Session Timetable

	Room	104&105	107	108	206	207
November 8th Tuesday	9:00–10:30	Opening Ceremony & Keynote Address (at Hall C)			Opening Ceremony & Keynote Address (at Hall C)	
	10:30–11:00	Coffee Break			Coffee Break	
	11:00–12:30		Materials	Measurement & Simulation Ⅰ	Engine Technology Ⅰ	Hybrids, Electric Drives & Fuel Cells Ⅰ
			Chair : H. Kurita	Chair : T. Okazaki	Chair : H. Okumura	Chair : Y. Muramatsu
			Co-Chair : B. Callahan	Co-Chair : R. Kee	Co-Chair : N. Mavinahally	Co-Chair : G. Bower
			20119504/2011-32-0504		20119509/2011-32-0509	20119527/2011-32-0527
			20119630/2011-32-0630 (cancelled)	20119653/2011-32-0653	20119615/2011-32-0615	20119592/2011-32-0592
			20119645/2011-32-0645	20119559/2011-32-0559	20119595/2011-32-0595	20119596/2011-32-0596
	12:30–14:00	Lunch (at Hall A &B)			Lunch (at Hall A &B)	
	14:00–15:30		Fuel Supply Systems Ⅰ	Measurement & Simulation Ⅱ	Engine Technology Ⅱ	Hybrids, Electric Drives & Fuel Cells Ⅱ
			Chair : I. Taki	Chair : S. Fujii	Chair : H. Okumura	Chair : Y. Muramatsu
			Co-Chair : J. Tromayer	Co-Chair :R. Kee	Co-Chair : N. Mavinahally	Co-Chair : G. Bower
			20119564/2011-32-0564	20119563/2011-32-0563	20119538/2011-32-0538	20119586/2011-32-0586
			20119625/2011-32-0625	20119639/2011-32-0639	20119557/2011-32-0557	20119644/2011-32-0644
			20119528/2011-32-0528		20119555/2011-32-0555	20119647/2011-32-0647
	15:30–16:00	Coffee Break			Coffee Break	
	16:00–17:30		Fuel Supply Systems Ⅱ	Vehicle Components	Engine TechnologyⅢ	Hybrids, Electric Drives & Fuel CellsⅢ
			Chair : I. Taki	Chair : T. Kobayashi	Chair : T. Shiozaki	Chair : Y. Muramatsu
			Co-Chair : J. Tromayer	Co-Chair : J. Carroll	Co-Chair : A.Trattner	Co-Chair : G. Bower
			20119570/2011-32-0570		20119506/2011-32-0506	20119546/2011-32-0546
			20119582/2011-32-0582	20119519/2011-32-0519	20119566/2011-32-0566	20119556/2011-32-0556
			20119601/2011-32-0601	20119611/2011-32-0611	20119585/2011-32-0585	20119560/2011-32-0560
November 9th Wednesday	8:00–10:00	Advanced Combustion Ⅰ	Lubricants Ⅰ	Vehicle Dynamics & Safety	Diesel Engines	Emissions Ⅰ
		Chair : Y. Moriyoshi	Chair : T. Nakazono	Chair : M.Baba	Chair : Y. Tokunaga	Chair : H. Deguchi
		Co-Chair : R. Kirchberger	Co-Chair : J. Tromayer	Co-Chair : J. Carroll	Co-Chair : B. Callahan	Co-Chair : R. Kee
		20119521/2011-32-0521	Organized Speech	20119537/2011-32-0537	20119576/2011-32-0576	
		20119522/2011-32-0522	20119634/2011-32-0634	20119502/2011-32-0502	20119602/2011-32-0602	20119532/2011-32-0532
		20119524/2011-32-0524	20119513/2011-32-0513	20119548/2011-32-0548	20119606/2011-32-0606	20119554/2011-32-0554
		20119659/2011-32-0659	20119545/2011-32-0545	20119558/2011-32-0558	20119635/2011-32-0635	20119654/2011-32-0654(cancelled)
	10:00–10:30	Coffee Break			Coffee Break	
	10:30–12:00	Advanced Combustion Ⅱ	Lubricants Ⅱ	Measurement & SimulationⅢ	Alternative Fuels Ⅰ	Emissions Ⅱ
		Chair : Y. Moriyoshi	Chair : T. Nakazono	Chair : S. Fujii	Chair : K. Yoshida	Chair : H. Deguchi
		Co-Chair : R. Kirchberger	Co-Chair : B. Dohner	Co-Chair : S. Schmidt	Co-Chair : A. Trattner	Co-Chair : R. Kee
		20119523/2011-32-0523	20119536/2011-32-0536	20119518/2011-32-0518	20119535/2011-32-0535	20119511/2011-32-0511(cancelled)
		20119574/2011-32-0574	20119651/2011-32-0651	20119623/2011-32-0623	20119551/2011-32-0551	20119572/2011-32-0572
		20119577/2011-32-0577	20119553/2011-32-0553	20119643/2011-32-0643	20119552/2011-32-0552	20119587/2011-32-0587
	12:00–13:30	Lunch (at Hall A &B)			Lunch (at Hall A &B)	
	13:30–15:00	Advanced Combustion Ⅲ	Collegiate Events Ⅰ	NVH Technology	Alternative Fuels Ⅱ	EmissionsⅢ
		Chair : A. Iijima	Chair : T. Mitome	Chair :T. Okazaki	Chair : K. Yoshida	Chair : H. Deguchi
		Co-Chair : R. Kirchberger	Co-Chair : J. Carroll	Co-Chair : J. Tromayer	Co-Chair : A. Trattner	Co-Chair : G. Bower
		20119589/2011-32-0589	20119549/2011-32-0549	20119650/2011-32-0650	20119591/2011-32-0591	
		20119600/2011-32-0600	20119571/2011-32-0571	20119514/2011-32-0514	20119632/2011-32-0632	20119512/2011-32-0512
		20119610/2011-32-0610	20119578/2011-32-0578	20119642/2011-32-0642		20119657/2011-32-0657
	15:00–15:15	Coffee Break			Coffee Break	
	15:15–17:35	Plenary Session (at Hall C)			Plenary Session (at Hall C)	
November 10th Thursday	8:00–10:00		Collegiate Events Ⅱ	Measurement & SimulationⅣ	Alternative FuelsⅢ	Engine Control Ⅰ
			Chair : T. Mitome	Chair : T. Okazaki	Chair : Y. Motoyama	Chair : Y. Nitta
			Co-Chair : J. Carroll	Co-Chair : S. Schmidt	Co-Chair : N. Mavinahally	Co-Chair : T. Raatz
				20119608/2011-32-0608		20119626/2011-32-0626
				20119529/2011-32-0529		20119627/2011-32-0627
			20119579/2011-32-0579	20119525/2011-32-0525	20119562/2011-32-0562	20119510/2011-32-0510
			20119580/2011-32-0580	20119526/2011-32-0526	20119605/2011-32-0605	20119629/2011-32-0629
	10:00–10:30	Coffee Break			Coffee Break	
	10:30–12:00		Collegiate EventsⅢ	Engine Components	Alternative FuelsⅣ	Engine Control Ⅱ
			Chair : T. Mitome	Chair : T. Kobayashi	Chair : K. Yoshida	Chair : Y. Nitta
			Co-Chair : B. Callahan	Co-Chair : S. Schmidt	Co-Chair : N. Mavinahally	Co-Chair : T. Raatz
			20119588/2011-32-0588			20119631/2011-32-0631(cancelled)
			20119656/2011-32-0656	20119649/2011-32-0649	20119561/2011-32-0561	20119637/2011-32-0637
			20119617/2011-32-0617	20119613/2011-32-0613	20119590/2011-32-0590	20119581/2011-32-0581
	12:00–13:30	Lunch & Closing Ceremony (at Hall C)			Lunch & Closing Ceremony (at Hall C)	

Abstracts of Technical Session

Tuesday, November 8, 11:00 - 12:30 at Room 107

Materials

Chair: Hirotaka Kurita (Yamaha Motor Co., Ltd.), Co-Chair: Brian Callahan (Achates Power & Basco)

[20119504/2011-32-0504]

Evaluation of J Factor and Leakage Quality for High Pressure Die Casting Applied Closed-deck Type Cylinder Block

Yamada Youji (Yamaha Motor Co., Ltd.), Yoshii Hiroshi (Yamaha Motor Co., Ltd), Anzai Koichi, Oikawa Katsunari (Graduate School of Engineering, Tohoku University), Yuuta Bannai (Yamaha Motor Co., Ltd.), Jun Yaokawa (Tohoku University), Mochizuki Satoshi (Yamaha Motor Co., Ltd.)

The relationship of J factor and internal casting quality in high pressure die casting was investigated by leakage testing conducted after the machining process. The trial die, used for motorcycle engine applications, was a single closed-deck-type linerless cylinder block with an expendable salt core. The J factor was calculated by using the VanRens equation with varied gate thickness, gate speed, plunger diameter, and casting pressure. To confirm casting quality by leakage testing, we conducted X-ray computerized tomography (XRC), micro-focus XRC, and thermal decomposition gas chromatographic determination analysis. In addition, XRC was used to calculate the total shrinkage volume. A strong correlation was found between the J factor and tightness against pressure leakage.

[20119630/2011-32-0630]

Lightening Approach for Small Vehicles by Developing Extruded Aluminum Suspension Arm

Ryo Yamauchi (SUZUKI MOTOR CORPORATION), Gouki Yotsuya (SUZUKI MOTOR CORPORATION)

This paper shows the lightening approach for small vehicles by developing lower arm of the hollow extruded aluminum, which is the low cost material and has closed cross section. The manufacturing cost was reduced by developing the industrial method to form the developed lower arm of the extruded aluminum by cold press, without welding. In addition, the developed method forming of the heat-treated extruded aluminum reduces the manufacturing cost more, compared to the conventional method forming before the heat treating. The structure of the developed lower arm has the wide center part receiving the coil spring and the narrow end part connecting to the vehicle body with the bush. The center part has the same cross section as the extruded aluminum, and the end part was formed by shrinking the extruded aluminum by cold press. In addition, the original expanding clinching method was developed to joint the aluminum outer tube of the bush for the prevention action against the galvanic corrosion. As mentioned above, the lightening approach for the suspension parts of small vehicles have been achieved by developing the lower arm made of the extruded aluminum with the elemental technologies of the material, structure and joint. The developed lower arm has already been adopted for the rear suspension of our passenger car, and achieves the weight lightening of 30% and the cost reduction of 22% compared to the conventional steel lower arm. In addition, that achieves the weight lightening of 50% compared to the lower arm made of aluminum by high vacuum die-casting. Hereafter, this developed approach by the extruded aluminum will be evolved widely to the suspension parts of not only passenger car but also the other small vehicles like ATV and EV commuter.

[20119645/2011-32-0645]

Anodizing method for Aluminum alloy by using high-frequency switching electrolysis

Hiroomi Tanaka (SUZUKI MOTOR CORPORATION), Masahiro Fujita, Hitoshi Muramatsu, Tomoharu Yamamoto (SUZUKI MOTOR CORPORATION), Sachiko Ono, Hidetaka Asoh (Kogakuin University)

Anodizing is applied to improve the durability and the corrosion resistance of aluminum alloy parts of engines and car bodies. Generally, anodic oxide film is formed using direct current anodizing (DCA). However, in the case of anodizing high silicon aluminum alloy cast parts, it is difficult to derive uniform film thickness distribution. Furthermore, it takes a long treatment time which causes low productivity. In this study, the authors have developed an anodizing method by using high-frequency switching anodizing (HSA) to solve these problems. The growth process of anodic oxide film is susceptible to the metallographic structure. Thus, the typical DCA application to the high silicon aluminum alloy produces a non-uniform film thickness, while HSA has the potential to form uniform film without being affected by metallographic structure. Moreover, the current density of HSA is higher than that of DCA which reduces treatment time to 1/5 as the film formation enhances. Our investigation is to apply HSA to the mass produced engine pistons that require both high durability and low cost.

Abstracts of Technical Session

Tuesday, November 8, 11:30 - 12:30 at Room 108

Measurement & Simulation I

Chair: Tadao Okazaki (Kubota Corporation), Co-Chair: Robert Kee (Queen's University Belfast)

[20119653/2011-32-0653]

The stress measurement of the crankshaft for high-performance engine

Satoshi Takayama (SUZUKI MOTOR CORPORATION), Kunio Arase (SUZUKI MOTOR CORPORATION)

To measure the stresses acting on the crankshaft of an engine, signals must be taken out from the rapidly spinning shaft. This paper discusses the measurement of stress signals from the crankshaft using a slip ring, which is the conventional method. By developing a special fixture that allowed us to measure rotations up to 14,000 rpm and using the fourgauge method, we succeeded in accurately measuring stress waves. We confirmed that, during the motoring operation, stresses due to the secondary component of the inertia forces of the reciprocating parts are dominant and that, during the firing operation, deformation occurs at various frequency bands. As the engine speed increased, the stress amplitude increased and reached a maximum around the highest engine speed. The results of a static analysis predicted values close to actual measurements. The experiment confirmed the possibility of developing an effective analysis method, by repeating validations, for predicting the reliability of crankshafts.

[20119559/2011-32-0559]

New Three-dimensional Piston Secondary Motion Analysis Method Coupling Structure Analysis and Multi Body Dynamics Analysis

Hirotaka Murakami (Honda R&D Co., Ltd.), Narutake Nakanishi, Naoto Ono, Tomoharu Kawano (Honda R&D Co., Ltd.)

A new piston secondary motion analysis has been developed that accurately predicts piston strength and the slap noise that occurs when the engine is running. For this secondary motion analysis, flexible bodies are used for the models of the piston, cylinder and cylinder head. This makes it possible to quantify the deformations and secondary motion occurring in each area of the engine. The method is a coupled analysis of the structure analysis and the multi body dynamics analysis. The accuracy of the results obtained in the new analysis method was verified by comparing them to measurement data of piston skirt stress and piston secondary motion taken during firing. To measure piston skirt stress, a newly developed battery-powered telemetric measurement system was used. The calculation results were close to the measurement results both for stress and for secondary motion from low to high engine speed. The same comparison was carried out on the vibrational acceleration produced on the cylinder, to determine how piston pin offset and piston skirt rigidity affect piston slap noise. Those calculation results of the vibrational acceleration also closely matched the results of the measurement. With those results, it has been confirmed that this method is an effective tool to make a comparison among different specifications of pistons. This developed method makes it possible to examine the specifications of pistons which are light weighted but still durable with minimal slap-noise.

Abstracts of Technical Session

Tuesday, November 8, 11:00 - 12:30 at Room 206

Engine Technology I

Chair: Hideyuki Okumura (Yamaha Motor Co., Ltd.), Co-Chair: Nagesh Mavinahally (MavinTech, LLC)

[20119509/2011-32-0509]

Compressed Air as a Quality and Pollution Free Fuel Substitute in Reciprocating Engines － Effective Solutions to Improve Engine Performance

Takayuki Sugita (Sanyo High School in Hiroshima)

An existing 4 stroke-cycle gasoline engine has been partially modified without dynamically changing its mechanism for the purpose to utilize compressed air as an alternative energy source. The principle is to mechanically control the compressed air flow through the intake and exhaust valves every revolution of the crankshaft by modifying the camshaft cam's lobes, which changes the engine operation from 4 strokes to 2 strokes cycle mode. In the previous investigation the principle was verified with a current 50 cc motorcycle modified engine and the pressure behavior inside the cylinder of the compressed air engine was evaluated. It turned out that the back pressure, which is defined as the positive pressure left in the expansion chamber while the piston is moving back from the bottom dead center to the top dead center, has high influence on the performance of the compressed air reciprocating engine. In this investigation the same pressure and performance measurement were conducted for the modified engine assembled the cylinder with side holes drilled to confirm an effect on the back pressure relief, thus verifying one of the effective solutions to improve the performance of the compressed air reciprocating engine.

[20119615/2011-32-0615]

Performance of Air Motor with Regenerating System Designed for Propulsion of Bicycle

Asako Sato (Graduate School of Science and Technology, Nihon University), Akira Iijima, Hideo Shoji, Koji Yoshida (Nihon University)

An air motor with regenerating system for propulsion of a bicycle was newly developed. An air motor was driven by the compressed air and the bicycle was propelled. When the bicycle was decelerating, the air motor was acted as a compressor and the kinetic energy of bicycle was regenerated as compressed air. The purpose of this study is to elucidate the performance of air motor and driving characteristic of bicycle. The air motor in this study was the reciprocating piston type like an internal combustion engine, and cylinder arrangement was in-line two-cylinder. The output power increased with an increase of supply air pressure although the maximum cylinder pressure was less than the supply air pressure. The output power decreased as the revolution increased due to friction loss. The maximum cylinder pressure reduced as the rotational frequency increased because the inlet valve opening duration was decreased. The regenerating pressure decreased at the high revolution because of compressed air leakage. The bicycle was gradually accelerated and the maximum velocity was about 10 km/h because the out put power was not enough to acceleration. Therefore, the friction loss of moving parts and air leakage should be improved to obtain the desired performance.

[20119595/2011-32-0595]

Compact Engine Architecture for Best Fuel Efficiency and high Performance - Challenge or Contradiction

Christian Hubmann (AVL List GmbH), Wolfgang J Schoeffmann, Hubert Friedl, Michael Francis Howlett (AVL List GmbH)

The world of automotive engineering shows a clear direction for upcoming development trends. Stringent fleet average fuel consumption targets and CO_2 penalties as well as rising fuel prices and the consumer demand to lower operating costs increases the engineering efforts to optimize fuel economy. Passenger car engines have the benefit of higher degree of technology which can be utilized to reach the challenging targets. Variable valve timing, downsizing and turbo charging, direct gasoline injection, highly sophisticated operating strategies and even more electrification are already common technologies in the automotive industry but can not be directly carried over into a motorcycle application. The major differences like very small packaging space, higher rated speeds, higher power density in combination with lower production numbers and product costs do not allow implementation such high of degree of advanced technology into small-engine applications. With these boundary conditions and the fact that the demand of lowering CO_2 emissions is also evident in the small engine market, solutions need to be created which are suitable for compact engine (CE) applications without major impact on the overall engine architecture. Therefore the development trend is focused on measures which can be easily implemented into existing engine design and powertrain packages optimizing: (Contd.)

Abstracts of Technical Session

Tuesday, November 8, 11:00 - 12:30 at Room 207

Hybrids, Electric Drives & Fuel Cells I

Chair: Yasuyuki Muramatsu (Yamaha Motor Co., Ltd.), Co-Chair: Glenn Bower (University of Wisconsin)

[20119527/2011-32-0527]

Improvement of Fuel Consumption for the Strong Hybrid Motorcycle

Yukiharu Yuki Hosoi (Yamaha Motor Co., Ltd.)

Any improvements of the fuel economy with engines are always required for all petroleum fuel vehicles. Such improvements often accompany some changes of the engine characteristics. It may cause slight disharmony with driving performances of the acceleration and/or top speed. The riding feelings on the motorcycles are so sensitive that means of changes for engine characteristics are limited to maintain good response in transition. We have developed the strong hybrid motorcycle "HV-X". It consists of a 4-stroke 250cm^3 a cylinder engine and two 300V AC motors with a planetary gear set. Though the engine comes from a conventional scooter, utilizing the electric power, the HV-X attains better fuel economy without severe influence onto the drive performance even the engine character changes.

[20119592/2011-32-0592]

Concept Study of Range Extender Applications in Electric Scooters

Hans-Juergen Schacht (Graz University of Technology), Franz Winkler, Roland Kirchberger, Stephan P. Schmidt (Graz University of Technology)

Nowadays, politicians are forced by air pollution prevention to demand zero emission vehicles (ZEV) in the form of pure electric vehicles. The poor capacity to weight factor of actual batteries compared to any kind of liquid or gaseous hydro-carbon fuel is the main reason for the retarded implementation of ZEV. Solutions offered by automobile manufacturers are mild to full hybrid powertrains based on the well established ICE platform. The difficulty of those approaches of electrification is to compete with the performance and benefit costumers expect from standard automobiles. Pure electric vehicles are rare and often disappointing regarding range and/or performance. Additionally the costs for such vehicles, which are mainly driven by the battery prices, are comparatively high, impeding their market entrance and acceptance. Low price electric city scooters are actually offered as pure electric vehicles in a wide variety of different models. The category of city scooters (L1e [1]) is regulated regarding limited speed and engine capacity. The driving distance is generally short and additional comfort features (such as heaters or air condition) are not expected nor demanded by the customers. The selling numbers of electric city scooters are strongly depending on the local legislation. (Contd.)

[20119596/2011-32-0596]

Novel range extender concepts for 2025 with regard to small engine technologies

Alexander Trattner (Graz University of Technology), Patrick Pertl, Stephan Schmidt (Graz University of Technology), Takaaki Sato (DENSO Automotive Deutschland GmbH)

Energy politics and environmental circumstances demand novel strategies for private transport. Several studies have shown that one of these possibilities can be an electric vehicle with a range extender - REX. Today these REX engines are under way as derivation from modern internal combustion engines. As the need for an optimized usage of energy will further increase in the future, alternative energy converter systems have to be investigated. For DENSO, as supplier of components, it is of strong interest how the basic layout of these concepts could look like. This is necessary in order to be prepared for the specific needs of these concepts in terms of auxiliaries, electric / electronic components as well as for the cabin climate & various control strategies. In these REX-concepts all energies have to be considered. A sophisticated usage of energy inside a REX vehicle is required which leads to the investigation of a combined heat and power usage on-board. Using know-how and experience from small engine research and manufacturing, the range extender solutions can be treated in a very efficient and target-oriented way. Within this study alternative concepts using fossil energy as on-board power plants are being researched for the application in a range extender vehicle after 2025. Based on an analysis and derivation of requirements for upcoming scenarios high potential range extender solutions are investigated. As possible application mechanical energy generation as well as a combined heatpower generation is considered. In the following, a detailed examination of these high potential solutions is performed. This covers simulations and calculations of the necessary and relevant sections in order to generate know-how, identify crucial points, main issues and possible solutions.

Abstracts of Technical Session

Tuesday, November 8, 14:00 - 15:30 at Room 107

Fuel Supply Systems I

Chair: Isato Taki (SUZUKI MOTOR CORPORATION), Co-Chair: Juergen Tromayer (Graz University of Technology)

[20119564/2011-32-0564]

Development of Intake Air Pressure Sensorless Fuel Injection System for Small Motorcycles

Yuki Takano (Honda R&D Co., Ltd.), Katsuhiro Utsugi, Kazuhiko Sakaguchi, Kenta Onishi (Honda R&D Co., Ltd.)

A new control system using O_2 feedback control has been developed as an alternative to intake air pressure sensors. This control method uses the operational condition compensation coefficient Kbu. This coefficient encompasses the state of the engine and environmental conditions such as atmospheric pressure, and corrects fuel injection in response to changes in these factors. Kbu makes it possible to control the amount of fuel injection without depending on an intake air pressure sensor. It also makes it possible to carry out the appropriate air-fuel ratio correction even at times when O_2 feedback control is not operating, such as the cold period, when the engine is first started, or during transient operation, by using Kbu values recorded in the Engine Control Unit. (henceforth ECU) This technology has made it possible to build a simplified electronically controlled fuel injection system for small motorcycles, while maintaining the same performance for exhaust emissions and fuel efficiency without an intake air pressure sensor.

[20119625/2011-32-0625]

Reduction of operation noises of Injector for small motorcycle

KENICHI SAITOH (Keihin Corporation), Mitsutomo Kawahara, Kazuhiko Sato (Keihin Corporation)

We have extended application of fuel injectors (hereafter as “injector”) for small motorcycle engines in developing countries by making it compatible with various engine displacements and trims as well as satisfying the needs from a variety of operating and environmental conditions. The motorcycles with a small-displacement engine are mainly for developing countries and often have an uncovered engine. Accordingly, a noise-insulating cover was indispensable to insulate injector noises. Since it was necessary to attain a low cost for the complete motorcycle by elimination of the noise-insulation cover for extensive application of an electronic fuel injection system (hereafter “FI”) in developing countries, we developed the quiet injector by thorough reduction of mass of the needle valve and lowering of the operation speed.

[20119528/2011-32-0528]

Piezoelectric Controlled Carburettor

Michael Reke (VEMAC GmbH & Co. KG), Sebastian Grobosch, Kai Niegetiet (VEMAC GmbH & Co. KG)

Small combustion Engines equipped with a conventional carburetor system have the disadvantage of incomplete combustion in different load ranges because of a sub optimal air fuel ratio. The results are harmful exhausts, high fuel consumption and a low degree of efficiency. Based on this problem VEMAC has invented the patented Piezoelectric Controlled Carburetor (PCC). A small piezo bending actuator in front of the fuel jet allows controlling the fuel flow through the jet according to the desired air-fuel-ratio (AFR) and the engine performance. To control the piezo bending actuator and process the data of the incoming sensor signals an engine control unit (ECU), with modular software architecture for different applications was developed. This paper describes the working principle of the PCC technology and presents the most up-to-date development and test results. The clear benefits of the PCC system with less fuel consumption and exhaust emissions compared to conventional carburetors to meet next level emission regulations are shown. The paper demonstrates that these benefits are achievable with a simple and cheap alternative to injection systems and discusses the advantages also in comparison to other electronic controlled carburetion systems, which were published in the last few years.

Abstracts of Technical Session

Tuesday, November 8, 14:00 - 15:30 at Room 108

Measurement & Simulation Ⅱ

Chair: Shigeru Fujii (Yamaha Motor Co., Ltd.), Co-Chair: Robert Kee (Queen's University Belfast)

[20119563/2011-32-0563]

Dynamic Simulation of Water and Soil using Particle Method

Yosuke Yamamoto (Honda R&D Co., Ltd.), Takayuki Sato, Genki Anraku (Honda R&D Co., Ltd.)

In conventional CAE (Computer Aided Engineering), methods using grids, such as the finite element method and the finite volume method, are commonly used. However grids are sometimes problematic in cases of dynamic free surface flows, with large deformation or breaking.
In this study, a novel three-dimensional fluid, structural analysis simulation program to reproduce the dynamic behavior of water or soil in the mechanical parts of a product equipped with a small engine was developed. This simulation program expresses water or soil as particles within boundaries having complicated configuration. These particles are then replaced with a polygon model to lower calculation load and to improve accuracy of configuration reproducibility. In the structural analysis, a breaking condition which considers the effect of soil compaction was designed to reproduce the break up of material with special characteristics such as soil.
Water splashing by an outboard engine was reproduced and the difference of two types of outboard engine configurations could be successfully expressed using the polygon model within the boundaries. Analytical results favorably corresponded to the experimental results qualitatively. Soil behavior by a tiller was reproduced and two different cases of breaking were analyzed. (Contd.)

[20119639/2011-32-0639]

INTRODUCTION OF COMPUTER SIMULATION TECHNOLOGY FOR ELECTRODEPOSITION PAINTING PROCESS

Takeshi Kashiyama (SUZUKI MOTOR CORPORATION)

The electrodeposition painting can make a coat adhere not only to the exterior surface but also on the inside of an object, and has excellent corrosion resistance. Therefore, it is widely used as paint for anti-corrosion to various vehicles. In electrodeposition painting, by the electricity from an electrode flowing into the surface of an object through paint solution, a paint deposits to the surface of an object and a paint film is formed. Therefore, if the object is simply in contact with paint solution, a paint film will not necessarily be formed. For example, even if paint solution has touched, since the electrical resistance of paint solution is not high, sufficient current flows through the outside of a motorcycle frame, nor the inner surface of the automobile body and a paint film may not be formed. In order to check the paint film thickness of electrodeposition painting conventionally, it was measuring by disassembling the actually painted object. As a result of measurement, when paint film thickness is inadequate, it is necessary to cope with the addition of a hole, part form change, etc. (Contd.)

Abstracts of Technical Session

Tuesday, November 8, 14:00 - 15:30 at Room 206

Engine Technology Ⅱ

Chair: Hideyuki Okumura (Yamaha Motor Co., Ltd.), Co-Chair: Nagesh Mavinahally (MavinTech, LLC)

[20119538/2011-32-0538]

Research on Noise Reduction of Linkage Drive Gear in Extended Expansion Linkage Engine

Gaku Naoe (Honda R&D Co., Ltd.), Kota Tokubi (Honda R&D Co., Ltd.)

The authors have reported on a study on extended expansion linkage engine to enhance thermal efficiency since 2006. This report discusses the use of a test engine applied to a Micro Combined Heat and Power Generation Unit for household use, in order to reduce engine noise at a rated operation.
Test engine noise is mainly caused by gear meshing for the multiple linkage system, so helical gear with higher contact ratio than that of spur gear was used. Measurement of engine noise revealed that test engine noise increased by 3.2 dB(A) over compared conventional engine. From results of behavior analysis by mechanical simulation, when transmission direction of the relative torque between the crankshaft and the eccentric shaft is reversed, the direction of the thrust force acting on the gear is reversed. For this reason, the test engine noise increases because each shaft vibrates, and rattle noise occurs. With the aim of reducing rattle noise, it is possible to control axial vibration using hydraulic pressure to act on each shaft ends. As a result, rattle noise is resolved, and the test engine noise achieves same noise level of the conventional engine.

[20119557/2011-32-0557]

Advanced Combustion System Analyses on a 125cc Motorcycle Engine

Frank Schuerg (Robert Bosch GmbH, Germany), K. Manikandan, Peter Roth (Bosch Ltd., India), André Kulzer, Andreas Kufferath (Robert Bosch GmbH, Germany)

Environmental consciousness and tightening emissions legislation push the market share of electronic fuel injection within a dynamically growing world wide small engines market. Similar to automotive engines during late 1980's, this opens up opportunities for original equipment manufacturers (OEM) and suppliers to jointly advance small engines performance in terms of fuel economy, emissions, and drivability.
In this context, advanced combustion system analyses from automotive engine testing have been applied to a typical production motorcycle small engine. The 125cc 4-stroke, 2-valve, air-cooled, single-cylinder engine with closed-loop lambda-controlled electronic port fuel injection was investigated in original series configuration on an engine dynamometer. The test cycle fuel consumption simulation provides reasonable best case fuel economy estimates based on stationary map fuel consumption measurements. For Indian Driving Cycle (IDC) it yielded roughly 1.4l/100km, for World Motorcycle Test Cycle (WMTC) 1.8l/100km. The thermodynamic split of losses analysis of test-cycle relevant operating points provides deeper physical insight into engine physics and reveals optimization potential. Namely, full load and low load enrichment increase fuel consumption, particularly at high engine temperatures. At colder engine, the ignition system is not capable to maintain an efficiency-optimal combustion phasing and the engine roughness increases. Such findings shall promote the development of customized single components and complete modular systems for 2-wheelers.

[20119555/2011-32-0555]

Reduction of Engine Oil Consumption and Durability Improvement of Four Stroke Forced Air Cooled SI Engine

Parthiban Rajamani (TVS Motor Company Ltd.), B Sadesh, Mohan D Umate, V Lakshminarasimhan, G Gnanakotaiah (TVS Motor Company Ltd.)

Engine oil consumption constitutes a significant share of the operating costs for a commercial vehicle and increases the HC emissions. This paper presents an experimental study of various measures to reduce engine oil consumption for a four stroke, single cylinder spark ignition engine as a part of development of a light commercial passenger carrier. By studying the piston geometry, ring pack, cylinder bore distortion, cylinder block, piston and ring heat transfer, the following parts were redesigned to reduce the engine oil consumption - piston geometry, cylinder block fin, oil jet for piston under crown, cooling fan profile and breather circuit. With the new design configuration the oil consumption under highway endurance conditions reduced by 30% while that under city endurance reduced by as high as 50%. The resultant design modifications also improved the durability of cylinder block and piston parts by 70%.

Abstracts of Technical Session

Tuesday, November 8, 14:00 - 15:30 at Room 207

Hybrids, Electric Drives & Fuel Cells Ⅱ

Chair: Yasuyuki Muramatsu (Yamaha Motor Co., Ltd.), Co-Chair: Glenn Bower (University of Wisconsin)

[20119586/2011-32-0586]

A methodical approach for thermal management simulation of hybrid powersport applications

Stephan P. Schmidt (Graz University of Technology), Paul Rieger, Hermann Edtmayer, Alexander Trattner (Graz University of Technology), Christof Dutzler, Gregor Heitzinger (BRP-Powertrain GmbH & Co. KG)

Within the automotive sector, the hybridization of the powertrain is well investigated and first announcements about mass production start dates have been made. Studies have shown that improvements regarding fuel economy and emission are possible. This potential and additional positive effects regarding driving performance should also be gained for the power-sport sector, even though very few investigations have been performed for this vehicle class. Though the requirements for a power-sport drivetrain differ from that of the automobile sector due to the high demand on the transient behavior, intense investigations have been started. The use of a complete vehicle simulation during the development of a hybrid vehicle is advantageous in the early phase and in the pre series calibration phase. The foreground topic for the simulation of a conventional powertrain is the power and torque distribution. For hybrid architecture it is additionally necessary to focus on the thermodynamic energy flows between the single components [1]. This publication covers the development of a complete vehicle simulation for a power sport vehicle based on a longitudinal dynamics simulation. The research was performed by a research consortium under the patronage of the ECO-PowerDrive project, which is funded by the Austrian government within the COMET excellence initiative. Focus of the enhancements were based on the existing models, the modular setup, a methodology for data exchange between the partners as well as the integration of a basic thermo-management model [2]. Within this paper, the description of a power-sport vehicle with respect to its thermal behavior and the thermal analysis and assessment is treated exemplarily. During the development of a hybrid vehicle it is important that all energy flows are known in quality and quantity in order to estimate the potential of the single components as there are internal combustion engine, power electronics, battery and e-motor. As a consequence of these estimations an effective operating strategy can be found.

[20119644/2011-32-0644]

Development and Evaluation of Air-Cooled Fuel Cell Scooter

Kengo Ikeya (SUZUKI MOTOR CORPORATION), Yohei Takada, Toru Eguchi, Kazuhiko Mizutani, Tohru Ohta, Kazuyuki Hirota (SUZUKI MOTOR CORPORATION)

Suzuki Motor Corporation unveiled the Burgman Fuel Cell Scooter (Burgman FCS) at the “TOKYO MOTOR SHOW 2009”. It is a simple and high-efficiency fuel cell scooter, which is equipped with a compact and unique air-cooled fuel cell system, jointly developed with the UK firm, Intelligent Energy Ltd. In order to evaluate the vehicle performance and find any powertrain related issues from actual road and traffic conditions, it has been tested in a fleet testing program supported by the UK Technology Strategy Board (TSB), in UK since February 2010. In addition, seeking for different operating conditions, it is planned to provide it in 2011 to a further field test to be held in Japan. Additionally in March 2011, it obtained Whole Vehicle Type Approval (WVTA) in the European Union; the first time this has been achieved for any fuel cell vehicle. This proved that it has achieved the high level environmental acceptability and safety requirements which are essential for the practical scooter. This paper describes the system outline of the vehicle including the safety perspectives, as well as the knowledge and outcomes obtained from the fleet testing results.

[20119647/2011-32-0647]

Integration Challenges for Air Cooled Fuel Cell Systems in Vehicles

Damian Patrick Davies (Intelligent Energy Ltd.), Nathan Grange (Intelligent Energy Ltd.)

Rarely has an air cooled fuel cell system been effectively used as a power source on small vehicles due to the size restriction of the fuel cell system, coupled with the difficulty of managing the stable operation of such under automotive conditions. However the reliable and high power density performance of the Intelligent Energy proprietary technology has shown this to be possible when it was recently integrated into the Suzuki Burgman Fuel Cell Vehicle. The unique design for fluid flow, cooling, water management and power electronics, all incorporated in an integrated package; work in conjunction with the vehicle integrator’s requirements for the whole power-train. Efficiently converting hydrogen gas into power at the drive motor was considered as a whole entity to minimize losses at all stages in the process. This meant all sub-components in the design were optimized for hydrogen utilization and were boosted by proprietary techniques to achieve a high current density at high cell voltages. The fuel cell system was initially developed to meet the requirements of a number of prototype vehicles, but latterly requirements of a production vehicle were addressed both in terms of performance, safety and regulatory standards.

Abstracts of Technical Session

Tuesday, November 8, 16:00 - 17:30 at Room 107

Fuel Supply Systems Ⅱ

Chair: Isato Taki (SUZUKI MOTOR CORPORATION), Co-Chair: Juergen Tromayer (Graz University of Technology)

[20119570/2011-32-0570]

Research on Clogging Mechanism of Multilayered Fuel Filters and Extension of Filter Life Span in Ethanol Blended Fuel

Atsushi Ito (Honda R&D Co., Ltd.), Hideaki Ando, Keita Kinoshita, Fujio Umebayashi, Tsubasa Ishii (Honda R&D Co., Ltd.)

Recently, the use of ethanol blended fuel is growing worldwide. Therefore, there is increasing needs for addressing issues relating to ethanol blended fuel use in gasoline engine fuel supply systems. In this paper, we focused on one of such issues, which is the reduced life of a multi-layered fuel filter used at inlet side of a fuel pump when it is used with ethanol blended fuel. In this study, we clarified that ethanol blended fuel tends to disperse dust particles contained in fuel to a greater extent than gasoline, and that it has a mechanism to accelerate clogging by concentrating the clogging only on the finest layer of the multi-layered filter. Also, in the process of clarifying this principle, we confirmed that dust particles dispersed by ethanol are coagulated when passing through the filter layers. Based on this, we developed a filter structure that increases dust particle capturing capability by combining dust particles into larger size before reaching the filter, thereby doubling the effective life of the filter for ethanol blended fuel.

[20119582/2011-32-0582]

Effects of ethanol ratio and temperature on gasoline atomizing using the local-contact microwave-heating injector

Thu Huong Thi Tran (Kanazawa University), Hiroshi Enomoto, Motoki Kushita, Takaaki Sakitsu, Naoki Ebisawa, Kosuke Nishioka (Kanazawa University)

Improvement of atomization process is one of the most effective methods to promote the cold-start period of an internal combustion engine (ICE) using port fuel injector (PFI). In this paper authors present a fuel heating method using microwave energy through the local-contact microwave-heating injector (LMI) to enhance the properties of fuel sprays in such a risky working area of ICE. Temperature and mixing ratios of blended fuel are varied and characteristics of atomization are investigated. The fuel using in experiments is blended fuel of gasoline and ethanol, the mixing ratio is varied among 0 (E0), 5 (E5), 50 (E50), and 100 (E100) percentages in volume ratio of ethanol. The temperature of the fuel is measured just before the injection by using K-typed sheath thermo-couple. Spray characteristics measured are Sauter Mean Diameter (SMD), droplet size distribution, spray cone angle, and particle size distribution width. The SMD and the droplet size distribution are measured by using laser diffraction method. The spray cone angle is measured through pictures of actual appearance atomization. The results show that, the higher percentage of ethanol in the blended fuel the higher temperature the fuel can reach, except the case mixing ratio of 0% ethanol, in which fuel temperature still remain no matter how is the heating duration. At each blended amount of ethanol, except E0, all of the spray atomization measured and analyzed characteristics show the clear improvements with the increase of fuel temperature.

[20119601/2011-32-0601]

Petroleum-Based and Bio-Derived Jet Fuel Efficiency Optimization Using Fuel Injection in a 34cc 4-Stroke Spark-Ignition Engine

Cary W. Wilson (US Air Force), Frederick Schauer (Air Force Research Lab), John Hoke (Innovative Scientific Solutions Inc.), Paul Litke (Air Force Research Lab), Jon-Russell J. Groenewegen (University of Dayton Research Institute)

Many of the engines used in Remotely Piloted Aircraft (RPA), come directly from the remote-control (R/C) aircraft market, which turn a propeller but are not necessarily built for the greatest efficiency or reduced fuel consumption. The DoD “single fuel concept” is pushing these platforms to be able to operate with JP-8 using an Otto Cycle engine. Additionally, with increased environmental concern with fossil fuels, possible future DoD requirements could require the use of bio-derived liquid fuels. The research presented in this paper takes steps to satisfying both the efficiency and single fuel requirements. The Fuji BF-34EI engine was successfully shown to operate effectively with JP-8, Diesel, Algae-based Diesel and Camelina based Hydroprocessed Renewable Jet fuel. When generally compared over the entire engine operating map, between AVGAS and JP-8, the latter is shown to present a 10-20% lower brake specific fuel consumption (BSFC). When variable spark ignition is used for running the heavy fuels, allowing for a greatly retardation in timing, knock is shown to be eliminated. Comparing to the fielded system (AVGAS Carbureted), yielded a decrease in specific fuel consumption of up to 43% and 54% for JP-8 and Camelina, respectively. Using fuel injection and spark optimization with the heavy fuels, BSFC was decreased by up to 14% and 32% for JP-8 and Camelina, respectively, when compared to AVGAS.

Abstracts of Technical Session

Tuesday, November 8, 16:30 - 17:30 at Room 108

Vehicle Components

Chair: Toshimi Kobayshi (Kawasaki Heavy Industries, Ltd.), Co-Chair: Jim Carroll (South West Research Institute)

[20119519/2011-32-0519]

Steering Damper For Motocross

Nobuo Hara (Yamaha Motor Co., Ltd.), Hitoshi Watanabe, Masanobu Negoro, Yasunobu Harazono, Masashi Matsuo, Terumi Yachi (Yamaha Motor Co., Ltd.), Satoshi Ishikawa (Yamaha Motor Engineering Co., Ltd.)

In this paper, we introduce a research of Steering Damper using MR fluid (Magnetorheological Fluid). In recent years, Steering Dampers have been used in motocross races on off road courses. Steering Dampers stabilize the front end of motocross bikes that are used in competitive races held on rough terrain. The advantage of a Steering Damper is increased stability, however hydraulic Steering Dampers give rise to the problem of 'Heavy Steering'. In order to solve this problem, we used MR Fluid and developed an Electronic Control Steering Damper that does not use a valve like hydraulic damper. The damper design uses "Direct Shear Mode" and features a steering angle sensor built into the damper, which results in easier, smoother steering. To test the effectiveness of our new design, we installed our new Steering Damper on the YZ 450F (Yamaha's competition model). We then asked for feedback from riders both in Japan and overseas. From the feedback we received, we were able to confirm the effectiveness and efficiency of our new design as well as its superiority over traditional designs.

[20119611/2011-32-0611]

Design Optimization of frame stiffness through hydroforming

Meghashyam Laxman Dighole (TVS Motor Company Ltd.), Dora K B, Chandan M R (TVS Motor Company Ltd.)

Two wheelers are very popular as means of transportation in ASIA. Chassis is a very critical part of a two wheeler taking most of the loads coming from the roads. During the design and development stage, stiffness of the frame needs to be established. Stiffness is one of the critical parameter, which decides the handling performance of the vehicle. Conventionally, the main tube of motorcycle frame will be of uniform cross section throughout the axis of the tube. Variable thickness cannot be achieved in this method. In the new process called hydro forming, variable sections can be achieved. FE analysis has been done on the frame and the stresses are predicted. The stress pattern helped in identifying the critical areas. The critical areas identified are validated through experimental strain measurement. The validated model is further used to optimize the design by reducing the stresses at critical areas to below the acceptable limit & improving the stiffness values. The final optimized frame cleared the structural & handling tests without any failure. With this method, we were able to improve the stiffness to weight ratio.

Abstracts of Technical Session

Tuesday, November 8, 16:00 - 17:30 at Room 206

Engine Technology Ⅲ

Chair: Tomoo Shiozaki (Honda R&D Co., Ltd.), Co-Chair: Alexander Trattner (Graz University of Technology)

[20119506/2011-32-0506]

Effects of Intake Port Geometry on the Performance of an SI Engine

B Selvaraj (TVS Motor Company Ltd.), S.N Sridhara, G Indraprakash (MS Ramaiah School of Advanced Studies, Bangalore), A Senthilkumar, Arvind Pangaonkar (TVS Motor Company Ltd.)

Flow field within the intake port determines the mass flow into the engine and in-cylinder charge motion of the spark ignition engine, which further influences power output, emissions and fuel consumption. Hence, a detailed investigation of influence of intake port geometry on the engine performance is required. In the present project work, an existing intake port of a single cylinder, 4-stroke and air-cooled gasoline engine was experimentally and numerically investigated. This intake port is further subjected to variation in geometry towards improving the volumetric efficiency and subsequently the power output has been estimated. Initially a steady state flow analysis was carried out for various intake port designs at different valve lift positions to determine the mass flow into the engine. The best intake port design based on the steady state flow analysis results was considered for unsteady analysis to determine the peak cylinder pressure and emission characteristics of the engine. Comparison of the CFD results with the experimental results for the baseline intake port design showed a good agreement. The CFD results predicted that the optimised design allows achieving increased mass flow rate by 20% at peak valve lift condition and increased combustion peak pressure by 10.7% at 5000 rpm.

[20119566/2011-32-0566]

Influence of Injection and Flame Propagation on Combustion in Motorcycle Engine - Investigation by Visualization Technique -

Miki Yumoto (Yamaha Motor Co., Ltd.), Kazuhiro Goto, Shoichi Kato, Minoru Iida (Yamaha Motor Co., Ltd.)

This paper reports visualization of behavior of spray, wall film, and initial flame propagation in an SI engine with port fuel injection system for motorcycle in order to directly investigate their influences on combustion and relations among them. Borescopes were used to visualize the flame propagation in the combustion chamber and wall film in the intake port. Various injection systems and injection parameters were tested: injection direction, timing, and size of droplets to investigate the effect of mixture formation. It is concluded that combustion stability under low load condition is greatly influenced by mixture inhomogeneity in the combustion chamber whose evidence is the luminous emission. It is caused by direct induction of considerable amount of liquid fuel with large size of droplets into combustion chamber or too inhomogeneous mixture in the intake port. Luminous emission in the flame was also seen under wide open throttle condition due to direct introduction of wall film into combustion chamber. Finally, great potential of highly atomized spray to keep combustion stability under low load condition and homogeneity under high load condition without defect of transient behavior due to wall film has been shown with injection timing of IVO.

[20119585/2011-32-0585]

Charging and Powersport for Motorcycles: a contradiction?

Christian Zinner (TU Graz), Oliver Schoegl, Stephan Schmidt (TU Graz), Thomas Schabetsberger, Stefan Leiber (BRP Powertrain), Martin Abart (TU Graz)

In this study, investigations on charging strategies for motorcycle applications have been performed on the basis of modern charging concepts. These investigations had been driven by the goal of CO_2-reduction and optimization of packaging size, while maintaining the extraordinary dynamic response behavior of modern motorcycle engines [1]. Based on experimental investigations of the boundary conditions and restrictions of motorcycle applications in contrast to automotive applications, intense experimental test bench and on the road investigations of the stationary and transient behavior of charging strategies have been performed. These investigations covered automotive state of the art charged engines as well as charged motorcycle applications. With these results, simulations of the air path for stationary and transient operation were used in order to evaluate the potential of several charging strategies for motorcycle applications.

Abstracts of Technical Session

Tuesday, November 8, 16:00 - 17:30 at Room 207

Hybrids, Electric Drives & Fuel Cells Ⅲ

Chair: Yasuyuki Muramatsu (Yamaha Motor Co., Ltd.), Co-Chair: Glenn Bower (University of Wisconsin)

[20119546/2011-32-0546]

Development of a Racing Motorbike with Electric Power Train

Peter Stuecke (Westsaechsische Hochschule Zwickau), Sebastian Fethke, Wolfgang Foken, Martin Jentsch, Andre Lehmann (Westsaechsische Hochschule Zwickau), Klaus Kloetzner, Dirk Reissmann (ADAC-Sachsen)

This paper presents a racing bike with electrical drive train, which shall be used as a prototype of a future electro racing class and as well as a test bed for future driving performance and sound tests. All major components of the drive train including motor, battery, battery controller and wiring are described in detail. Safety issues related to the selection of the voltage level are discussed. The mechanical integration of the electrical drive train into a given racing bike is presented. Moreover, power and torque characteristics of the motor and the total weight of the motorcycle are put into relation to performance requirements of the racing class in question. The electric drive train has a modular design and can be simplified compared to internal combustion engines, because of the favorable torque characteristic of electric motors a gearbox is not necessary. Sound issues of both, the conventional racing bike and the electrically powered one are discussed. The paper concludes with an outlook including the description of the next steps of the project targeting an improved motor design and the potential efficiency gain. It sets applications for motor sports into perspective and points out how street bikes and the public domain can benefit from developments carried forward by racing sports.

[20119556/2011-32-0556]

Development of Electric Motorcycle for Business Use

Toshiyuki Cho (Honda R&D Co., Ltd. Motorcycle R&D Center), Ryuji Akiba, Takashi Sone (Honda R&D Co., Ltd.)

In recent years, the reduction of CO_2 emissions is under way, and the expectancy for electrical power is getting bigger for motorcycles as well. This time, an electric motorcycle with good driving performance, adequate range and quick charging performances for business use has been developed using a small battery. The travel modes have been investigated for business applications of delivery services to classify the traveling patterns and the objectives have been settled based on them. The energy efficiency has been improved by the application of the smallest amount of battery and by the integrated power unit configuration. With this achievement, the range of 34 km (at a constant speed of 30 km/h) has been realized while maintaining the 12-degree hill-climbing departure performance when loaded with a rider and a 30 kg load, which is the requirement of performance for business use. Moreover, the charging and discharging are controlled by the battery monitoring system which enables both driving and charging operations in temperatures from -10° C to 35° C to satisfy the requirement for business use. In addition, a quick charger with two-step charging current control, which can charge from 0% to 80% State of Charge (hereafter SOC) within 20 minutes, has been developed.

[20119560/2011-32-0560]

Development of Electric Motor for Electric Motorcycle for Business Use

Naoki Kobayashi (Honda R&D Co., Ltd.)

A new DC brushless motor, which has an almost equivalent driving performance to a 50 cm^3 scooter engine, has been developed to be used in a new electric motorcycle for business. The traction motor is compact enough to be mounted close to the driveshaft of the transmission, which helps reduce friction in the drive train.
Consequently, in the downsized motor, by mounting the drive train unit with the PDU (Power Drive Unit) on the wheel side by applying reduction gears, it enables the reduction of maximum motor torque requirement. It also enables other parts of the drive system to be integrated into one unit. In this motor, IPM (Interior Permanent Magnet) structure has been implemented to cope with the high rotation of the motor, and the concentrated winding stator coil has been implemented for downsizing. As for the rotor, the magnets were placed in sections and the yoke shapes were improved to achieve higher rotation speeds that provide the higher power. The motor performances with the maximum power of 2.8 kW, the maximum torque of 11 Nm, the practical efficiency of 75% or more, and the maximum motor speed of 9000 r/min or more, have been achieved, which have satisfied the maximum specifications required from the drive train unit of the motorcycle.

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 104 & 105

Advanced Combustion I

Chair: Yasuo Moriyoshi (Chiba University), Co-Chair: Roland Kirchberger (Graz University of Technology)

[20119521/2011-32-0521]

Analysis of Supercharged HCCI Combustion Using on a Blended Fuel

Ryosuke Shimizu (Graduate School, Nihon University), Akira Iijima, Koji Yoshida, Hideo Shoji (Nihon University)

Homogeneous Charge Compression Ignition (HCCI) combustion has attracted much interest as a combustion system that can achieve both low emissions and high efficiency. But the operating region of HCCI combustion is narrow, and it is difficult to control the auto-ignition timing. This study focused on the use of a two-component fuel blend and supercharging. The blended fuel consisted of dimethyl ether (DME), which has attracted interest as alternative fuel for compression-ignition engines, and methane, the main component of natural gas. A spectroscopic technique was used to measure the light emission of the combustion flame in the combustion chamber in order to ascertain the combustion characteristics. HCCI combustion characteristics were analyzed in detail in the present study by measuring this light emission spectrum. The effects of the combustion process on the engine operating characteristics were also investigated under the conditions of the two-component fuel blend and supercharging. A spectroscopic measurement technique was used to obtain the light emission spectra of the combustion flame. The results showed that the application of supercharging moderated the recombination reaction of CO and O. (Contd.)

[20119522/2011-32-0522]

A Study of HCCI Engine Operating on a Blended Fuel of DME and Methane

Kiyoshi Komatsu (Graduate School of Science and Technology, Nihon University), Mitsuo Asanuma (Graduate School, Nihon University), Akira Iijima, Koji Yoshida, Hideo Shoji (Nihon University)

In this study, experiments were conducted using a blend of two types of fuel with different ignition characteristics. One was dimethyl ether (DME) that has a high cetane number, autoignites easily and displays low-temperature oxidation reaction mechanisms; the other was methane that has a cetane number of zero and does not autoignite easily. A mechanically driven supercharger was provided in the intake pipe to adjust the intake air pressure. Moreover, flame light in the combustion chamber was extracted using a system for observing light emission that occurred in the space between the cylinder head and the cylinder and in the bore direction of the piston crown. The results of previous studies conducted with a supercharged HCCI engine and a blended fuel of DME and methane have shown that heat release of the hot flame is divided into two stages and that combustion can be moderated by reducing the peak heat release rate (HRR). As a result of this experiment, the shape of the heat release in hot-flame being greatly influenced by the equivalence ratio change. It is inferred from the results that engine operation should be possible in the high load region while avoiding the occurrence of knocking.

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 104 & 105

Advanced Combustion I

Chair: Yasuo Moriyoshi (Chiba University), Co-Chair: Roland Kirchberger (Graz University of Technology)

[20119524/2011-32-0524]

A Study of HCCI Combustion Using Spectroscopic Measurements and Chemical Kinetic Simulations － Effects of Fuel Composition, Engine Speed and Cylinder Pressure on Low-temperature Oxidation Reactions and Autoignition

Yusuke Takahashi (Graduate School, Nihon University), Kenta Suyama (Graduate School, Nihon University), Akira Iijima, Koji Yoshida, Hideo Shoji (Nihon University)

The Homogenous Charge Compression Ignition (HCCI) engine is positioned as a next-generation internal combustion engine and has been the focus of extensive research in recent years to develop a practical system. One reason is that this new combustion system achieves lower fuel consumption and simultaneous reductions of nitrogen oxide (NOx) and particulate matter (PM) emissions, which are major issues of internal combustion engines today. However, the characteristics of HCCI combustion can prevent suitable engine operation owing to the rapid combustion process that occurs accompanied by a steep pressure rise when the amount of fuel injected is increased to obtain higher power output. A major issue of HCCI is to control this rapid combustion so that the quantity of fuel injected can be increased for greater power. Controlling the ignition timing is also an issue because it is substantially influenced by the chemical reactions of the fuel. Various approaches are being researched for expanding the range of stable engine operation, including the application of turbocharging, the use of residual combustion gas, stratification of the fuel concentration, and the use of a blend of two types of fuel having widely different ignition characteristics. (Contd.)

[20119659/2011-32-0659]

Two-stage combustion strategy for reducing NOx emissions in a Compression Ignition Engine

Yunjung Oh (Hanyang University), Donggon Lee, Kyusoo Jeong (Graduate School of Hanyang University), Sayop Kim (The Research Institute of Industrial Science, Hanyang University), Chang Sik Lee, Sungwook Park (Hanyang University), Daesik Kim (School of Mechanical and Automotive Engineering, Gangneung-Wonju National University)

This paper describes the effects of two stage combustion strategy on the engine performance and the exhaust emission characteristics in a compression ignition engine. The two-stage combustion strategy targets reduction of NOx emissions by decreasing oxygen concentration for second stage combustion. Thus, the first injection was provided in order to consume in-cylinder oxygen, rather than generate power.

A multi-dimensional CFD code was utilized to predict engine performance and emission characteristics. For the accurate and efficient computational calculation of ignition and combustion characteristics of diesel fuel, the reduced nheptane mechanism was used in this study. The calculation for two-stage combustion was performed after validating against the experimental result. The KH-RT breakup model and gas-jet model was applied for the prediction of spray behavior and characteristics. To calculate the ignition and combustion process, CHEMKIN Ⅱ [1] code was used. This mechanism was composed of 30 species and 65 reactions. It was revealed that the peak combustion pressure and the peak heat release rate in two-stage combustion strategy were reduced. It was due to the separate fuel injection and combustion. In the exhaust emission characteristics, twostage combustion significantly reduced the nitrogen oxides (NOx) emission.

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 107

Lubricants

Chair: Tohru Nakazono (Yanmar Co., Ltd.), Co-Chair: Juergen Tromayer (Graz University of Technology)

[Organized Speech]

Technical Trends in Small Engine Lubricants

Akira Koyama (JX Nippon Oil & Energy Corporation)

This presentation will cover technical trends in small engine Lubricants. To improve fuel economy through engine oil technology, researchers must develop lower viscosity lubricants which reduce viscous resistance in the hydrodynamic lubrication region and additive technologies which reduce friction in the boundary lubrication region. We have studied the application of the new anti-wear additive "ZP" as an alternative to ZDTP, an anti-wear additive that has been an essential component of engine oils for over half a century. In testing a GHP engine oil formulated with "ZP", we observed an improvement in drain life, corrosive wear resistance, and engine cleanliness.

[20119634/2011-32-0634]

Study of Lower Viscosity Motorcycle Engine Oils for Fuel Saving − Anti-fatigue Performance −

Nobuaki Watanabe (Idemitsu Kosan Co., Ltd.), Akira Mitarai, Maiko Inuzuka (Idemitsu Kosan Co., Ltd.)

Fuel savings by engine oil have been requested for two-wheeled vehicles from the viewpoint of environmental issues. In four-wheeled vehicles, reduction of oil viscosity and addition of friction modifiers have been effective in improving fuel efficiency. However, direct application of engine oil for four-wheeled vehicles to two-wheeled vehicles is difficult. In a four-cycle two-wheeled vehicle, the transmission, gears, and a wet clutch system are imbedded within the engine 1). Engine oil must display a remarkable performance as it is required to function as transmission oil and to improve anti-metal fatigue life and clutch performance 2), 3). If fuel efficiency is improved by reducing the viscosity of engine oil used in two-wheeled vehicles, the fatigue life tends to worsen. Therefore, reduction in oil viscosity is difficult to achieve. In this study, the anti-metal fatigue life of an engine oil was evaluated using a gear or a rolling bearing in a crankshaft where fatigue failures may occur due to the reduction in oil viscosity. Measures to prolong fatigue life were examined by testing different engine oil formulations, including single-grade oils and multi-grade oils to which polymers were added as viscosity index improvers (VIIs). (Contd.)

[20119513/2011-32-0513]

The Development of a Low Viscosity, Highly Efficient Lubricant for Sport Motorcycle Applications

Gianluigi Zoli (Castrol Global Lubricants Technology), Matthew Symonds, May Turner, Mark Leonard, Nick Solomon, Cliff Newman, Ieuan Adams (Castrol Global Lubricants Technology)

The highly competitive sport motorcycle market demands continuous increase in engine performance. At the same time, legislation in the main industrialized countries establishes stringent limits for gaseous emissions from two wheelers. As already witnessed in the passenger car industry, motorcycle manufacturers are giving increased focus to the lubricant as a potential tool to improve engine performance and reduce gaseous emissions. When compared to a conventional, high viscosity formulation, an optimized low viscosity, low friction engine oil can bring significant increase in power release and fuel economy, as well as a reduction in tailpipe emissions. However, the use of highly efficient lubricants in sport motorcycle applications needs careful evaluation since motorcycle engines with an integrated clutch and gearbox require the lubricant to achieve very precise viscometric and frictional limits. This paper describes the development of a new concept for high performance motorcycle engine oils, capable of delivering a tangible increase in engine efficiency whilst maintaining a high level of wet clutch operability along with good engine and gearbox durability. The development process included the formulation of a specific additive package with an optimized friction coefficient and the definition of a base oil mix with a suitable viscometric profile. (Contd.)

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 107

Lubricants

Chair: Tohru Nakazono (Yanmar Co., Ltd.), Co-Chair: Juergen Tromayer (Graz University of Technology)

[20119545/2011-32-0545]

Fuel Economy Durability - A Concept to be Considered for Motorcycle Oils

Brent Richard Dohner (The Lubrizol Corporation), George Szappanos, Alex Michlberger, Ananda Gajanayake (The Lubrizol Corporation)

Motorcycle manufacturers have recognized that highly friction modified passenger car oils can be deleterious to clutch performance, leading to clutch slippage. To address this issue, a JASO specification for four-stroke motorcycle oils was developed in 1999, categorizing oils into high friction oils termed JASO MA and low friction oils termed JASO MB. The high friction oils were preferred for most motorcycles where the engine oil also lubricates the clutch and gears. New motorcycle transmission technologies have increased the number of dry clutch applications which has led to an increased demand for JASO MB oils to improve fuel efficiency. While JASO MB oils contain friction modifiers to improve initial fuel economy, the motorcycle specifications have not addressed the fuel economy durability of motorcycle oils. This paper will investigate the fuel economy durability of JASO MB quality oil in various ways in order to determine if the fuel economy benefit is maintained throughout the time the oil spends in the engine.

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 108

Vehicle Dynamics & Safety

Chair: Masayuki Baba (Honda R&D Co., Ltd.), Co-Chair: Jim Carroll (South West Research Institute)

[20119537/2011-32-0537]

Ride Comfort Analysis of Motorcycle Using Virtual Prototype

Chandan Bansilal Chavan (TVS Motor Company Ltd.), Dora Karedla, Rengarajan Babu, Mudassar A Shaikh (TVS Motor Company Ltd.)

This research is aimed at developing a multi-body simulation model of a motorcycle, which is useful in studying the ride dynamics. A virtual prototype of a motorcycle has been built in the form of an ADAMS model with 9 degrees of freedom. The virtual model imbibes a parametric approach, which enables upfront optimization of the dynamic behavior of the vehicle in terms of ride & handling characteristics. Comfort and adherence indices proposed by various authors in the past have been studied. Suitable indices are proposed in order to establish a correlation between objective indices of the model with experimental prototype. An experimental motorcycle is built in-line with the virtual model; experimental tests conducted on test tracks, test data acquired & analysed. The indices are computed based on the power spectral densities acquired from both simulations as well as experimental results and a correlation established between the indices. Subjective assessment of ride comfort has been further carried out on selected settings to confirm the results. (Contd.)

[20119502/2011-32-0502]

Simulation and Analysis of Small-vehicle Deceleration to Reduce Occupant Injury at Frontal Collision

Takanobu Fujimura (SUZUKI MOTOR CORPORATION)

With the surge of environmental problems, the number of small vehicles with lower energy consumption is increasing. For such a vehicle, difficulty of achieving crashworthiness exists since it has smaller deformation space in a frontal impact accident. Smaller deformation space needs high vehicle deceleration for absorbing kinetic energy of the vehicle. The high vehicle deceleration in the event of a frontal collision may produce high occupant deceleration, resulting high chances of an occupant injury value.
In this study, over 138 types of vehicle decelerations expressed by three variables in a frontal collision were examined in order to reduce occupant decelerations. Solving differential equations, following results were obtained
1. The minimum value of the maximum occupant deceleration exists. The value is 45.2% lower than the value whose deceleration steps up gradually.
2. The vehicle deceleration that produces the minimum value of the maximum occupant deceleration is confirmed to include acceleration; i.e. initially the vehicle decelerates, next accelerates, and then decelerates.
3. The most optimum way of countermeasure that reduces the maximum occupant deceleration become clear. (Contd.)

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 108

Vehicle Dynamics & Safety

Chair: Masayuki Baba (Honda R&D Co., Ltd.), Co-Chair: Jim Carroll (South West Research Institute)

[20119548/2011-32-0548]

A Study on Cruising performance of Planning Craft with outboard motor

Tatsunori Kataoka (SUZUKI MOTOR CORPORATION), Nobuyuki Shomura (SUZUKI MOTOR CORPORATION), Toru Katayama, Yoshitaka Nishihara (Osaka Prefecture University)

In this study, to improve the cruising performance of planing craft with outboard motor, we have examined a estimation method of the hull attitude angle at cruising and resistance in case of changing the tilt angle and mounting position of the outboard motor by the tank test using a scale model of a hull and an outboard motor in the ship testing tank. Planing craft with outboard motor have different characteristics from large vessels. The characteristics are shown below.

・The hull attitude angle at cruising is different in each forward speed.

・The thrust accounted for a large percentage of hull weight. And the flow field around the hull changes along with the operation of the propeller.

・The hull attitude angle at cruising is changed by the rigging state of the outboard motor.

In this study, we calculated the hull attitude angle at cruising in each forward speed by the hydrodynamic forces measured from the fully captive model test that systematically varied the trim angle and rise of small scale model ship. We considered the self propulsion factors in the calculated hull attitude angle at cruising, and recalculated the hull attitude angle at cruising and resistance. So we could obtain the estimated result that the error margin is within 10% against the measurements of actual planing craft.

[20119558/2011-32-0558]

Stability control of motorcycle

Yoshihiro Masuda (Kawasaki Heavy Industries, Ltd.), Yoshimoto Matsuda (Kawasaki Heavy Industries, Ltd.)

We developed active control more suitable for sports riding than the previous electronic stability control system for enjoying sports riding by many users.

One of them, the traction control system S-KTRC (Sports Kawasaki TRaction Control) uses the sensor output like not only the slippage calculated from the front and rear wheel speed but also engine speed, throttle position, and gear position etc. As the result, conditions of the motorcycle and rider's intention are calculated by 'Motorcycle model' in the ECU continuously. By this 'Motorcycle model', S-KTRC confirms the real time conditions and predicts the succeeded condition, every 5 milliseconds to decide to govern torque.

The ABS system KIBS (Kawasaki Intelligent anti-lock Brake System), it is possible to control the rear wheel's lift by using the pressure data of the front brake at the sudden braking operation. And by using the engine data, it is also possible to avoid the no preferable intervention by the ABS control, when the motorcycle goes into the corner under the shift down operation. Moreover, this system keeps the soft feedback feeling to rider's hand and foot by this precision ABS control. (Contd.)

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 206

Diesel Engines

Chair: Yoshiro Tokunaga (Kawasaki Heavy Industries, Ltd.), Co-Chair: Brian Callahan (Achates Power & Basco)

[20119576/2011-32-0576]

Effect of Wall Impingement on Heterogeneous Structure in Diesel Sprays

Noritsune Kawaharada (Nagasaki University), Daisaku Sakaguchi, Keisuke Komada, Hironobu Ueki, Masahiro Ishida (Nagasaki University)

A 2-D phase doppler technique was used for the measurements of the velocity, size, and flight direction of droplets in diesel sprays. The data acquisition rate of the phase doppler system was 250 kHz. Diesel fuel sprays injected intermittently into the atmosphere were investigated. The injector orifice was 0.113 mm in diameter. The rail pressure was set at 40 MPa by using a common rail system. The injection period was 3.0 ms and the time interval between injections was 330 ms. Measurement position was located at 40 mm from the nozzle exit for free sprays. In order to evaluate velocity vectors of each droplet, velocity components with angles plus and minus 45 degrees to the spray axis were measured. The data measured at each position was 10,000 and was accumulated over about 1,000 injections. It was found that most droplets near the spray center had velocity vectors along the spray axis. Droplets in the spray periphery region had the velocity component from the spray center to the spray periphery at a certain time from the start of injection. And droplets had the velocity component from the spray periphery to the spray center. (Contd.)

[20119602/2011-32-0602]

Feasibility Study on the Utilization of Water-in-Oil Type Emulsified Fuels to Small DI Diesel Engines

Hironori SAITOH (Sojo University), Koji UCHIDA (Sojo University)

This study deals with the thermal efficiency improvement of diesel engines operated by W/O (water-inoil) type emulsified fuels. This paper focuses on the feasibility of W/O emulsions as fuels applied to small diesel engines from the view point of compatibility between lower fuel consumption and lower NOx emission. Effects of water content ratio and mean diameter of water scattered in gas oil on ignition, combustion and emission characteristics in a small DI diesel engine with progress of fuel injection timing were experimentally investigated. Results showed that water content ratio strongly influenced on ignition delay and associated combustion characteristics after auto-ignition, and mean diameter of dispersed water in gas oil was not sensitive parameter on ignition and combustion. Under the 60% load condition in 2000 rpm engine operating speed, for 20 volume percent water content W/O emulsified fuel, slight progress of fuel injection timing yielded approximately 5% improvement of thermal efficiency and 60% reduction of NOx emission compared with the base engine performance fueled by gas oil.

Abstracts of Technical Session

Wednesday, November 9, 8:00 - 10:00 at Room 206

Diesel Engines

Chair: Yoshiro Tokunaga (Kawasaki Heavy Industries, Ltd.), Co-Chair: Brian Callahan (Achates Power & Basco)

[20119606/2011-32-0606]

Study on Performance of Diesel Engine Applied with Emulsified Diesel Fuel - The Influence of Fuel Injection Timing and Water Contents -

Masatoshi Iwai (Graduate School of Science and Technology, Nihon University), Koji Yoshida, Akira Iijima, Hideo Shoji (Nihon University)

The application of emulsified fuel for diesel engines is expected to reduce NOx and soot simultaneously. The purpose of this study is to clarify the influence of water content in emulsified fuel and fuel injection timing on diesel engine performance. The engine performance of emulsified fuel was compared with the water injection method. In the water injection test, water was injected to intake manifold and diesel fuel was directly injected into combustion chamber. Two emulsified fuels of which mixing ratio of water and emulsifier to diesel fuel were 15 and 30 vol.% were tested. Engine performance and exhaust gas emission of water injection method were almost similar to those of diesel fuel, so that water presented in combustion chamber had almost no influence on engine performance. Therefore, it can be considered that the micro explosion of fuel droplet enhanced the fuel atomization and mixing of fuel and air. When the fuel injection timing was retarded, the emulsified fuel could reduce NOx emission and smoke concentration however the thermal efficiency was deteriorated. The emulsified fuel could improve the brake thermal efficiency when the fuel injection timing was optimally adjusted, whereas NOx emission could not be reduced.

[20119635/2011-32-0635]

Development of EGR system for industrial diesel engine using CFD approach

Masahiko Sugimoto (Kubota Corporation), Kazumichi Matsuishi, Tadao Okazaki (Kubota Corporation)

In accordance with the rising concern about global environmental protection, exhaust emissions regulations for industrial diesel engines are also being strengthened worldwide in stages. In order to comply with the EPA Tier3 and interim Tier4 level, EGR (Exhaust Gas Recirculation) system is recognized as one of the most potential technologies to reduce Nitrogen Oxide (NOx), but there were concerns about durability deriving from the fuel quality and cost increase from additional parts like as EGR cooler, reed valve and EGR valve. To overcome these problems and to fulfill the market demands for industrial diesel engines, such as low cost, compactness, high output and high durability, most appropriate system should be chosen for each engine type. This paper describes two different techniques to optimize the different EGR systems for engines with different combustion systems, namely optimization process of internal EGR for In-Direct Injection system (IDI) by using one dimensional engine cycle simulation and distribution improvement of external EGR for Direct Injection system (DI) by using 1D-3D coupled computational fluid dynamic (CFD) simulation.

Abstracts of Technical Session

Wednesday, November 9, 8:30 - 10:00 at Room 207

Emissions I

Chair: Hiromi Deguchi (SUZUKI MOTOR CORPORATION), Co-Chair: Robert Kee (Queen's University Belfast)

[20119532/2011-32-0532]

Study on Diffusion Behavior of Evaporative Fuel Gas from Gasoline in Carbon Canister in Consideration of Temperature-Dependence

Hideaki Kuronuma (Nagoya University), Noriyuki Kobayashi (Graduate School, Nagoya University), Soichiro Masuda (Nagoya University), Kazunari Satoh, Koji Yamasaki (MAHLE Filter Systems Corp.)

It is important to quantify the diffusion behavior of evaporative fuel gas in order to control evaporative emission from carbon canister. Especially, it is necessary to take the changes in adsorption-desorption amount and diffusion coefficients by air temperature into account to design carbon canister satisfying various conditions of air. In this study, we estimated diffusion coefficients in carbon canister for the binary system of butane and nitrogen and examined temperature-dependence of diffusion coefficients. The temperature dependence of diffusion coefficients was not clearly observed. Diffusion coefficient of gas phase increased as the temperature was higher. Amount of desorption decreased as the temperature was raised by contraries. Those effects made the complex temperature dependence of the diffusion coefficient. They caused the density increment and the flow caused by pressure simultaneously.

[20119554/2011-32-0554]

Characterization of Nano Particle Emissions and it's Metrices for 2-wheeler Motorcycles

Husein Adam Nakhawa (The Automotive Research Association of India), S. P. Tijare, S. S. Ramteke (The Automotive Research Association of India)

In the recent studies, the health implications of ultra fine particle emissions from vehicles have been investigated in the number of international studies. The adverse health effects are not only dependent on total particulate mass but also on other attributes including size, number and surface area of the particles and also their constituents like SOF, IOF, PAH, benzene, 1-3 butadiene etc. which are mainly responsible for higher mortality rate due to their carcinogenicity and mutagenecity. These ultra fine particles cause more adverse effects than larger particles. With this need UNECE GRPE had launched a particulate measurement program (PMP) to formulate the regulation to control both particulate mass and number of ultra fine particles. These new regulations are applicable to the diesel and gasoline direct injection passenger cars and heavy duty engines of Euro-V/VI technology. However, at present the other vehicle categories like 2, 3 wheelers and alternate fuels are not been covered. Limited experiments have been carried out on the various categories of 2-wheeler gasoline vehicles for PM2.5, particle number and it's other metrices including their chemical speciation. This paper presents the work carried-out on the nano particle measurement with the test setup complying with GRPE-PMP requirements. (Contd.)

[20119654/2011-32-0654]

Development of Single Cylinder Gasoline Three wheeler for Compliance to EUROII Emission Norms

Balasaheb Jalindar Shinde (M/s Piaggio Vehicles Pvt. Ltd., Pune, India), Hanumant B Shedge, Bapu B Borhade, Satish S Sane (M/s Piaggio Vehicles Pvt. Ltd., Pune, India)

This paper describes the development of Single Cylinder Gasoline engine for three wheeler application compliance to EURO II emission norms. The base engine was gasoline and passing present Indian Bharat Stage III norms. This engine has best feature of electronic ignition timing w.r.t. speed. The main exercise was to re optimize the carburetor i.e. Main Jet, Pilot jet, Jet Needle etc.Other exercise include study of exhaust emission of vehicle for CR (9:1) with/ without 3 way catalytic converters and effect of spark timing on exhaust emission were also studied. The exercise was to measure carburetor fuel flow on carburetor bench and raw emission on Chassis dynamometer in road load & WOT condition .Also emission measurements on chassis dynamometer with different carburetor setting .During testing it was also ensured to maintain lambda between 1.01 to 1.03. The present India Driving Cycle and proposed EURO II i.e. ECE R40 cycles emissions were compared. The optimized setting shows vehicle has met EURO II emission with 59 % margin in CO, 91% margin in HC and 47 % in NOx.

Abstracts of Technical Session

Wednesday, November 9, 10:30 - 12:00 at Room 104 & 105

Advanced Combustion Ⅱ

Chair: Yasuo Moriyoshi (Chiba University), Co-Chair: Roland Kirchberger (Graz University of Technology)

[20119523/2011-32-0523]

Experimental Study on Mixture Formation and Ignition Processes of Spray Injected by Hole-Type Nozzle for DISI Engine

Jiangping Tian (Dalian University of Technology), Hajime Kataoka, Keiya Nishida (University of Hiroshima)

The purpose of this study is to investigate the spray characteristics and ignition stability of gasoline sprays injected from a hole-type nozzle. Using a single-hole VCO (Valve-Covered-Orifice) nozzle, the spray characteristics were studied with LAS (Laser Absorption Scattering) technique, and then flame propagation and ignition stability were investigated inside a high temperature high pressure constant volume vessel using a high speed video camera. The spatial ignition stability of the spray at different locations was tested by adjusting the position of the electrodes. By adjusting the ignition timings, the stable ignition windows for 3 determined locations where the ignition stability was high at a fixed ignition timing were studied. The flame propagation process was examined using high speed shadowgraph method. Experimental results show that when the ignition points are located on the spray axis, the ignition probability is low. When the distance between the ignition point and the spray axis increases, the ignition probability increases and then decreases. High ignition probability distribution did not coincide with vapor phase equivalence ratio distribution. Too dense liquid phase (droplets) will decrease ignition probability, while proper liquid phase density can improve the ignition stability. (Contd.)

[20119574/2011-32-0574]

Study of Methods to Enhance Energy Utilization Efficiency of Micro Combined Heat and Power Generation Unit

Yoshiharu Takita (Honda R&D Co., Ltd.), Atsumu Naoi, Shohei Kono (Honda R&D Co., Ltd.)

To increase energy utilization efficiency of a micro combined heat and power generation unit, methods for simultaneously enhancing efficiencies of power generation and of heat recovery, which are normally in the trade-off relationship has been studied.

To increase power generation efficiency, an extended expansion linkage engine higher in thermal efficiency than conventional engines has been adopted. The power generation efficiency was enhanced by 3.8 points to 26.3% from 22.5% of a conventional model.

However, since introducing an extended expansion engine increases kinetic energy and lowers the temperature of exhaust gas from the engine, it is difficult to enhance the heat recovery. Focusing on the fact that most released heat energy is discharged through ventilation from the unit, ventilation cooling system was reexamined, and reduction of the released heat energy was considered.

First, positioning of heat-generative electronic parts on the inverter was changed, and the minimum airflow necessary for cooling was determined. In order to cool the entire unit with this airflow, an effective way to cool the alternator and the engine room was examined, and a method in which the ventilation which previously cooled the alternator is then delivered into the engine room was adopted. (Contd.)

[20119577/2011-32-0577]

The Effects of Electric Fields on Flame Propagation of Homogeneous Hydrogen-Air Mixture

Ryuichi Yamaguchi (Graduate School of Science and Technology, Nihon University), Akira Iijima, Hideo Shoji, Koji Yoshida (Nihon University)

The flame propagation behavior of homogeneous hydrogen-air mixture under application of high-voltage uniform or non-uniform electric field was explored by using combustion vessel. When a uniform electric field was applied, two plate electrodes were attached to ceiling and bottom of combustion chamber and, to apply a non-uniform electric field, an electrode in ceiling was needle-shaped and an electrode in bottom was plate-shaped. The positive or negative polarity DC high voltage was applied for an electrode in ceiling. When a positive polarity non-uniform electric field was applied to the mixture at any equivalence ratios and the input voltage was higher than 12 kV, the flame propagation was enhanced in the downward direction. This is because the corona wind was generated from the tip of needle-shaped electrode to grounded electrode by the brush corona. However, a negative polarity non-uniform electric field was applied, for any equivalence ratios, the combustion was not affected even if the input voltage of 16 kV was applied, because the corona wind was not generated in case of a negative polarity. When a positive polarity uniform electric field was applied, the flame propagation was almost the same as the conventional combustion for any equivalence ratios.

Abstracts of Technical Session

Wednesday, November 9, 10:30 - 12:00 at Room 107

Lubricants

Chair: Tohru Nakazono (Yanmar Co., Ltd.), Co-Chair: Brett Dohner (The Lubrizol Corporation)

[20119536/2011-32-0536]

Field to Lab Correlation and Lubrication Oil Change Frequency Estimation for Two Wheeled Vehicles Through Oil Analysis Technique

Anil V Singanamalli (TVS Motor Company Ltd.), Sasun C, Kumar Abhishek (TVS Motor Company Ltd.)

The customer needs and expectations in the automotive industry have become more demanding in recent past. This puts huge pressure on new product development (NPD) cycle as well as timelines on the automotive OEMs. The design verification and proving falls at the end of any NPD cycle and consumes significant amount of time. The major constituents of design verification and proving phase are the accelerated life tests conducted at a laboratory scale. These tests need to be correlated to the field usage condition in a correct and precise way in order to shorten the time spent in design iterations. This paper discusses on arriving at a correlation between field usage and one of the laboratory scale accelerated life tests for a small four stroke two wheeled vehicle engine through lubrication oil analysis technique. The lubrication oil used in different customer engines is collected from field and analyzed. The same exercise was done for one of the accelerated life tests conducted in laboratory and correlation between field usage and accelerated life tests is arrived at. The paper discusses the tools and techniques used for arriving at a correlation constant and also the safe oil replacement frequency for field usage conditions.

[20119651/2011-32-0651]

Methodology of Lubricity Evaluation for DME Fuel based on HFRR

Mitsuharu Oguma (National Institute of Advanced Science and Technology (AIST)), Shinichi Goto, Tadanori Yanai (AIST), Yasuhiko Mikita (Iwatani Corporation)

The methodology of lubricity evaluation for DME fuel was established by special modified HFRR (High-Frequency Reciprocating Rig) such as Multi-Pressure/Temperature HFRR (MPT-HFRR). The obtained results were summarized as follows: The HFRR method is adaptable with DME fuel. There is no effect of the test pressure (up to 1.8 MPa) and the test temperature (up to 100 °C) of MPTHFRR on wear scar diameter. The results with MPT-HFRR can be applied at the sliding parts of the injection needle and the fuel supply pump's plungers which are secured lubricity by the boundary lubrication mode mainly and the mixed lubrication mode partially. Using the fatty acid based lubricity improver in amounts of approximately 100 ppm, the lubricity of DME, which has a lack of self-lubricity, is ensured as same as the diesel fuel equivalent level. There is a big deviation of measured wear scar diameter when the LI concentration is not enough. It is caused that the amount of LI is not enough for the surface area of the material on which polar lubricant must be absorbed. The reason of securing lubricity is that the fatty acid, which is a main component of test LI, absorbs chemically on the sliding metal surface of fuel injection parts, and it forms metallic soap. Over adding fatty acid based LI doesn't give any advantage on lubricity.

[20119553/2011-32-0553]

Comparison of Developed In-housed Engine Test for Motorcycles to Field Trial: Applicable to Distinguish in Each Engine Oil Performance Level

Somnuek Jaroonjitsathian (PTT Public Company Limited), Sunthorn Predapitakkun, Chetwana Rungwanitcha, Somchai Siangsanorh, Nirod Akarapanjavit, Ratanavalee In-chanon, Amporn Sudsanguan (PTT Public Company Limited)

This study describes the development of engine test applicable to motorcycles. Due to the dramatically stringent of emission regulation, the aim of this development is to develop the engine test specifically for motorcycles based on the unconventional fuel, of which test results is comparable to field trial test results. Furthermore, this developed engine test is able to distinguish the engine oil in each performance level. Resulting in this comparison the newly development of engine test is comparable to field trial in aspects of detergency, anti-wear performance, and oil consumption.

Abstracts of Technical Session

Wednesday, November 9, 10:30 - 12:00 at Room 108

Measurement & Simulation Ⅲ

Chair: Shigeru Fujii (Yamaha Motor Co., Ltd.), Co-Chair: Stephan Schmidt (Graz University of Technology)

[20119518/2011-32-0518]

Development of CVT Shift Dynamic Simulation Model with Elastic Rubber V-Belt

Daisuke Hirajo (Yamaha Motor Co., Ltd.), Tetsuya Kimura, Koji Kobayashi (Yamaha Motor Co., Ltd.)

This paper presents a practical simulation model of the rubber V-belt CVT which is widely used as a low cost driveline element for small displacement motorcycles. The characteristic of this CVT is determined by the axial force balance between driver and driven pulleys, and the elastic force of a rubber V-belt. Because these axial and elastic forces are calculated by the kinematic and FEM analysis, a large-scale simulation model which costs long execution time for the calculation is needed to estimate the characteristic of CVT. This calculation uses the onedimensional simulation model built up with MATLAB and SIMULINK environment, so that it was possible to get the calculation result with relatively low execution time. The elastic deformation of the rubber V-Belt was calculated by a simple spring model which was verified by experiments and FEM. This simulation model can be used to predict CVT characteristic and estimate the performance of vehicle such as acceleration, fuel consumption, and emission.

[20119623/2011-32-0623]

Sensory Evaluation for Motorcycle Gear Shift Feeling with Simulator

Akio Ikemoto (SUZUKI MOTOR CORPORATION), Shogo Kida, Shunichi Mori, Tsutomu Sonehara, Toshihisa Takagi (SUZUKI MOTOR CORPORATION)

Gear shift feeling is often an important factor which appeals to motorcycle riders. Therefore, it is important for designers to create a pleasant gear shift feeling when developing a motorcycle. Sensory evaluation tests are indispensable for quantifying the gear shift feeling, but are very difficult to conduct with an actual motorcycle. Therefore, we developed a simulator dedicated to sensory evaluation tests, used it to conduct sensory evaluation tests, and thus clarified the relationship between the physical amount of gear shift properties and gear shift feeling. This paper describes the development of the simulator, the sensory evaluation tests conducted on gear shift feeling using the simulator, and the results of analysis.

[20119643/2011-32-0643]

Prediction Method of the Speed Characteristics of V-Belt CVT

Michinori Takeuchi (SUZUKI MOTOR CORPORATION), Mitsugu Koide, Yoshihiko Sunayama (SUZUKI MOTOR CORPORATION)

The Mechanical CVT is mainly used for small size motorcycle called “scooter”, which has a 250 cc or less engine capacity. The speed characteristics of the Mechanical CVT are decided by engine speed and load-torque on driven pulley. In few papers, these characteristics are studied under full-load or no-load condition [1]-[2]. However, the characteristics at part-load condition are not well known. To develop a motorcycle with low fuel consumption, it is important that the characteristics at part-load condition are considered in driving cycle. Driving cycle simulation is needed to estimate CVT ratio at design stage. This research proposes equations representing the speed characteristics of the Mechanical CVT at part-load condition. Driving cycle simulation is also developed for estimation of the fuel consumption at optional driving cycles and the dynamic behavior of the CVT system. It could be a CVT design tool to makes sure whether its performance is achieved for design targets.

Abstracts of Technical Session

Wednesday, November 9, 10:30 - 12:00 at Room 206

Alternative Fuels I

Chair: Koji Yoshida (Nihon University), Co-Chair: Alexander Trattner (Graz University of Technology)

[20119535/2011-32-0535]

Impact of the Wall Film Formation on the Full Load Performance of an Engine Operated with the Ethanol Blend E85

Thomas Lauer (Vienna University of Technology), Michael Heiss (Vienna University of Technology), Markus Klein (GM Europe Engineering - Powertrain)

A naturally aspirated SI engine with port fuel injection was investigated at the Institute for Powertrains and Automotive Technology of the Vienna University of Technology to analyze the impact of the ethanol blend E85 on the full load performance. Measurements and numerical studies with a predictive wall film model have been carried out to explain the mixture cooling, the calorific fluid properties after inlet valve closing and the volumetric efficiency with conventional fuel and E85.
It could be shown that only with a detailed modelling of the wall film formation in the inlet port an accurate prediction of the engine's full load performance is possible when studying different fuels with varying fluid properties. Anyway, an integrated approach that includes measurements and numerical investigations is necessary to analyse the mixture preparation and the engine process correctly.

[20119551/2011-32-0551]

Experimental investigation in combustion characteristics of ethanol-gasoline blends for stratified charge engine

Chinda Charoenphonphanich (Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Thailand), Piyaboot Ornman, Preechar Karin (King Mongkut's Institute of Technology Ladkrabang, Thailand), Nuwong Chollacoop (National Metal and Materials Technology Center (MTEC), Thailand), Hidenori Kosaka (Tokyo Institute of Technology)

The increasing of global energy demand and stringent pollution regulations have promoted research on alternative fuels. In Thailand, ethanol, can be produced from many sources of national agriculture products as renewable fuel, which was strongly promoted by government due to its many merits for use in transportation field. In this study, combustion characteristics of ethanol-gasoline blend (20%, 85%, and 100%) as well as pure gasoline (E0) were investigated by using a swirl-generated constant volume combustion chamber. Flame propagations of different fuel blends were observed by high speed Schlieren photography technique while pressure history data were recorded for detailed combustion analysis. Combustion behavior, combustion duration and rate of pressure rise of all tested fuels were investigated in various swirl intensities and equivalence ratios. In addition, effect of swirl intensities and ethanol concentration on lean misfire limit were also discussed. The results showed that the high concentration of ethanol blend with the high swirl intensity can significantly extended lean misfire limit while lowering combustion variations. Furthermore, combustion duration can be accelerated by increasing the percentage of ethanol in fuel blend. Through this study, a better understanding of stratified charge combustion fuelled with ethanol/gasoline blends can be achieved.

[20119552/2011-32-0552]

Low Temperature Starting Techniques for Ethanol Engine Without Secondary Fuel Tank

Chinda Charoenphonphanich (Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Thailand), Wittawat Imerb, Preechar Karin (King Mongkut's Institute of Technology Ladkrabang, Thailand), Nuwong Chollacoop (National Metal and Materials Technology Center (MTEC), Thailand), Katsunori Hanamura (Tokyo Institute of Technology)

The present study aims to investigate the parameters affecting cold start characteristics of ethanol at low temperature, and suggest a solution to avoid cold starting problem without the installation of second fuel tank. The testing engine is a 125 CC. volume displacement, single cylinder four strokes SI engine with fuel injection and ignition timing system controlled by ECU (electronic control unit). The cold starting performance tests were extensively conducted with different percentage of ethanol blends, surrounding temperatures, heating inside combustion chamber, heater injector, pre-cranking without fuel injection, and amount of fuel injection. From the experimental results, when using ethanol fuel in conventional engine, the problem of cold starting was observed at surrounding temperature lower than 20 °C for ethanol. Increasing of injection duration can lower the possible cold start temperature of neat ethanol. Glow plug and pre-cranking heating methods can help the engine start at much lower temperature. The combination of many techniques can make the ethanol engine start at the temperature as low as 3.5 °C. These findings offer solutions to the cold start problem in engine fueled with neat ethanol fuel in Thailand.

Abstracts of Technical Session

Wednesday, November 9, 10:30 - 12:00 at Room 207

Emissions Ⅱ

Chair: Hiromi Deguchi (SUZUKI MOTOR CORPORATION), Co-Chair: Robert Kee (Queen's University Belfast)

[20119511/2011-32-0511]

Exhaust emissions tests of small gasoline engines used as drives for power generators and handheld machinery

Piotr Lijewski (Poznan University of Technology), Jerzy Merkisz, Pawel Fuc (Poznan University of Technology)

The paper presents the results of investigations on the exhaust emissions carried out under actual operating conditions of gasoline engines operating in power generators, pumps and chainsaws. During the operation of these devices the authors measured the exhaust emissions: CO, HC, NOx and CO_2. For the measurements the authors used a portable exhaust emission analyzer SEMTECH DS. by SENSORS. This analyzer measures the concentrations of the exhaust gas components in an on-line mode while the engine is running under actual operating conditions (road, field etc.). The exhaust emission tests of non-road engine applications are currently performed on engine test beds in the NRSC (ISO 8178) and NRTC tests. The presented method is a new solution in determining of the exhaust emissions from such engines. The obtained results were compared with the applicable emission requirements. Based on the performed investigations the authors evaluated the applicability of the measurement method in the research works aiming at a reduction of the emissions from small gasoline engines.

[20119572/2011-32-0572]

A demonstration of the emission behaviour of 50 cm^3 mopeds in Europe including unregulated components and particulate matter

Juergen Tromayer (Graz University of Technology), Gerd Neumann, Roland Kirchberger, Helmut Eichlseder (Graz University of Technology), John May, Dirk Bosteels, Cecile Favre (Association for Emissions Control by Catalyst (AECC) AISBL)

The European emission legislation for two-wheeler vehicles driven by engines of ≤ 50 cm^3 is continuously developing. One of the most important issues in the near future will be the finalisation of the European Commission's proposals for future steps in the emissions regulations as well as the verification of the impacts of current standards on the market. To have a basis for the discussion about these topics, the Association for Emissions Control by Catalyst (AECC) with the Institute for Internal Combustion Engines and Thermodynamics of Graz University of Technology (IVT) carried out an extensive test programme to show the actual emission situation of state-of-the-art mopeds including mass and number of particulate matter as well as unregulated gaseous components.

One of the main goals of these tests was to measure exhaust emissions without any modifications to the engines of standard production vehicles available on the European market. The selection of test vehicles was carried out to get the best possible variety of technologies representing the actual situation on the street. (Contd.)

[20119587/2011-32-0587]

Different speed limiting strategies for 50cm^3 two-wheelers and their impacts on exhaust emissions and fuel economy

Juergen Tromayer (Graz University of Technology), Gerd Neumann, Roland Kirchberger (Graz University of Technology)

Usually the power output of 50cm^3 two wheelers is higher than necessary to reach the maximum permitted vehicle speed, making engine power restriction necessary. This publication deals with different power restriction strategies for four-stroke engines and their effect on exhaust emissions. Alternative power limitation strategies like EGR and leaning were investigated and compared with the common method of spark advance reduction to show the optimization potential for this certain engine operation conditions. From these tests, a substantial set of data showing the pros and cons in terms of emissions, combustion stability and fuel economy could be derived for each speed limiting technique.

Abstracts of Technical Session

Wednesday, November 9, 13:30 - 15:00 at Room 104 & 105

Advanced CombustionⅢ

Chair: Akira Iijima (Nihon University), Co-Chair: Roland Kirchberger (Graz University of Technology)

[20119589/2011-32-0589]

Design of a tumble-orientated intake port layout for a gasoline combustion process used in power sport application

Oliver Schögl (Graz University of Technology), Hermann Edtmayer, Stephan Schmidt (Graz University of Technology), Thomas Schabetsberger, Stefan Leiber (BRP-Powertrain)

In this publication, an intake design study was implemented in the development of a GDI engine concept at the Institute for Internal Combustion Engines and Thermodynamics at Graz University of Technology. For a high performance three-cylinder gasoline engine, different intake port geometries were developed, designed and evaluated with CAD and 3D CFD simulation methods. An emission reduction might be achieved with the improvement of the combustion behavior, as well as an increase of performance with an optimized cylinder charging. The combustion behavior was influenced by increasing the turbulence level via an intensified charge movement. The assessment criteria comprised the cylinder charge represented by the flow coefficient and the charge movement using the tumble number. The different intake designs were investigated in terms of a naturally aspirated engine concept using external (MPFI concept) and a supercharged engine concept with an internal homogeneous fuel mixture formation (DI concept). The studies took place in three basic steps. In the first, the statistical methodology of design of experiments (DoE) was applied to evaluate different parameters; the second consisted of a comparison of different intake port variants using a steady state flow simulation. (Contd.)

[20119600/2011-32-0600]

Thermodynamic Analysis and Comparison of the K6 Cycle

Matthew David Carlson (University of Wisconsin-Madison), Timothy A. Shedd (University of Wisconsin-Madison), Gerald E Kashmerick (Kashmerick Engine Systems LLC)

International concerns over small engine efficiency and emissions characteristics have lead to several efforts to develop improved internal combustion engine cycles, including investigation of Homogeneous Charge Compression Ignition (HCCI) and Premixed Charge Compression Ignition (PCCI) modifications to classic combustion cycles. Kashmerick Engine Systems LLC. has proposed a K6 cycle that moves the combustion process to an external continuous-combustion chamber to decrease the rate of combustion and allow optimization of the combustion chamber and piston-cylinder as a compression and expansion device separately to improve efficiency and reduce emissions. This paper describes 0-dimension modeling of both an air-standard dual-cycle model and an air-standard K6 cycle model in Engineering Equation Solver (EES) to compare the ideal performance of the two cycles. The dual-cycle is also correlated to a small engine currently in production to estimate typical compression and expansion efficiencies, which are then used with the K6 cycle model to estimate real-world performance. This work suggests that the K6 cycle may offer improvements over a dual-cycle for several air fuel ratios, and yields a useful tool to aid in optimization of cycle parameters for experimental work.

[20119610/2011-32-0610]

Reduction in Pollutant Emissions in an “Off-Road” DI Diesel Engine by Means of Exhaust Gas Recirculation

Patrizio Nuccio (Politecnico di Torino), Marco Bertone (Politecnico di Torino)

The aim of this work was to obtain a reduction in pollutant emissions, in particular for NOx and Soot, in an “Off-Road” DI Diesel Engine, equipped with a common rail injection system, by means of exhaust gas recirculation (EGR). First, an engine simulation was performed using a one-dimensional code, and the model was then calibrated with experimental results obtained from a previous research work conducted on bench tests.
Thanks to the engine model, specific emissions were then determined in all conditions, that is, in “eight modes” pertaining to engine loads and speeds. Both the injection advance and EGR amount were changed for all of these conditions in order to obtain the best compromise between fuel consumption and emissions and to respect standard regulations. The investigation was performed using both the Wiebe and a more complex combustion models; this latter allows in fact to determine the soot emission through the Nagle-Strickland model. As the standard emission limits were not respected, in spite of the presence of EGR at part-load, a pilot injection was also introduced into the simulation at full load, for maximum torque and power conditions, in order to reduce soot emissions. The presence of the pilot injection at full load allowed satisfactory results to be obtained for the emission limits and for fuel consumption, as some experimental tests have shown.

Abstracts of Technical Session

Wednesday, November 9, 13:30 - 15:00 at Room 107

Collegiate Events I

Chair: Takashi Mitome (SUZUKI MOTOR CORPORATION), Co-Chair: Jim Carroll (South West Research Institute)

[20119549/2011-32-0549]

Technical developments of power train of the 2010 F-SAEJ championship car originally developed by Osaka university student formula team

Shinichi Okunishi (Osaka University), Kyohei IZUMI, Takumi TOKINOYA, Yoshiyuki MATSUMOTO, Kenji YOSHIDA (Osaka University)

Osaka University Formula Racing Club (OFRAC) [1] won the first prize in the 8th Student Formula SAE Competition of Japan [2] organized by the Society of Automotive Engineers of Japan (JSAE). The technical developments, especially on the power train system, acted very important roles for this winning. Three technical developments were introduced to meet the machine concept "Get more performance at corner exit." They are; (1) Dry sump lubrication system to reduce the height of the center of gravity (C.G.), (2) Rotary throttle valve system to get more power and (3) Semi-automatic shift up assist system to reduce the loss of traction force during shifting up. In this paper, these unique technologies, which were originally student-developed, on the power train of our championship car, 'OFRAC Naniwa-X,' are focused [3].

[20119571/2011-32-0571]

Improvement of a small engine's efficiency with a supercharger

Ahn Changjoo (Sophia University), Takashi Suzuki, Yasuhumi Oguri, Hiroki Toshitani, Tatsuyoshi Nakahuku, Yusuke Nakano (Sophia University)

Many environmental problems, such as global warming, drain of fuel and so on, are apprehended in all over the world today, and downsizing is one of the wise ways to deal with these problems. It is significant that a decrease of the engine power must not be produced by using a small displacement engine, so more efficient engine system should be designed to increase the torque with a little fuel.

This study achieves an improvement of efficiency for mounting the super charging system on the small displacement engine. As a result, comparing a super charged engine and a naturally aspirated one to drive the same course and laps, fuel consumptions are 2547 [cc] and 3880 [cc], respectively, and an improvement of fuel consumption is 52%.

Designing points to mount super charging system is introduced below.

1. It can be forecasted that intake air blowby gas at the combustion chamber is increased in low engine speed because engine for motor cycle is used. Therefore, the valve timing (cam profile) is changed.
2. Stress analysis and fluid flow analysis were done for the new intake chamber made by powder laminated casting. The sectional area of the new intake chamber is set to become gradually smaller, in order to increase the flow rate.
3. Inter cooler is adapted, because intake air compressed with super charger becomes hot and it causes a decrease of charging efficiency and an increase of the knocking of an engine.
4. The fuel injection map and the ignition timing map are optimized for changes above.

These changes above made it possible to make higher torques for a wider range of engine speeds, and this leads to low fuel consumption. It is because that coming down torque peak and average engine speed reduce engine friction. In this way, the value of fuel consumption with super charger can be lower than the one with naturally aspirated.

[20119578/2011-32-0578]

Feed-back control of ignition timing using peak cylinder pressure angle with rough timing table

Thu Huong Thi Tran (Kanazawa University), Hiroshi Enomoto, Kosuke Nishioka, Kenichi Shimizu (Kanazawa University)

Cylinder pressure is used for the closed-loop ignition angle control of a gasoline engine. This paper focused on the crank angle position where the maximum cylinder pressure reached (θPmax) and the relationship between the θPmax and the ignition angle. This closed-loop control set the θPmax a target value with an initial ignition angle and does not need a detailed ignition angle map. Response time and deflection with the target value are examined with a test bench. The θPmax target, ATDC 18deg. is confirmed in consideration of the effect of knocking and the exhaust gas composition. The target ignition angle was varied step by step within a limit of upper and lower values, the response was observed and each gain was decided. At the engine speed of 5000rpm, the duration to reach a steady value of θPmax is 0.10s and the response time of ignition angle is 0.02s. The response time is almost the same of two crankshaft revolutions, hence an adequate performance is reliable because it can support the burning of two times. In addition, the change of the θPmax is settled with the standard deviation of value measured at the same level and get enough precision.

Abstracts of Technical Session

Wednesday, November 9, 13:30 - 15:00 at Room 108

NVH Technology

Chair: Tadao Okazaki (Kubota Corporation), Co-Chair: Juergen Tromayer (Graz University of Technology)

[20119650/2011-32-0650]

Radiation Noise Analysis for Electric Scooter Swing-arm with Finite Element Method

Shunzi Sato (SUZUKI MOTOR CORPORATION), Yoshihiko Sunayama, Yoshisada Sakamoto (SUZUKI MOTOR CORPORATION)

Traditionally, a Boundary Element Method (BEM) is often used for a radiation noise analysis. In recent years, to define an infinite region, a Finite Element Method (FEM) that can use an infinite boundary condition has been developed. However, studies on the radiation noise analysis by the FEM are few.
Recently a number of an electric scooter has been increased. One of development issues is a radiation noise by a vibration of a wall surface of a swing-arm. In this paper, the vibration of the wall surface of the swing-arm is calculated, and a sound pressure level (SPL) of the radiation noise is calculated using a result of the frequency response analysis. And compare results of an experimental and an analytical sound pressure, its results were matched to within 5% error. Furthermore we used the method of this paper, proposed the model to reduce the radiation noise 10dB. Then we compare with the FEM and the BEM to verify the computation time and the mesh size.

[20119514/2011-32-0514]

A Complete Acoustic Analysis on the Passive Effect of Small Engine Silencer Elements

Raimo Kabral (Tallinn University of Technology), Hans Rämmall, Jüri Lavrentjev (Tallinn University of Technology), Fabio Auriemma (Universita Federico II di Napoli)

A modern exhaust silencer system designed for an internal combustion engine typically incorporates a number of acoustic elements, which all contribute in the overall acoustic performance of the system and determine the sound radiation into the surroundings. The characteristics of individual elements in acoustic silencers affecting sound propagation are referred to as the passive acoustic effect treated in this paper. An acoustic transmission loss is a parameter often used in engineering to describe the passive acoustic performance of exhaust system elements. However, in order to provide a complete acoustical characterization of silencers and silencer components the acoustic 2-port elements (the scattering matrix or alternatively the transfer matrix) should be additionally analyzed.
In this paper the scattering matrixes are studied systematically for several small engine silencer elements in a variety of operating conditions. Acoustic 2-port determination procedure has been followed by implementing a dedicated hot-flow test facility set-up in Tallinn University of Technology. The complete 2-port analysis has been performed on a formula SAE straight-flow racing muffler and on a custom designed small series exclusive motorcycle muffler. Additionally, the acoustic characteristics of wools commonly used in small engine mufflers are studied by testing a number of prepared wool samples.
Results are provided to exhibit a vibroacoustic effect of silencer outer shells on the sound transmission through the unit, which was found to significantly affect the passive acoustic data.
Experimental results measured for a complete multi-element commercial silencer are compared to the ones obtained by 1D and 3D simulations.

[20119642/2011-32-0642]

Prediction of Vibration Fatigue Life for Motorcycle Exhaust Systems

Masashi Michiue (Kawasaki Heavy Industries, Ltd.), Kenji Nishio, Hiroshi Sugiura, Takumi Kawasaki, Fumihide Inamura, Manabu Morikawa (Kawasaki Heavy Industries, Ltd.)

In this study, the technology that can predict fatigue life for motorcycle exhaust systems is developed. To predict the fatigue life, analyzing the engine vibration, modeling the vibration characteristics of exhaust systems and evaluating the fatigue damage of welded joints are considered essential. This paper shows an integrated numerical simulation and evaluation method. Furthermore, it is also shown with the result of a component vibration test of the muffler assembly to validate the technology. The results indicate a good correlation between the numerical simulation and the test.

Abstracts of Technical Session

Wednesday, November 9, 13:30 - 14:30 at Room 206

Alternative Fuels Ⅱ

Chair: Koji Yoshida (Nihon University), Co-Chair: Alexander Trattner (Graz University of Technology)

[20119591/2011-32-0591]

An Investigation on the Spray Characteristics of DME with Variation of Ambient Pressure using the Common Rail Fuel Injection System

SeJun Lee (Graduate School, University of Ulsan), Ock Taeck Lim (University of Ulsan), Norimasa Iida (Keio University)

It is investigated of the DME spray characteristics about varied ambient pressure and fuel injection pressure using the common rail fuel injection system when the nozzle holes diameter is varied. The common rail fuel injection system and fuel cooling system is used since DME has compressibility and vaporization in atmospheric temperature. The fuel injection quantity and spray characteristics were measured. The spray was analyzed of spray shape, penetration length, and spray angle at the six nozzle holes. The 2 type injectors were used, the one was 0.166 mm diameter the other one was 0.250 mm diameter. The ambient pressure which is based on gage pressure was 0 MPa, 2.5 MPa, and 5 MPa. The fuel injection pressure was varied by 5 MPa from 35 MPa to 70 MPa. When using the converted injector, compared to using the common injector, the DME injection quantity was increased 127 % but it didn't have the same heat release. Both of the common and converted injectors had symmetric spray shapes. In case of converted injector, there were asymmetrical spray shapes until 1.2 ms, but after 1.2 ms the spray shape was symmetrical. Compared with the common and converted injector, the converted injector had shorter penetration length and wider spray angle than the common injector.

[20119632/2011-32-0632]

Numerical Analysis of Carbon Monoxide Formation in DME Combustion

Yuya Muramatsu (Graduate School, Ibaraki University), Mitsuharu OGUMA, Tadanori YANAI (National Institute of Advanced Industrial Science and Technology), Mitsuru KONNO (Ibaraki University)

Dimethyl ether (DME) is an oxygenated fuel with the molecular formula CH_3OCH_3, economically produced from various energy sources, such as natural gas, coal and biomass. It has gained prominence as a substitute for diesel fuel in Japan and in other Asian countries, from the viewpoint of both energy diversification and environmental protection. The greatest advantage of DME is that it emits practically no particulate matter when used in compression ignition (CI) engine. However, one of the drawbacks of DME CI engine is the increase carbon monoxide (CO) emission in high-load and high exhaust gas circulation (EGR) regime.
In this study, we have investigated the CO formation characteristics of DME CI combustion based on chemical kinetics. In order to understand the equivalence ratio (f) - temperature (T) dependence of CO formation in DME combustion, we generated the CO f-T map through numerical calculations with detailed chemical reaction models and compared it with that of methane combustion. (Contd.)

Abstracts of Technical Session

Wednesday, November 9, 14:00 - 15:00 at Room 207

Emissions Ⅲ

Chair: Hiromi Deguchi (SUZUKI MOTOR CORPORATION), Co-Chair: Glenn Bower (University of Wisconsin)

[20119512/2011-32-0512]

Accelerated Durability Test for Metallic Substrates Tailored for Motorcycle Application

Lorenzo Pace (Emitec G.m.b.H.), Martin Forster, Rudolf Prem, Richard Humer (KTM-Sportmotorcycle AG), Francois Jayat, Roman Konieczny (Emitec G.m.b.H)

Future emission legislation for 2 and 3 wheelers in EU and many other Countries will introduce durability of pollution control devices. Along with a durable coating technology, the mechanical durability of the substrate must be ensured to guarantee the requested conversion efficiency for the entire life of the motorcycle. A traditional approach consisting in engine bench and vehicle testing is no more competitive considering the very short time to market needed in the motorcycle market and the relevant cost related to this kind of tests. For this reason a new time and cost efficient accelerated component durability test was developed, which can account for the combined effects of critical load at a metallic catalytic converter. This paper shows the methodology used to determine the critical stressors and their levels in real operating conditions by measuring and analyzing a broad range of vehicle test information. The information was used to develop a temperature profile and a high vibration load, which were implemented in a superimposed hot vibration / thermal cycling component bench test. This highly accelerated test provides a time and cost efficient reproduction of field failure modes and allows the project team to choose a tailored and robust design for metallic catalytic.

[20119657/2011-32-0657]

High performance cost efficient catalytic coatings for carbureted small motorcycles

Ansgar Wille (Heraeus Precious Metals GmbH & Co. KG), M. Bonifer (Heraeus Precious Metals GmbH & Co. KG), U. Endruschat (Heraeus Catalysts (Danyang) Co., Ltd.)

In this paper we will present the development of Pd-rich catalytic coatings especially tuned for the application of carbureted motorcycles with a displacement of 110cc to 150cc. We will compare a standard PtRh coating with Pdrich coatings with regard to activity, durability and precious metal costs. In this paper we will focus on the activity of the catalysts regarding the wide lambda window of carbureted motorcycles. Catalyst activity has been evaluated not only with regard to the level of Pd in the coating but also regarding overall washcoat architecture and application of the catalytic coating to the substrate. We have evaluated the basic parameters by a laboratory exhaust gas simulation using lean/rich boundary conditions. In addition we proved the correlation to the real application by testing several motorcycles in comparable lean/rich boundary conditions with regard to the China 3 regulation.

Abstracts of Technical Session

Thursday, November 10, 9:00 - 10:00 at Room 107

Collegiate Events Ⅱ

Chair: Takashi Mitome (SUZUKI MOTOR CORPORATION), Co-Chair: Jim Carroll (South West Research Institute)

[20119579/2011-32-0579]

Development of small gasoline engine with electronic variable valve timing unit

Thu Huong Thi Tran (Kanazawa University), Hiroshi Enomoto, Kosuke Nishioka, Kenichi Shimizu (Kanazawa University)

This paper investigates influences of intake and exhaust valves overlap (at this duration, both of the intake valve and exhaust valve are open) on engine performance. An electric, variable cam phase mechanism (VVT, Variable Valve Timing unit) is installed in a small gasoline engine. The influences on the engine torque and BSFC, Brake Specific Fuel Consumption, are investigated on the engine bench. In addition, in case the overlaps exceeding the experimental range an engine simulator is used to predict the effects. The experimental results indicate that the VVT system can adjust the target overlap with the accuracy of 1.5deg. in a range of engine speed from 3000rpm to 7000rpm. The response time of the VVT unit was observed at the engine speed of 3000rpm. The results show that the rotation direction of motor affects on the response time of the unit. The measurement of engine torque and BSFC is performed for several overlap values at each engine speed. As a result, by extending overlap using VVT unit, the engine torque can improve in whole range of controllable engine speed in the experiment. The simulation results also predict the possibility of further improvement on engine torque by extending cam overlap.

[20119580/2011-32-0580]

Effect of cylinder diameter of monotube-type MR-damper on the damping force change ratio and the response time

Kohei Izumi (Kanazawa University), Hiroshi Enomoto, Toshihiko Komatsuzaki, Hajime Komatsu (Kanazawa University)

MR-damper (Magneto-Rheological fluid damper) is used an actuator with high speed in response to control the movement of four-wheel vehicles. In this paper, performances of two MR-dampers were measured. These dampers had difference in diameter of cylinder, length of piston and orifice. These changes will influence the damping force, the damping force change ratio and the response time of damping force change. As a result, a larger damper showed 1.4 times damping force change ratio of smaller one and shorter response time in compression.

Abstracts of Technical Session

Thursday, November 10, 8:00 - 10:00 at Room 108

Measurement & SimulationⅣ

Chair: Tadao Okazaki (Kubota Corporation), Co-Chair: Stephan Schmidt (Graz University of Technology)

[20119608/2011-32-0608]

Challenges In Muffler Mounting Design For Resilient Mounted Scooter Engine

Dora K B (TVS Motor Company Ltd.), Anandkumar M S, Anand R B, Jayaram N (TVS Motor Company Ltd.)

In recent times gearless scooters are becoming popular means of transport in ASIA because of their ease of handling in crowded traffic and superior comfort over motorcycles. Major difference, which is contributing for least vibrations incase of scooters is mechanism of engine mounting on the frame. In most of the cases motorcycle engines are rigidly fixed to the frame where as in case of scooters engine will be swinging with respect to frame. It is easy to design muffler mounting for fixed engines. Since there is no relative motion between engine and frame for motorcycle both can be fixed to frame. Swinging scooter engine demands muffler mounting directly on engine. These direct mounts may include bosses, brackets, and bolts. While useful for their intended purpose, it is possible that vibrational energy can pass between the exhaust components and the engine through this direct mounting. This occurs due to directly coupling a large radiating surface (the exhaust component) to an active vibrating structure engine. There is also the possibility that the exhaust mounting bolts get loose because of vibration and in turn leads to shear failure of bolts and structural failure of muffler and engine parts. (Contd.)

[20119529/2011-32-0529]

Investigation of the Flow Velocity in the Spark Plug Gap of a Two-Stroke Gasoline Engine Using Laser-Doppler-Anemometry

Markus Bertsch (MOT GmbH), Kai W. Beck, Ulrich Spicher (Karlsruhe Institute of Technology (KIT)), Kai Schreer, Christian Disch (MOT GmbH)

The two-stroke SI engine remains the dominant concept for handheld power tools. Its main advantages are a good power-to-weight ratio, simple mechanical design and low production costs. Because of these reasons, the two-stroke SI engine will remain the dominant engine in such applications for the foreseeable future. Increasingly stringent exhaust emission laws, in conjunction with the drive for more efficiency, have made new scavenging and combustion processes necessary. The main foci are to reduce raw emissions of unburned hydrocarbons via intelligent guidance of the fresh air-fuel mixture and to improve performance to reduce specific emissions. The flow velocity in the electrode gap of the spark plug is of great interest for the ignition of the air-fuel-mixture and the early combustion phase of all kinds of SI engines. In these investigations, the flow velocity in the spark plug gap of a two-stroke gasoline engine with stratified scavenging was measured under various conditions. Two spatial directions in the spark plug gap were measured without influencing the in-cylinder flow. The measurements were performed using LDA (Laser Doppler Anemometry), a non-intrusive optical velocity measurement technology. For the application of the LDA equipment, the placement of one optical access in the cylinder head was necessary. (Contd.)

Abstracts of Technical Session

Thursday, November 10, 8:00 - 10:00 at Room 108

Measurement & SimulationⅣ

Chair: Tadao Okazaki (Kubota Corporation), Co-Chair: Stephan Schmidt (Graz University of Technology)

[20119525/2011-32-0525]

CFD investigation of the thermal behavior of a high performance bike engine

Stefano Fontanesi (University of Modena), Giuseppe Cicalese (University of Modena), Stefano Fantoni, Massimo Rosso (Ducati Motor Holding S.p.A)

The paper presents a combined experimental and numerical activity carried out to improve the accuracy of conjugate heat transfer CFD simulations of a high-performance S.I. motorbike engine water cooling jacket. The computational domain covers both the coolant jacket and the surrounding metal components (head, block, gasket, valves, valve seats, valve guides, cylinder liner, spark plug). In view of the complexity of the modeled geometry, particular care is required in order to find a tradeoff between the accuracy and the cost-effectiveness of the numerical procedure. The CFD-CHT simulation of water cooling jackets involves many complex physical phenomena: in order to setup a robust numerical procedure, the contribution of some relevant CFD parameters and sub-models was discussed by the authors in previous publications and is referred to [1-4]. Among the formers, the effects of a proper set of boundary conditions and a detailed representation of the physical properties of the involved materials were evaluated. Among the latter, the contribution of a two-phase approach taking into account the effects of phase transition within the engine coolant was considered. (Contd.)

[20119526/2011-32-0526]

1D and 3D CFD Investigation of Cyclic Dispersion and Knock Occurrence in a CNG Small-Size SI Engine

Stefano Fontanesi (University of Modena), Elena Severi (University of Modena), Fabio Bozza, Alfredo Gimelli (University of Naples "Federico II")

The paper presents a combined experimental and numerical investigation of a small unit displacement two-stroke SI engine operated with gasoline and Natural Gas (CNG). A detailed multi-cycle 3D-CFD analysis of the scavenging process is at first performed in order to accurately characterize the engine behavior in terms of scavenging patterns and efficiency. Detailed CFD analyses are used to accurately model the complex set of physical and chemical processes and to properly estimate the fluid-dynamic behavior of the engine, where boundary conditions are provided by a in-house developed 1D model of the whole engine. It is in fact widely recognized that for two-stroke crankcase scavenged, carbureted engines the scavenging patterns (fuel short-circuiting, residual gas distribution, pointwise lambda field, etc.) plays a fundamental role on both of engine performance and tailpipe emissions. In order to assess the accuracy of the adopted numerical approach, comparisons between numerical forecasts and experimental measurements of instantaneous in-cylinder pressure history for steady-state operations of the engine are at first performed and shown in the paper. Subsequently, results from 3D simulations are used to improve the scavenging characterization within the 1D model, where particular emphasis is now devoted to the investigation of the knock occurrence. (Contd.)

Abstracts of Technical Session

Thursday, November 10, 9:00 - 10:00 at Room 206

Alternative Fuels Ⅲ

Chair: Yuu Motoyama (Yamaha Motor Co., Ltd.), Co-Chair: Nagesh Mavinahally (MavinTech, LLC)

[20119562/2011-32-0562]

EXPERIMENTAL STUDY ON PERFORMANCE, EMISSIONS AND COMBUSTION CHARACTERISTICS OF A SINGLE CYLINDER DUAL FUEL LPG/DIESEL ENGINE

Tuan Anh Le (School of Transportation Engineering, Hanoi University of Science & Technology), Truc The Nguyen (School of Transportation Engineering, Hanoi University of Science & Technology)

This paper shows experimental results on engine's characteristics in a single cylinder diesel Common Rail engine AVL5402 converted to LPG/diesel dual fuel.
Findings from the study show that at full load, higher LPG mass fraction can be reached at lower engine speed due to knocking limit however the economic efficiency with dual fuel is better at higher engine speeds as at these operating regimes the better injection quality and better fuel evaporation can help combustion improve. Comparing to the original engine, when LPG/diesel dual fuel is used, the smoke number and carbon monoxide (CO) decreases at almost all running modes while total hydrocarbon (THC) and nitrogen oxide (NOx) are higher. The improvement of combustion process is a reason for lower smoke number and CO, and higher NOx emissions. Higher THC is explained by unburned hydrocarbon, mainly unburned LPG-air mixture.
Advancing diesel injection timing and increasing pilot injection timing at full load, 1400 rpm and 2000 rpm speeds present similar effects in engine's performance and exhaust emissions. Of which, there is no significant changes of engine's power, the ignition time is advanced, and CO and smoke number are reduced but THC and NOx. (Contd.)

[20119605/2011-32-0605]

A Study on Influence of Forced Over Cooling on Diesel Engine Performance

Syuichi Nanba (Graduate School of Science and Technology, Nihon University), Akira Iijima, Hideo Shoji, Koji Yoshida (Nihon University)

The ignitability and engine performance of FAMEs at the cold condition were experimentally investigated by using two FAMEs, i.e. coconut oil methyl ester (CME) and soybean oil methyl ester (SME). The cold start test and forced over cooling test were conducted. In the forced over cooling test, engine was forced cooled by the injecting water mist to engine cooling fin. In the cold start test, the cylinder pressure of CME rose earliest because CME has a superior ignitability. The crank angle at ignitions of diesel fuel and CME were not so affected by the forced over cooling, however ignition timing of SME was remarkably delayed. In cases of forced over cooling, COV of maximum combustion pressure of CME was lower than that of normal air cooling condition. The forced over cooling has a potential to reduce NOx emission, however HC, CO and smoke concentrations were increased in a high load due to incomplete combustion. The incomplete combustion was relatively suppressed for CME as compared with other fuels. The high load operation could be achieved by the forced over cooling because of improvement of charging efficiency, however the brake thermal efficiency was deteriorated due to an increase in cooling loss.

Abstracts of Technical Session

Thursday, November 10, 8:00 - 9:00 at Room 207

Engine Control I

Chair: Yutaka Nitta (SUZUKI MOTOR CORPORATION), Co-Chair: Thorsten Raatz (Bosch)

[20119626/2011-32-0626]

A control oriented model development for a gas control path with a stepper motor-based actuator for a Gas Engine

Himadri Bhushan Das (TVS Motor Company Ltd.), Kavitha Shailesh N, Srikanth Kanchi K, S Jabez Dhinagar, Lakshminarayana Padhi (TVS Motor Company Ltd.)

In today's automotive power train control, the usage of model based control system is getting more focused because of the advantages associated with this approach. The model-based system can be implemented to predict and control different control parameters associated with Power train control.
As a part of this work a multivariable control oriented model is developed to control the inlet manifold airflow of a small S.I. engine running on Gas. A stepper motor-based actuator is placed on the gas flow control path. A model based controller approach is adopted to control the actuator, which is placed on the low-pressure tube with inlet manifold to control the gas flow.
In the initial phase of work, a state based non-linear model is developed for the actuator. This model captures the total dynamics of a permanent magnet stepper motor-based flow control device in a state space model. Different parameters for the model are calculated using system identification methodology.
In the second phase of work, a mean value model for inlet manifold is developed. In this model, the abovementioned actuator is placed on an addition to the carburetor for the manifold airflow path. (Contd.)

[20119627/2011-32-0627]

A control oriented model development for fuel delivering structure of a port injection based system

Kommuri Naga Kavitha (TVS Motor Company Ltd.), Himadri Bhushan Das, S Jabez Dhinagar, Lakshminarayana Padhi (TVS Motor Company Ltd.)

In recent years the fuel injection technology has taken a great leap in two wheeler industries both in terms of having lean emissions and in terms of improving efficiency. Especially in a market like India where fuel efficiency is given, as prime importance and fuel contamination duly exists, it becomes all the more a bigger challenge to address to these kinds of problems by some means.
The main function of the fuel system is to make sure right amount of fuel is injected into the intake manifold at right time with the help of Electronic Control Unit. Variation from the right quantity and quality of fuel leads to partial burning and finally to more emissions and poor performance. So monitoring fuel pressure, there by the quantity and fuel quality is very much important to reduce emissions and to achieve desired performance. (Contd.)

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Abstracts of Technical Session

Thursday, November 10, 9:00 - 10:00 at Room 207

Engine Control I

Chair: Yutaka Nitta (SUZUKI MOTOR CORPORATION), Co-Chair: Thorsten Raatz (Bosch)

[20119510/2011-32-0510]

Estimation of Indicated Mean Effective Pressure Using Crankshaft Angular Velocity Variation

Kenji Nishida (Honda R&D Co., Ltd.), Tetsuya Kaneko, Yoichi Takahashi, Koji Aoki (Honda R&D Co., Ltd.)

We have successfully developed a system to estimate Indicated Mean Effective Pressure (hereafter "IMEP") by detecting the crankshaft angular velocity variation during one cycle of a four-stroke single-cylinder gasoline engine. The system has been commercially applied to the spark-ignition timing control system for small-displacement motorcycle engines. The determined amplitude of crankshaft angular velocity variation during one cycle is defined as "delta omega (Δω)". The relationship between Δω and IMEP has been experimentally examined using engine unit bench tests and actual motorcycles. From the experimental results, it was confirmed that Δω represents IMEP. This paper discusses the experimental study on the estimation of IMEP using crankshaft angular velocity variation.

[20119629/2011-32-0629]

Application of Air Fuel Ratio Control to a Motorcycle with Dual Oxygen Sensor

Takashi Abe (Kawasaki Heavy Industries, Ltd.), Yoshinobu Mori, Daisuke Yanase, Shinichi Kuratani (Kawasaki Heavy Industries, Ltd.)

At the upstream part of the Three-Way Catalyst (TWC) an O_2 sensor (UpO_2S) is used for O_2 Feedback Control (O_2F/B) that controls the air fuel ratio (A/F) close to the stoichiometric level. O_2 sensor has a bit of individual characteristic difference as for the switching the excess air ratios of output (λ shift). This phenomenon becomes remarkable according to the effects of unburnt elements in exhaust gas. Despite the O_2F/B implementation, A/F isn't controlled to the stoichiometric level and the conversion efficiency of the TWC could be lower. Maintaining a higher level of TWC conversion efficiency requires more accurate A/F control and corrections of the UpO_2S λ shift issue. Therefore, using an O_2 sensor at the downstream part of the TWC ($DownO_2S$) - where the effects of unburnt elements in exhaust gas are smaller-can be an effective way to restore these challenges. We measured the relation between $DownO_2S$ behavior and the TWC conversion efficiency on motorcycles and found out a strong correlation between them. With this correlation in mind, we were able to improve the TWC conversion efficiency by employing an A/F control system with Dual Oxygen Sensor (UpO_2S and $DownO_2S$).

Abstracts of Technical Session

Thursday, November 10, 10:30 - 12:00 at Room 107

Collegiate Events Ⅲ

Chair: Takashi Mitome (SUZUKI MOTOR CORPORATION), Co-Chair: Brian Callahan (Achates Power & Basco)

[20119588/2011-32-0588]

Effect of electrically controlled MR-damper on the cornering of small racing car

Kohei Izumi (Kanazawa University), Hiroshi Enomoto, Toshihiko Komatsuzaki, Hajime Komatsu (Kanazawa University)

Chassis performance greatly influences driving in the turn inn movement. Spec of the active damper is simulated to achieve a chassis that satisfies various requirements. In this paper, an MR-damper (Magneto-Rheological fluid damper), which is high-response active damper, is chosen. The MR-damper is mounted in FSAE vehicles and controlled vehicle behavior electronically in a simulator. As a result, the MR-damper brought a big effect to pitch action rather than roll action, and an initial damping force effected vehicle behavior more than damping force change ratio.

[20119656/2011-32-0656]

Development Process of a Formula SAE Vehicle of HU

Kazuki WATANABE (Hokkaido University), Ken TERAKAWA (Hokkaido University)

Chassis design on a racing car must meet many conflicting requirements including high torsional and flexual rigidity, driver safety, optimum suspension geometry, a low center of gravity and light weight. In comparison to our 2010 model, the frame weight of the 2011 model was reduced by 15% whilst increasing torsional rigidity to 920Nm/deg. Suspension geometry was refined based on driver feedback and track chronometry. Suspension components were simplified, reducing weight by 10% and greatly reducing cost. A standardization approach was taken from the 2011 model, allowing a near complete compatibility of commercial parts amongst different year models.

[20119617/2011-32-0617]

Dry Sump Design for a 600cc Yamaha YZFR6 Engine

Shane McKenna (Queen's University Belfast), Chris McKeown, Glenn Sloan, Geoffrey McCullough, Geoff Cunningham (Queen's University Belfast)

The Formula SAE competition challenges engineering students to design, build and compete in a single-seat race car. The rules limit the swept volume of the engine to 610cc and so most teams elect to use a motorcycle engine which inherently offers the desirable attributes of high power density and low mass. Engines from 600 cc motorcycles designed primarily for road use are particularly common in this competition. When used in the motorcycle these engines rarely suffer from oil starvation induced by lateral acceleration as the engine tilts with the motorcycle during cornering thereby keeping the oil pickup submerged in the oil. However, when installed in the race car, the engine is constrained in the horizontal plane and is also subjected to higher lateral accelerations. This causes oil surge during cornering and results in almost instant and catastrophic engine failure. The Queens Formula Racing (QFR) team uses an 03-04 model, 600 cc Yamaha YZF R6 engine for their Formula SAE car. A number of designs aimed at preventing oil surge were previously tested including a custom designed baffle and the use of a hydraulic accumulator. (Contd.)

Abstracts of Technical Session

Thursday, November 10, 11:00 - 12:00 at Room 108

Engine Components

Chair: Toshimi Kobayashi (Kawasaki Heavy Industries, Ltd.), Co-Chair: Stephan Schmidt (Graz University of Technology)

[20119649/2011-32-0649]

Development of lead-free crankshaft for motorcycle

Osahiko Horii (SUZUKI MOTOR CORPORATION), Shigenori Yamada (SUZUKI MOTOR CORPORATION), Shigefumi Nishitani(Sumitomo Metals (Kokura), Ltd.), Kunihiko Hiraoka, Hiroshi Chigira (SUZUKI MOTOR CORPORATION)

Lead-added free-cutting steel has been used by many parts which need high machinability because lead improves chip friability and drill life. However, the demand of lead reduction increases in recent years, because of environmental impact substance reduction. Therefore, we developed lead-free crankshaft for motorcycle.
Until now, crankshaft for motorcycle has been manufactured with lead-added free-cutting steel by a following process; Hot-Forging - Quenching and Tempering (QT) - Prior Machining - Nitrocarburizing - Finishing process because of strength and machinability. When we tried to change steel to lead-free, we examined to change to sulfur-added free-cutting steel. However, chip friability of sulfur-added free-cutting steel is inferior to lead one. Thus, we concerned about increase in machining expense. Then, heat-treatment after forging was examined to change from QT to normalizing for reducing the heat-treatment expense. As a result, total production cost achieved equivalent to conventional.
Deterioration of fatigue strength was feared because of a decrease of hardness by changing heat-treatment. Thus, we paid attention to that crankshaft for motorcycle needs nitrocarburizing. We adjusted the alloying elements so that hardness near the surface after nitrocarburizing which influences especially fatigue strength might become higher than conventional. Therefore, fatigue strength became equivalent to conventional.

[20119613/2011-32-0613]

Transistor Coil Ignition System for Kick Start Based Small Engines

Sivakumar Arumugham (TVS Motor Company Ltd.), Dipanjan Mazumdar, Jabez Dhinagar (TVS Motor Company Ltd.)

Two wheeler 4-stroke small Engine with Kick Start requires longer spark duration along with better spark energy in order to burn the lean mixture and to have better Start ability, lower trigger start RPM is also important to enable ease of start. An effective Ignition System needs to be designed for the above purpose. Hence Transistor Controlled Ignition/ Inductive Discharge System (TCI/IDI) unit is preferred which gives all the above mentioned requirements. Normally any conventional TCI/IDI operated 4-stroke two wheelers will have D.C power line align with a Power Source for its operation. The 2 Wheeler Kick start version cannot afford the DC Power Source due to Cost, Hence the Electrical System will not have the DC Power Line. So it is not possible to operate a Conventional TCI/IDI system as it is DC Power based System. The challenge is to operate the TCI/IDI ignition unit without DC Power Source i.e. using AC Source. In order to prove the above concept extensive data were collected on the charging pattern and power consumption during operation of various loads with existing charging system. Based on the collected data and customer usage pattern, appropriate power requirement characteristic graphs are obtained. Hence New TCI/IDI has been designed with longer Spark duration and Less Trigger Start RPM. Finally proto parts are developed as per the required power characteristic and then the system was tested on proto engines. This new system* delivers the attributes of a TCI/IDI ignition unit required for a 4-stroke two wheeler engine without using a DC Power Source i.e. only Kick Start. This is having a huge impact on the reduction of Vehicle electrical system cost as DC Power Source is one of the major cost driver for any electrical system with IDI/TCI ignition unit for better performance. Hence it increases the effective efficiency than Conventional Ignition System designed for Kick Start based small Engines.

Abstracts of Technical Session

Thursday, November 10, 11:00 - 12:00 at Room 206

Alternative FuelsⅣ

Chair: Koji Yoshida (Nihon University), Co-Chair: Nagesh Mavinahally (MavinTech, LLC)

[20119561/2011-32-0561]

A Study on Improvement of Diesel Spray Characteristics Fueled by Rape-seed Oil

Azwan Bin Sapit (The University of Tokushima), Sho Nagayasu, Yasunori Tsuboi, Yuzuru Nada, Yoshiyuki Kidoguchi (The University of Tokushima)

It is widely known that direct application of biomass fuels oil to DI diesel engines increases the carbon deposit in the engine. To minimize this effect, biomass fuel is subjected to transesterification process. Nevertheless, it is still desirable to use biomass fuel without transesterification. As diesel engine combustion and emissions are strongly dependent on spray characteristics and mixture formation, this study tries to clarify the spray characteristics of rape-seed oil (SVO) including spray structure, spray development, fuel evaporation, and droplets atomization.
Optical observation reveals that rape-seed oil (SVO) spray forms a stick-like structure without branching structure at spray boundary and has heterogeneous density distribution in a liquid column at spray centerline. SVO spray hardly penetrates at exceedingly initial stage of injection, in particular at low injection pressure. Combination of high injection pressure and high ambient temperature lengthens spray penetration and produces branching structure and fine droplets. Macro-scale characteristics of SVO spray can be improved by applying reduction of nozzle sac-volume and scaling of nozzle hole-diameter accompanied with high injection pressure. However, it is hard to improve stick-like structure and heterogeneous density distribution of SVO spray under low injection pressure and low ambient temperature.

[20119590/2011-32-0590]

Diesel Combustion Characteristics of Biodiesel with 1-Butanol

Eiji Kinoshita (Kagoshima University), Kazunori Hamasaki, Ryota Imabayashi (Kagoshima University)

In order to improve the fuel properties and diesel combustion of biodiesel, waste vegetable oil methyl ester (from rapeseed and soybean oil mixture) with 5-20 mass% 1-butanol (BWME) are tested using a DI diesel engine. The viscosity and pour point of BWME decrease by blending 1-butanol. There is no problem in the startability and stability of the engine operation with BWME. Thermal efficiency of BWME is almost the same as that of the gas oil. The smoke emission decreases with increasing 1-butanol although the HC and CO emissions increase due to the longer ignition delay. It is concluded that BWME can be utilized as an alternative diesel fuel. Furthermore, to improve the ignitability and exhaust emissions of biodiesel with 1- butanol, palm oil methyl ester (PME) with high cetane number is tested as a base fuel of the 1-butanl blend. When the 1-butanol content in PME/1-butanol (BPME) is 15 mass%, BPME has almost the same ignition delay and HC and CO emissions compared with the gas oil. From the experimental results, it is concluded that PME is better than rapeseed oil methyl ester as a base fuel of the biodiesel with 1-butanol due to the better ignitability and lower exhaust emissions.

Abstracts of Technical Session

Thursday, November 10, 10:30 - 12:00 at Room 207

Engine Control Ⅱ

Chair: Yutaka Nitta (SUZUKI MOTOR CORPORATION), Co-Chair: Thorsten Raatz (Bosch)

[20119631/2011-32-0631]

Development of Low-cost Fuel Injection Control Unit for Small Motorcycles with Single-cylinder Engine

Keiji Kiyohara (Keihin Corporation), Ryuji Asou (Keihin Corporation)

Amid the replacement of the fuel system with FI (Fuel Injection), which aims to provide the improved fuel efficiency and reduced exhaust emission of small motorcycles, further cost reduction and downsizing of the control unit is demanded primarily in the developing countries.
While existing control units have a limitation in downsizing due to the restriction of component mounting area, Keihin Corporation developed “SiP (System in Package)” custom microcontroller which packaged a microcontroller chip and a custom chip of integrated input and output circuit in one and applied to the motorcycle control units for the first time in the world to bring about a breakthrough. This helped to achieve the downsizing of the unit with two-story chip structure and eliminate the protective parts by high noise endurance. Additional 10 percent reduction in size and 30 percent reduction in cost compared to the existing control units became possible.

[20119637/2011-32-0637]

Optimum Knock Sensor Location through Experimental Modal Analysis of Engine Cylinder Block

Yatin Vasant Chaudhary (TVS Motor Company Ltd.), Stephen J Walsh (Loughborough University), Om Prakash Singh, C Subramoniam (TVS Motor Company Ltd.)

The knock sensor is provided on an engine cylinder block to detect abnormal engine combustion (knocking) and to provide feedback to engine control unit (ECU). The ECU then modifies the engine input and avoids knocking. A commonly used knock sensor is an accelerometer that detects cylinder wall vibration and estimates knocking of the engine. Selecting the location of a knock sensor in many cases involves a challenging trial and error approach that depends upon the measurement of the knock signal at many locations on engine structure. However, a cylinder block exhibits many structural resonances. Thus, a large vibration signal at the surface of cylinder block can be either due to knocking of the engine or due to the resonances of the cylinder block structure because of normal excitation forces. Hence, this conventional method does not always yield reliable results. The aim of the work reported in this paper is to experimentally determine the inherent dynamic characteristics of a cylinder block and to combine this with a calculation of the fundamental knock frequency and, thus, to identify the optimum location for the knock sensor.

[20119581/2011-32-0581]

DEVELOPMENT OF ELECTRONIC THROTTLE ACTUATION FOR A 50cc 2-STROKE SCOOTER APPLICATION

Jeffrey Allen (Scion-Sprays Ltd.), Ben Smither, Paul Ravenhill, Gavin Farmer (Scion-Sprays Ltd), Eric Demesse, Philippe Grosch (Peugeot Scooter)

This paper is an introduction to the opportunities, challenges and technical solutions chosen for implementation of an electronic throttle control (ETC) system on a 50cc 2-stroke scooter.
The paper outlines the selection of the ETC motor and the choice of the throttle position sensing (TPS) system along with the development of a new twin sensor throttle demand (TDS) twist grip, and briefly describes the benefits achieved in fuel economy, electronic vehicle speed control, improved start-up and idle stability.
The ETC software operational strategy; including start flare, idle speed control and vehicle speed control are presented as real world strategies to achieve 22% improvements in fuel economy and accurate electronic vehicle speed control.