Uniflow Scavenged Two-Stroke Concept
8. Authors (Affiliation)	Stefan Sturm, Stephan Schmidt, Michael Lang, Roland Kirchberger (Graz University of Technology)

9. Abstract

The target data for a modern two-stroke engine used in the automotive sector, for example as a hybrid compound in a Plugin Hybrid Electric Vehicle (PHEV) or Range Extender Electric Vehicle (REX), include a range of demands and challenges to be a viable alternative to the four-stroke engine. A modern two-stroke concept must fulfill at least the same level of durability requirements and should have also advantages in terms of packaging, cost and weight. A major challenge is to generate a gas-exchange process which reduces the loss of fuel and air during the scavenging process to a minimum and enables a stochiometric exhaust gas. In a two-stroke engine, the in-cylinder burned gases of the previous combustion cycle are scavenged out of the cylinder by the inflowing fresh air. Therefore, an implementation of a 3-way catalyst as an effective aftertreatment system with operation at a stochiometric combustion requires a highly efficient scavenging and fuel injection strategy throughout the entire operational range to avoid possible losses of fresh air and fuel towards the exhaust line.

6. Paper No.(JSAE/SAE)	20229057/2022-32-0057
7. Paper title	On the Potential of Transfer Port Injection Strategies for a Two-Stroke Engine
8. Authors (Affiliation)	Francesco Balduzzi, Luca Romani, Giovanni Ferrara (Università degli Studi di Firenze), Paolo Trassi, Jacopo Fiaschi (Betamotor SpA)

9. Abstract

The main drawback of an in-cylinder Low Pressure Direct Injection (LPDI) in a two-stroke engine is the difficulty of achieving a satisfactory vaporization level in low load conditions. The liquid droplets are characterized by large diameters and, when the temperature level and the velocity of the scavenging flow field are low, the time needed for the droplet vaporization and the homogenization with fresh air becomes too long to guarantee a suitable mixture formation. A transfer port injection allows a higher flexibility, due to the possibility of performing a mixed injection either directly in the cylinder or indirectly in the crank case, depending on the load request or engine speed. Also, an even lower injection pressure can be adopted with respect to an in-cylinder LPDI injection, which is relevant in case of lightweight and low power applications. On the other hand, the time available for the direct in-cylinder injection is limited to the scavenge phase.

6. Paper No.(JSAE/SAE)	20229063/2022-32-0063
7. Paper title	Describing the Auto-Ignition Quality in Small, Air Cooled, Two Stroke Engines
8. Authors (Affiliation)	Per Risberg, Thomas Elm, Mikael Bergman, Fredrik Hellquist (Husqvarna Group), Anna Karvo, Rupali Tripathi (Neste Oyj)

9. Abstract

In this paper, a matrix of six different fuels with different combinations of MON and RON values were tested on a Husqvarna 550 XP Mark II, a modern air cooled, sequential stratified scavenging 2-stroke chainsaw engine. Ignition timing sweeps were performed and knock limited spark advance (KLSA) were calculated. Then the data has been analyzed with a multi-variate analysis of KLSA against both MON and RON to try to determine how MON and RON should be combined to best describe the anti-knock quality on this specific engine. The results show that neither MON nor RON describes the anti-knock quality well on this product. The AKI (the average of RON and MON) described the anti-knock quality best of the conventionally recognized anti-knock quality measurements. From the multivariate analysis the K-value was determined to be 0,59. Using a fuel with a more ideal combination of MON and RON on this type of products without knock control can limit the maximum cylinder pressure and cylinder top temperature. This is likely to extend the life time of the forest and garden equipment significantly. Small engine gasoline fuel, also known as alkylate gasoline, has a good combination of RON and MON that makes it outperform other market fuels from an Anti-knock quality perspective on the tested engine. At the same time small engine gasoline has other benefits, such as less health hazardous exhaust emissions, that can improve the work environment for loggers. This tailor made forest and garden fuel remain mysteriously anonymous outside of Europe.

Abstracts of Technical Sessions

1. Date	**Wednesday, November 2**
2. Room	**Room 409**
3. Time	**13:30 - 15:00**
4. Session	**Materials & Manufacturing**
5. Chair (Affiliation),	**Hirotaka Kurita (Yamaha Motor Co., Ltd.)**
Co-chair (Affiliation)	**Christoph V. Hiller (ANDREAS STIHL AG & Co. KG)**

6. Paper No.(JSAE/SAE)	20229010 / 2022-32-0010
7. Paper title	Development of Resin Coated Piston suitable for Monolithic Cylinders made of Hypereutectic Al-Si Alloy
8. Authors (Affiliation)	Keita Watanabe, Hirotaka Kurita (Yamaha Motor Co., Ltd.)

9. Abstract

This study focuses on improving durability of the resin coated piston developed especially for the monolithic cylinder made of a hypereutectic Al-Si alloy, so-called DiASil®. The newly developed resin was designed to be cured at a relatively low temperature considering over-aging of a piston and confirmed that it exhibited a lower friction coefficient compared to an existing resin coating. Furthermore, pistons of which skirts had various depth and pitch of grooves filled with the resin coating were offered to evaluate wear and seizure characteristics. The results showed deeper grooves on piston skirts were remarkably effective to delay a seizure. All the seizures were triggered when the ratio of Al substrate exposed to the sliding surface reached up to 60-80%, which implied it can be the empirical criteria for a seizure. Therefore, it can be considered the seizure does not occur as long as adequate resin coating remained in the grooves. Finally, influential factors for the seizure and printability of deep grooves were discussed.

6. Paper No.(JSAE/SAE)	20229024 / 2022-32-0024
7. Paper title	Development of 1520 MPa Class Lightweight Suspension Springs
8. Authors (Affiliation)	Hideki Kato, Shinji Kasatori (Honda Motor Co., Ltd.), Hirokatsu Kameda (Hitachi Astemo, Ltd.), Shoichi Suzuki (NIPPON STEEL SG WIRE CO., LTD.)

9. Abstract

The spring is an important component part of the suspension of motorcycles and automobiles. As the spring constitutes an unsprung weight, the suspension complies more quickly if the spring weighs less. Especially in off-road motorcycles, which are often subjected to extremely hard conditions such as full acceleration and braking, quick turning and jumping, a reduction of unsprung weight contributes to an enhancement of dynamic performance. As an effective means to reduce weight, use of the light-weight titanium instead of the commonly used steel is seen in some examples. However, applications of titanium are limited only to large-diameter springs because of its higher cost and challenging in coiling. To achieve a steel spring that weighs lower than a titanium counterpart, we aimed at a spring that features such a fatigue strength that allows stressing as higher as to 1520 MPa. Three technical options are used, 1) Shot peening, 2) Removal of decarburized surface on wire material, 3) Control of inclusion of impurities. As a result, we developed a steel spring with lower weight than titanium.

6. Paper No.(JSAE/SAE)	20229041 / 2022-32-0041
7. Paper title	Silver surface treatment applicable to bolts for motorcycles
8. Authors (Affiliation)	Hiroshi Hirayama (Honda motor Co., Ltd.), Manabu Inoue, Takeshi Koike (Dipsol Chemicals Co., Ltd.)

9. Abstract

In motorcycles, the exposed mechanical parts play important roles in the styling design. The bolts that fasten these parts a good appearance in addition to the fastening function. Since many parts of a motorcycle are designed so as to appeal the mechanical and metallic beauty, needs are higher for silvercolor bolts. Motorcycle bolts are exposed to the external environment, so they are required to have also cosmetic durability. Though there is a surface treatment having a higher cosmetic durability such as the chromium plating, due to its metallic gloss like a mirror, chrome-plated bolts are applicable only to specific models and parts. In this study, we developed a surface treatment that enhance the appearance and cosmetic durability required of boltsfor motorcycles. The layer of developed surface treatment is dip coating with thin film polyorganosiloxane material on zinc plating. Clarified a zone where both the appearance and the cosmetic durability are attainable through the studies on the amount of aluminum flakes in the dip paint and the amount of chemical conversion coating. Clarified that the friction coefficient can be adjusted to the same level as the previous plating by maintaining the amount of friction modifier within a specific zone. With the above-mentioned, we achieved surface treatment for bolts that has a generally applicable silver color appearance and cosmetic durability.

Abstracts of NPT Sessions

1. Date	Wednesday, November 2
2. Room	Exhibition Hall C
3. Time	13:00 - 15:00
4. Session	New Product Technology Part 9 of 10
5. Chair (Affiliation), Co-chair (Affiliation)	Keisuke Namekawa (SUZUKI MOTOR CORPORATION) Guilherme Batalha (Graz University of Technology)

6. Paper Number	NPT2022-006
7. Paper title	Improvement of 6.1L Diesel Engine V6108 for Tractor to Comply with Emission Regulations and Meet Market Demands
8. Authors (Affiliation)	Naoya Junicho, Toshio Nakanishi, Hideki Yoshikawa, Soichiro Watanabe (Kubota Corporation)

9. Abstract

Recently, Kubota has been going ahead with business expansion to large scale farming around the world. Therefore, we mass-produced a diesel engine "V6108" with the maximum output of 99.2 kW for tractors in 2009. We set the displacement of V6108 to 6.1 L, which is the maximum of Kubota, in order to emphasize the low-speed torque required for tractors. Generally, 6-L class industrial diesel engines have 6 cylinders, but V6108 pursues compactness and has advantages of cost and maintenance by reducing number of cylinders six to four. Up to now, we have increased the output to 129 kW to meet the demands of the tractor market for higher output.
This paper introduces the features of V6108 for tractors and technologies for increasing the output while complying with the emissions regulations that have become stricter in stages.

6. Paper Number	NPT2022-011
7. Paper title	Development of 2021 MT-09
8. Authors (Affiliation)	Nobuyuki Miyoshi (YAMAHA MOTOR CO.LTD.)

9. Abstract

MT-09 that appeared as a NEW model in 2014 started providing value to the market as an image leader of "Master of Torque" which is a common slogan of "MT series". Since then, the second generation, which has a completely redesigned appearance, and the TRACER9 and XSR900, which are equipped with different product characteristics using a common engine, continue to provide value to the market and are highly evaluated.
This time, in order to further improve the attractiveness of the product, raise awareness of safety that has been increasing in recent years, and respond to exhaust gas regulations, we have newly developed the third generation "MT-09" that has completely renewed the engine, body and electrical components.

6. Paper Number	NPT2022-025
7. Paper title	Engine and electronic control development for the new GSX-S 1000 and GSX-S 1000 GT
8. Authors (Affiliation)	Seiya Suzuki, Keisuke Namekawa, Yoshisato Inayama, Toshihiko Atsumi (SUZUKI MOTOR CORPORATION)

9. Abstract

Launched in 2015, the GSX-S1000 is based on the GSX-R1000 engine, which has a proven track record in a number of superbikes and endurance races, and was born as a sporty street bike with upright riding position. It is a model that enhances the power in the low-to-mid range, and allows you to enjoy riding on the street with exciting intake and exhaust sound.
The current model GSX-S1000 series have been highly evaluated by engine development focused on sports driving on the street. In the new model, "GSX-S1000GT" as a sports touring model has been added to the GSX-S1000 series. And, the goal of engine development was to improve touring performance in addition to sports performance.

6. Paper Number	NPT2022-018
7. Paper title	Development of H'ness CB350
8. Authors (Affiliation)	Hidetoshi Wakasa, Takuya Osanai, Shintaro Teshima, Takeyuki Kariyasu (Honda Racing Corporation)

9. Abstract

Recently in India, the market is growing for middle and large size motorcycles in addition to the smaller models mainly for daily transportation purposes. In the core of such users are those of the young generation who often share their touring experiences via SNS. The use of motorcycles, which used to be a mere means of transportation, is changing to enjoy them as a hobby. On the other hand, they also maintain traditional values with a focus on an awesome, high-status image as well as user-friendliness in day-to-day use. In addition to that, they also demand such a convenience that allows stress-free use of smartphone, which is important in modern life, even when the user is on the motorcycle. Keeping these backgrounds in mind, we planned a new model to fill the variety of needs from daily commuting to a long touring.

1. Date	Thursday, November 3
2. Room	Room 407
3. Time	9:30 - 10:30
4. Session	Hybrid and Electric Drives Part 2 of 2
5. Chair (Affiliation), Co-chair (Affiliation)	Yasuyuki Muramatsu (Yamaha Motor CO.,ltd.) Kai Beck (ANDREAS STIHL AG & Co. KG)

6. Paper No.(JSAE/SAE)	20229085 / 2022-32-0085
7. Paper title	Effect of Varnish Impregnation Range of Motor Stator on Vibration Characteristics
8. Authors (Affiliation)	Yoshisada Sakamoto, Mihiro Nakanishi, Motoki Hirano, Yoshiyuki Terada (Suzuki Motor Corporation)

9. Abstract

A motor for an electric vehicle has a stator core and a coil bonded with insulating varnish. The Impregnation of varnish in the stator and at the coil end greatly affects the vibration characteristics of the stator. In this paper, the experimental modal analysis of the sample stator was carried out to measure the vibration characteristics, and a vibration analysis model of the stator with the finite element method was developed.
The laminated structure of an electromagnetic steel plate constituting a stator is modeled by anisotropic material properties. The joint stiffness of the varnish which connects the stator and the coil is modeled. We also modeled the varnish applied to the coil end. We carried out eigenvalue analysis and frequency response analysis. The simulation results are basically consistent with the experimental mode shapes and natural frequencies under 1000 Hz.
The effect of the varnish impregnation range between the electromagnetic steel plates of the stator on the vibration characteristics was investigated. The natural frequencies of the first and second mode which is deformed into an oval shape in the stator cross section are increase as the varnish impregnation range is wider. The response level around the stator at excitation point also increases. In addition, vibration analysis was performed by changing the varnish coupling stiffness of the coil end, and it was confirmed that the bond strength of varnish at the coil end has a large effect on the natural frequency of the stator.

6. Paper No.(JSAE/SAE)	20229094 / 2022-32-0094
7. Paper title	Suboptimal Online Energy Management for a Fuel Cell/Supercapacitor/ Battery Electric Vehicle Using Artificial Neural Network Approach
8. Authors (Affiliation)	CHIEN-LIANG CHEN (Department of Industrial Education, National Taiwan Normal University), YI-HSUAN HUNG (Undergraduate Program of Vehicle and Energy Engineering, National Taiwan Normal University), ZHU-YANG QIU (Department of Industrial Education, National Taiwan Normal University)

9. Abstract

This research aims at developing the suboptimal energy management strategy by using artificial neural network (ANN) for a triple-electrical-energy electric vehicle (EV). The controller hardware designs will be implemented in the future. Firstly, we constructed a low-order dynamic equations that abstracted the characteristics of the vehicle, including energy sources (the fuel cell, lithium battery, and supercapacitor), driver's model, traction motor, transmission, and longitudinal vehicle dynamics, etc.. The key parameters were mostly retrieved from the commercialization software-Advanced Vehicle Simulator (ADVISOR). Base on the vehicle structure of the Toyota Mirai, we built the range-extended EV. The powertrain system included an 110kW fuel cell set, a 40Ah lithium-ion battery set, and a 165F/48V supercapacitor and a 150kW AC motor. The ECMS control strategy included a six-layer for-loop: the battery state-of-health (SOH), power demand, the battery state-of-charge (SOCb), the supercapacitor state-of-charge (SOCSC), the power ratio of battery to power demand(α) and the power ratio of the supercapacitor to power demand(β). The ECMS data for ANN training was divided to two parts, the input part is four for-loop and the output part is α and β. To evaluated the benefit of the ANN, a rule-based (RB) control was designed as well. A standard driving cycle, New European Drive Cycle (NEDC), was chosen for the energy improvement evaluation. The energy consumption for RB and ECMS is [17.6258, 8.9141kWh], respectively, in two-time NEDC cycles. The energy improvement for ECMS is approximately 50% and the ANN accuracy is higher than 90%. The hybrid system can be scaled down to a small mobility in the near future.

Abstracts of Technical Sessions

1. Date	**Thursday, November 3**
2. Room	**Room 408**
3. Time	**9:30 - 10:30**
4. Session	**Two Stroke Engine Part 2 of 2**
5. Chair (Affiliation),	**Akira Iijima (Nihon University)**
Co-chair (Affiliation)	**Luca Romani (University of Florence)**

6. Paper No.(JSAE/SAE)	20229076/ 2022-32-0076
7. Paper title	Study of Pre-chamber Jet Combustion Behavior using a Small Two-stroke Optically Accessible Engine
8. Authors (Affiliation)	Takato Deushi, Takuma Naka, Tatsuya Tsujiguchi, Akira Iijima (Nihon University) Shiro Yamaguchi, Minoru Kuroiwa, Kuniyoshi Eto (Yamabiko Corporation)

9. Abstract

A small 2-stroke engine can be an effective power source for an electric generator mounted on a series hybrid electric vehicle. In recent years, a technology referred to as pre-chamber jet combustion has attracted attention as a means of enhancing thermal efficiency by improving mixture ignitability. In this study, experiments were conducted to investigate differences in combustion behavior between the application of spark-ignited (SI) combustion and pre-chamber jet combustion to a small, two-stroke engine. The experimental equipment used was a two-stroke, single-cylinder, optically accessible engine with a displacement of 63.3 cm3. Differences between conventional SI combustion and pre-chamber jet combustion were examined by means of in-cylinder pressure analysis, in-cylinder combustion visualization and image processing software. The diameter of the connecting orifice of the pre-chamber was varied between two types. The results revealed that the combustion time and indicated mean effective pressure obtained with pre-chamber jet combustion were more stable compared with conventional combustion. It was also found that a linear jet combustion flow was formed with a smaller connecting orifice diameter and the combustion time was shortened, but combustion was not stable. In addition, it was found that the maximum pressure decreased with a higher jet flow velocity.

6. Paper No.(JSAE/SAE)	20229080 / 2022-32-0080
7. Paper title	Numerical Investigation of the Effect of Engine Speed and Delivery Ratio on the High-Speed Knock in a Small Two-Stroke SI Engine
8. Authors (Affiliation)	Kuniyoshi Eto, Tatsuya Kuboyama, Yasuo Moriyoshi, Toshio Yamada (Chiba University)

9. Abstract

Knocking occurs within the high-speed range of small two stroke engines used in handheld work equipment. High-speed knock may be affected by the engine speed and delivery ratio. However, evaluation of these factors independently using experimental methods is difficult. Therefore, in this study, these factors were independently evaluated using numerical calculations. The purpose of this study was to clarify the mechanism by which the intensity of high-speed knocking that occurs in small two-stroke engines becomes stronger. The results suggest that temperature inhomogeneity due to insufficient mixing of fresh air and previously burned gas may induce high-speed knocking in the operating range at high engine speeds.

Abstracts of Technical Sessions

1. Date	**Thursday, November 3**
2. Room	**Room 409**
3. Time	**9:30 - 11:00**
4. Session	**Diesel Engine**
5. Chair (Affiliation),	**Tadao Okazaki (LEMA/ Kubota corporation)**
Co-chair (Affiliation)	**Roland Kirchberger (Graz University of Technology)**

6. Paper No.(JSAE/SAE)	20229013 / 2022-32-0013
7. Paper title	Effect of Pilot Injection on Improvement of Fuel Consumption and Exhaust Emissions of IDI Diesel Engines
8. Authors (Affiliation)	Yoshiyuki KIDOGUCHI, Yuzuru NADA, Tatsuya ICHIKAWA, Haruto MIYOSHI, Kazuhiro SAKAI (Tokushima University)

9. Abstract

It is well known that indirect injection (IDI) diesel engines have better exhaust performance but lower fuel economy than direct-injection (DI) diesel engines. In recent years, fuel efficiency has been strongly demanded to reduce global warming. Therefore, the IDI engine is required to reduce fuel consumption. According to past research, fuel injection control can be one of the means to improve fuel efficiency in the IDI system. This paper tried to apply two-stage fuel injection as one of the fuel injection control methods to improve fuel efficiency while suppressing exhaust emissions. Particularly, since it is considered necessary to reduce the amount of injection during the ignition delay period in the sub-chamber with the IDI type, two-stage injection with a small amount of pilot injection was applied. In the study, engine tests were first conducted by changing the injection timing with single-stage injection, and then, the heat generation processes were analyzed to understand the combustion characteristics that are important for improving fuel efficiency and exhaust performance with IDI diesel combustion. Based on these analyses, pilot injection was applied as a means of controlling combustion characteristics to improve fuel economy and exhaust emissions. As a result, it has been shown that if two-stage injection with a small amount of pilot injection is used in place of single-stage injection, combustion with a shortened combustion period is possible. This combustion can avoid delay of the end of combustion while suppressing the initial combustion, thereby improving fuel efficiency. Especially when the main injection timing is delayed later than that of single-stage injection, fuel injection can be performed without delaying the end of main injection due to pilot injection.

6. Paper No.(JSAE/SAE)	20229052 / 2022-32-0052
7. Paper title	Development of 1.5L Diesel Engine for Stage V with common rail system
8. Authors (Affiliation)	Shoichi Okimi, Kentaro Nagai, Reo Yoshida, Tomoya Akitomo, Takahiro Yamazaki (KUBOTA Corporation)

9. Abstract

EU StageV emissions regulations have been enforced in the European market since 2019, increasing environmental requirements for diesel engines. EU StageV has been tightened compared to EPA Tier4 regulation, which demand PM (Particulate Matter) reduction and added new PN (Particle Number) regulations.
Until the previous regulation EU Stage IIIA, the power category from 19kW to 37 kW had adopted mechanical IDI (Indirect-Injection). This mechanical engine is characterized by compactness and lightweight because of simple structure. Therefore, this engine is appreciated by customer with easy installation. On the other hand, to achieve EU StageV, it is necessary to adopt the electronic direct injection common rail system with more precise fuel injection and advanced exhaust gas aftertreatment device.The newly developed engine is not only small displacement of 1.5L, but also four-cylinders, and it is low vibration in addition compactness and lightweight. However, the bore of this engine is smaller than other similar displacements, because it is the unique four-cylinders. It was modified to DI (Direct-Injection) for the first time at this displacement, and common rail system was adopted. By applying Center-Direct-Injection-System, in which the injectors are arranged vertically at the center of combustion chamber, it was possible to inject fuel uniformly. Therefore, air and fuel are easily mixed even in small bore and small combustion chamber. Furthermore, Intake and Exhaust system were changed from two valves to four valves to intake more air. These modifications may increase engine dimensions, the exhaust emissions reduction device was specially designed, and we realized compactness and lightweight by new built-in arrangements.

6. Paper No.(JSAE/SAE)	20229068 / 2022-32-0068
7. Paper title	Studies on Spray and Combustion Characteristics of Throttle Type Nozzle Used in a Swirl-Chamber Diesel Engine
8. Authors (Affiliation)	Zenta Sudo, Beini Zhou, Yuma Hozen, Jin Kusaka (Waseda Univercity), Kenya Ajiro (Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.), Tomohiro Koga (Mitsubishi Heavy Industries, Ltd.)

9. Abstract

Among industrial engines, vortex chamber diesel engines are mainly used in small engines with output of less than 19 kW, and they employ an indirect injection system in which fuel is injected into a sub-chamber called a vortex chamber. The throttle-type nozzle used in swirl-chamber diesel engines is expected to change its spraying behavior depending on ambient conditions because the pressure fluctuations in the nozzle cause the needle valve to lift, and the injection amount is controlled by the amount of lift of the needle valve. In addition, the dimensions of the vortex chamber of a vortex chamber diesel engine are smaller than the spray development distance, and wall impingement of the spray is expected. In this study, spraying and combustion experiments were conducted using a constant volume chamber to understand the behavior of the spray from a throttle-type nozzle. Then, based on the obtained data, we developed a numerical simulation model to reproduce the hollow spraying behavior of a throttle nozzle.

Abstracts of NPT Sessions

1. Date	**Thursday, November 3**
2. Room	**Exhibition Hall C**
3. Time	**9:30 - 11:00**
4. Session	**New Product Technology Part 10 of 10**
5. Chair (Affiliation),	**Jun Ishikawa (Honda Motor Co., Ltd.)**
Co-chair (Affiliation)	**Guilherme Batalha (Graz University of Technology)**

6. Paper Number	NPT2022-017
7. Paper title	Development of NT1100
8. Authors (Affiliation)	Tasuku Oyama, Takazumi Hayashi, Shinsuke Yuki, Masaki Nishimura (Honda Motor Co., Ltd.)

9. Abstract

There is steady demands for big tourer motorcycles mainly in European countries. Many of such users switch from a middle-class motorcycle or an existing big tourer. To fill needs of such customers, we have recently developed a new big tourer model. With respect to the product concept, we set two issues; “user friendlier in casual use yet reliable in weekend touring” and “modern and elegant appearance”.
Accordingly, we set performance goals at “agility and pleasant wind flow in city use” and “stability and wind protection at higher speeds”. Keeping in mind higher speed riding and luggage-loaded travels, the frame body of the proven adventure tourer CRF1100L is employed, and the motorcycle’s dimension is altered for more on-road use. The split-type windscreen equipped with the height adjuster is applied to provide efficient wind protection at higher speeds as well as at lower speeds in city use. In terms of styling, the dynamic silhouette and the modern and elegant appearance of body surfaces are further shaped up with the character lines in each part. Thus realized is the big tourer NT1100.

6. Paper Number	NPT2022-019
7. Paper title	Development of Dax125
8. Authors (Affiliation)	Takashi Yagi, Toru Uesaka (Honda Motor Co., Ltd.), Yuichi Yokoyama (Honda R&D Co., Ltd.)

9. Abstract

In the Recent Japanese motorcycle, sales are growing in the smaller model segment having an engine under 125cc. Honda’ s models of that category for leisure purposes are popular among experienced users and so-called “return” users. Also in ASEAN countries, there is an increasing presence of such motorcycles as a means of self-expression by young people trying to go up the ladder. Keeping in mind the said backgrounds, we have recently developed for the growing market the Honda Dax125 having a steel monocoque frame with an emphasis on Honda’ s uniqueness. The unique steel monocoque frame serving as an exterior design part is the biggest feature of this model and realizes a lovely and eyecatching styling design having casual atmosphere. With the pressed-steel, T-shaped monocoque frame serving as a key component, various functional parts such as the fuel tank, the air filter, and the accessories are contained in it. The frame dimension is determined to allow riding with a passenger and to help ensure adequate strength and stiffness when coupled with the 125cc engine. The styling design, the component parts design and the analysis by CAE were conducted simultaneously when determining the layout of complete motorcycle. This developed is the new Dax125 which has nostalgic yet fresh atmosphere and allows casual riding with a passenger as a “family-and-leisure sneakers”.

6. Paper Number	NPT2022-027
7. Paper title	Development of a new electric three-wheeled vehicle “noslisu” that combines natural maneuverability, stability, and loading capacity
8. Authors (Affiliation)	Hiroshi Ishii, Takeshi Nakajima, Wataru Yamamoto (Kawasaki Motors, Ltd.)

9. Abstract

Kawasaki Motors, Ltd. will release a new electric threewheeled vehicle named “noslisu” series in the spring of 2023. “Noslisu” is an electric three-wheeled vehicle developed by our company that has abundant load ability, stable running, and unique functional beauty. The development of “noslisu” began with the desire to contribute to the affluent lives of more people in society by providing them with mobility that is safe, comfortable, and easy to move around on. By adopting a unique and patented leaning mechanism that combinesthe stability inherent to three-wheeled vehicles with our mobility development technology cultivated in the motorcycle business, we have achieved smooth and stable driving with minimal risk of tipping over. In addition, since the vehicle stands on its own even when empty, no kickstand is needed when parking.
The “noslisu cargo” was developed to meet the many requests for “more cargo”. By securing a loading space in the center of the vehicle, the “noslisu cargo” has the largest loading capacity of all the “noslisu” series. This makes the “noslisu cargo” ideal for use in many logisticsscenarios, such as parcel delivery and in-plant transportation. Therefore, it will also contribute to the realization of carbon neutrality in the logistics industry, the utilization of diverse human resources, and the exploration of an alternative means of transportation to automobiles.
In the future, we plan to market the product to general consumers. By realizing outdoor leisure activities and the ability for anyone to carry and transport large-capacity cargo easily, we will open up new possibilities for diversifying lifestyles. By developing these three sets of specifications, we will contribute to the realization of a safer and more comfortable world with carbon neutrality. This article will explain the concept of “noslisu,” our efforts to realize the technology and, finally, our future plans.