SETC 2007 Presented Papers (Toki Messe, Niigata, Japan)

Tuesday, October 30 - Thursday, November 1

	201A	201B	301A	301B	302A	302B
Tuesday, October 30	**Opening Ceremony & Keynote Address**					
	Engine Technology (Part 1 of 5)	Diesel Engine (Part 1 of 2)	NVH Technology (Part 1 of 2)	Materials (Part 1 of 3)	Emissions (Part 1 of 3)	Alternative Fuel (Part 1 of 4)
	20076514 / 2007-32-0014	20076519 / 2007-32-0019	20076603 / 2007-32-0103	20076581 / 2007-32-0081	20076552 / 2007-32-0052	20076571 / 2007-32-0071
	20076510 / 2007-32-0010	20076520 / 2007-32-0020	20076605 / 2007-32-0105	20076587 / 2007-32-0087	20076557 / 2007-32-0057	20076572 / 2007-32-0072
	20076513 / 2007-32-0013		20076601 / 2007-32-0101		20076554 / 2007-32-0054	20076573 / 2007-32-0073
	Engine Technology (Part 2 of 5)	Diesel Engine (Part 2 of 2)	NVH Technology (Part 2 of 2)	Materials (Part 2 of 3)	Emissions (Part 2 of 3)	Alternative Fuel (Part 2 of 4)
	20076501 / 2007-32-0001	20076522 / 2007-32-0022	20076604 / 2007-32-0104	20076585 / 2007-32-0085	20076560 / 2007-32-0060	
		20076523 / 2007-32-0023		20076583 / 2007-32-0083	20076555 / 2007-32-0055	
	20076504 / 2007-32-0004	20076521 / 2007-32-0021		20076582 / 2007-32-0082	20076556 / 2007-32-0056	
	Engine Technology (Part 3 of 5)	Fuel Supply System & Hybrid, Electric Drive & Fuel Cell		Materials (Part 3 of 3)	Emissions (Part 3 of 3)	Alternative Fuel (Part 3 of 4)
	20076516 / 2007-32-0016	20076550 / 2007-32-0050		20076584 / 2007-32-0084	20076553 / 2007-32-0053	20076564 / 2007-32-0064
	20076509 / 2007-32-0009	20076551 / 2007-32-0051		20076586 / 2007-32-0086	20076559 / 2007-32-0059	20076575 / 2007-32-0075
	20076508 / 2007-32-0008	20076612 / 2007-32-0112			20076558 / 2007-32-0058	20076565 / 2007-32-0065
Wednesday, October 31	Engine Technology (Part 4 of 5)	Two-Stroke Engine (Part 1 of 3)	Design & Simulation (Part 1 of 4)	Engine Control (Part 1 of 3)	Collegiate Events (Part 1 of 3)	Alternative Fuel (Part 4 of 4)
	20076503 / 2007-32-0003	20076532 / 2007-32-0032	20076591 / 2007-32-0091		20076615 / 2007-32-0115	20076568 / 2007-32-0068
	20076507 / 2007-32-0007	20076530 / 2007-32-0030	20076589 / 2007-32-0089	20076544 / 2007-32-0044	20076616 / 2007-32-0116	20076569 / 2007-32-0069
	20076511 / 2007-32-0011	20076529 / 2007-32-0029	20076592/2007-32-0092	20076547 / 2007-32-0047	20076618 / 2007-32-0118	20076574 / 2007-32-0074
	Engine Technology (Part 5 of 5)	Two-Stroke Engine (Part 2 of 3)	Design & Simulation (Part 2 of 4)	Engine Control (Part 2 of 3)	Collegiate Events (Part 2 of 3)	Engine Component
	20076505 / 2007-32-0005	20076527 / 2007-32-0027	20076595 / 2007-32-0095	20076543 / 2007-32-0043	20076617 / 2007-32-0117	20076563 / 2007-32-0063
	20076506 / 2007-32-0006	20076525 / 2007-32-0025	20076596 / 2007-32-0096	20076545 / 2007-32-0045	20076620 / 2007-32-0120	20076562 / 2007-32-0062
	20076515 / 2007-32-0015	20076528 / 2007-32-0028	20076597 / 2007-32-0097	20076549 / 2007-32-0049	20076619 / 2007-32-0119	20076561 / 2007-32-0061
				Engine Control (Part 3 of 3)	Advanced Combustion	Vehicle Dynamics & Safety (Part 1 of 3)
				20076570 / 2007-32-0070	20076535 / 2007-32-0035	20076607 / 2007-32-0107
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	Plenary Session					
Thursday, November 1	HCCI (Part 1 of 2)	Lubricants (Part 1 of 2)	Design & Simulation (Part 3 of 4)		Two-Stroke Engine (Part 3 of 3)	Vehicle Dynamics & Safety (Part 2 of 3)
	20076540 / 2007-32-0040	20076578 / 2007-32-0078	20076599 / 2007-32-0099		20076533 / 2007-32-0033	20076606 / 2007-32-0106
		20076579 / 2007-32-0079	20076598 / 2007-32-0098		20076524 / 2007-32-0024	20076609 / 2007-32-0109
		20076577 / 2007-32-0077			20076531 / 2007-32-0031	20076608 / 2007-32-0108
	HCCI (Part 2 of 2)	Lubricants (Part 2 of 2)	Design & Simulation (Part 4 of 4)		Collegiate Events (Part 3 of 3)	Vehicle Dynamics & Safety (Part 3 of 3)
	20076538 / 2007-32-0038	20076576 / 2007-32-0076			20076613 / 2007-32-0113	20076610 / 2007-32-0110
	20076541 / 2007-32-0041	20076580 / 2007-32-0080	20076593 / 2007-32-0093		20076614 / 2007-32-0114	20076623 / 2007-32-0123
	20076539 / 2007-32-0039		20076600 / 2007-32-0100		20076622 / 2007-32-0122	
	Lunch and Closing Ceremony					

TECHNICAL SESSION

Tuesday, October 30

< Room 201A >

11:00-12:30

Engine Technology (Part 1 of 5)

Chair : Tomoo Shiozaki (Honda R&D Co., Ltd.)

Co-Chair : Robert Fleck (Queen's University of Belfast)

20076514/2007-32-0014 (240381)

Are low-cost, low-tech solutions adequate for small capacity EU III motorcycles?

Jürgen TROMAYER, Roland KIRCHBERGER, Gerd NEUMANN, Helmut EICHLSEDER (Institute for Internal Combustion Engines and Thermodynamics, Graz University of Technology) - Austria

Abstract: More and more stringent emission legislation is implemented in the world wide market of motorcycles leading to higher product costs. But not every market is ready for high technological levels. Therefore the main topic of interest is: "Will a small one cylinder motorbike engine need an electronic device for fuel metering or is it possible to use standard carburetors in combination with some smart but simple ideas, to fulfil EU III cold start emission regulations?" The described ideas deal with a novel secondary air supply, an improved cooling system and simple NOx reduction methods, always paying attention to the performance and driveability of the vehicle. After describing the prototype design of the engine modifications, the achievable results with their pros and cons are discussed. Online recorder measurements give interesting emission plots of HC, CO and NOx. The homologation measurement results point out the obtainable values of the limited emissions. Finally, solutions for a marketable mass production can be derived from each tested implementation.

20076510/2007-32-0010 (240232)

Continuous Combustion General Purpose Engine System

Jerry E Kashmerick (Kashmerick Engine Systems LLC), Timothy A Shedd (University of Wisconsin) - U.S.A.

Abstract: A modified Brayton cycle is incorporated into a continuous combustion engine system. This 6-stroke engine system is described and illustrated with pressure-volume diagrams. Potential advantages over the traditional 4-stroke Otto cycle are reviewed in the areas of emissions, flexible-fuel use, energy conversion efficiency, and noise. A detailed 1-D air standard thermodynamic model of the K6® cycle is generated and used to investigate the potential efficiency of this cycle and analyzed from partial throttle to wide-open throttle power output. The affects of compression ratio and expansion variations on efficiency are evaluated. The power output and power density are estimated. Key assumptions in the analysis of the thermodynamic model are discussed. Comparisons are made to a similar level of analysis of an Otto cycle 4-stroke engine. A utility engine simulating this cycle operating on compressed air is described.

20076513/2007-32-0013 (240377)

Potential of high technology 50cm³ two stroke and four stroke engines

Roland KIRCHBERGER, Mario HIRZ, Franz WINKLER, Matjaz KORMAN, Helmut EICHLSEDER (Institute for Internal Combustion Engines and Thermodynamic, Graz University of Technology)- Austria

Abstract: Future exhaust emission targets and increasing customer demands call for the implementation of enhanced engine technologies, as well known from automotive applications, into small capacity engine categories. Especially the applied engineering solutions in the market of motor vehicles driven by engines up to 50 cm³ displacement have been significantly changed in the last years. Beside low cost technologies (air cooled two stroke or four stroke engines with carburetor), enhanced mixture preparation and exhaust gas after treatment systems come to use. Highly technological two stroke engines are equipped with direct fuel injection systems in combination with efficient exhaust gas after treatment methods; in four stroke engine applications intake port fuel injection systems in combination with oxidation catalysts or 3-way catalytic conversion are established on the market. Several applications of new and innovative technologies have already been worked out in research programs and presented at several SETC conferences (please refer to the following papers: SETC 2006-32-0065 [1], SETC 2005-32-0098 [2] and [3] for the two stroke engines and SETC 2006-01-0404 [4], 2004-01-2105 [5] for four stroke engines). These technologies are now available in a pre-serial production status or as prototype engines.

TECHNICAL SESSION

Tuesday, October 30

< Room 201A >

14:00-15:30

Engine Technology (Part 2 of 5)

Chair : Tomoo Shiozaki (Honda R&D Co., Ltd.)

Co-Chair :Takashi Mitome (Suzuki Motor Corporation)

20076501/2007-32-0001（236207）

A Fresh Approach to the Design of Clean Engines for the Performance Motorcycle Market

Rodney A Houston, Steven R Ahern (Orbital Corporation Limited) - Australia

Abstract: Until the early to mid 1990's the engine of choice for off road and recreational vehicles were mainly2-stroke engines due to the superior power density and Wide Open Throttle (WOT) torque characteristics. With the introduction of increasingly more stringent emission control requirements there has been a large swing to 4-stroke engines. In recent years there has been significant development to improve the powerdensity of the 4-stroke engine in an effort to match the performance 2-stroke engine, however at acompromise to the torque characteristics and the manufacturing and maintenance cost of the engine. This paper looks at a fresh approach to develop a new concept engine to deliver a better compromise between the 4-stroke and existing carburettor 2-stroke characteristics, and provides early experimental results from the development work for a preferred WOT torque characteristic.

20076504/2007-32-0004 (238491)

Improving the Performance of a Small Spark-Ignition Engine by Using Oxygen-Enriched Intake Air

Yuh-Yih Wu, K.David Huang (National Taipei University of Technology) – Taiwan

Abstract: In order to improve the performance of a small gasoline engine, a part of oxygen is added to the intake air when the engine is operated at wide open throttle. The combustion process can be enhanced by using an oxidant that contains a higher proportion of oxygen than that in normal air. This paper studies the combustion characteristics and engine performance of such engine. Engine testing is performed on a 50 cc four-stroke spark-ignition engine with the oxygen concentration of intake air ranging from 21% to 25% by volume. The engine torque is increased with increasing oxygen concentration. The HC and CO emissions are decreased with oxygen enrichment, but the NOx emission is increased.

TECHNICAL SESSION

Tuesday, October 30

< Room 201A >

16:00-17:30

Engine Technology (Part 3 of 5)

Chair : Yoshiro Tokunaga (Kawasaki Heavy Industries, Ltd.)
Co-Chair : Robert Fleck (Queen's University of Belfast)

20076516/2007-32-0016 (238618)

Development of a 4 stroke engine snowmobile to meet the future emission standard

Takuji Nakano (Yamaha Motor Co.,Ltd) – Japan

Abstract: A snowmobile is driven in nature freely. In recent years, the U.S. federal government requires to reduce the environmental hazards. The emission control of U.S. Environmental Protection Agency was established for 2006 model. From the driving performance point of view just changing engines from 2 stroke engines to 4 stroke engines for environmental issues require new chassis, layout and it is difficult to keep the performance in snow due to extra weight. As for the engine, it has high output, compact, low center of the gravity of chassis. As for the chassis, it has an unique layout for 4 stroke engine installing and is lightweight using several materials. The snowmobile has the high-output lightweight 4 stroke engine which can meet the EPA Phase III 2012 model regulation and the market need of the high performance and a lightweight chassis.

20076509/2007-32-0009 (240016)

The Influence of Port Fuel Injection on Combustion of a Small Displacement Engine for Motorcycle

Shoichi Kato, Takanori Hayashida, Minoru Iida (Yamaha Motor Co., Ltd.) – Japan

Abstract: The demands on internal combustion engines for low emissions and fuel consumption are increasing year by year. On the other hand, engines to be used in motorcycles need to provide high output and quick response to meet user desire. In order to realize low fuel consumption while keeping high performance, it is necessary to properly understand cyclic variations during combustion as well as the influence of the injection system on fuel control during transient periods. The current paper reports on the results of a study in the influence of port fuel injection on combustion stability in a small displacement motorcycle engine, using both a series of experiments and CFD. The parameters of the injection systems under study are: (1) injection targeted area, (2) injection timing, and (3) fuel droplet size. The results of the current study show that injection aimed at the upstream wall yielded the best combustion stability. With injection aimed at the intake valve face, combustion stability deteriorated depending on injection timing and coolant temperature. Even when using an injector with good atomizing properties, combustion stability could not significantly be improved. Comparing CFD results with experimental result, it is shown that the cyclic variations of NMEP can be correlated with the mixture distribution in the cylinder. CFD results also shows that wall film quantity which can be expected to affect the transient behavior of the engine is relatively high with injection aimed at the upstream wall and low with injection aimed at the intake valve face.

20076508/2007-32-0008 (239851)

Reduction of Fuel Consumption for Medium-sized Outboard Motor

Hajime Yoshimura, Tomohiro Miyauchi, Masanori Tsubouchi (Honda R&D Co., Ltd.) - Japan

Abstract: An open loop lean-burn control technology using heated exhaust gas oxygen (HEGO) sensors has been developed with a focus on simplifying control systems that reduce fuel consumption in outboard motors. Correction values for fuel injection quantity obtained from feedback control using a HEGO sensor are stored as learning values in different operating ranges. Despite employing a HEGO sensor that can only detect air-fuel ratios close to stoichiometry, the technology also enables accurate control of non-stoichiometric air-fuel ratios. The medium-sized outboard motor in which the developed technology has been employed balances low fuel consumption with low exhaust emissions. The engine has achieved equivalent fuel consumption performance to that of a motor with a lean-burn control system using a universal exhaust gas oxygen (UEGO) sensor, which produces linear output across a wide range of air-fuel ratios[(1)], and complies with US CARB 2008 exhaust gas regulations and EU Recreational Craft Directive exhaust gas regulations.

TECHNICAL SESSION

Tuesday, October 30

< Room 201B >

11:00-12:00

Diesel Engine (Part 1 of 2)

Chair : Tadao Okazaki (Kubota Corporation)

Co-Chair : Roy Douglas (Queen's University of Belfast)

20076519/2007-32-0019 (234338)

VIC-EGR Concept in Single Cylinder DI Diesel Engine for Compliance with BS-III Emission Norms

Syed Kaleemuddin, B.B. Asangihal, S. Bhattacharya, G. Amba Prasad Rao (Greaves Cotton Limited) - India

Abstract: Extensive research has been dedicated towards identifying the sources of pollution and the ways and means of mitigating the emission levels to save our planet from alarmingly high pollution levels. It is not exaggeration to say that the petroleum run engines are one of the major contributors to this high pollution levels. For meeting stringent emission legislation, engine has to be optimized for lower emission with better performance. In the recent years, more work is being carried out to reduce NOx emissions from the diesel engines. The present work deals with the development of variable injection cam and the optimization of DI automotive 510cc engine incorporated with VIC (Variable Injection Cam) and the engine performance is studied both analytically and experimentally. Also, it is well established that by diluting the incoming charge with exhaust gases (with EGR technique), the NOx emission could be significantly reduced. A comparison was also made with VIC and EGR and their combined effect on the performance as well as on emissions. The performance is analytically studied with combustion pressure and heat release data. It is observed that the combined effect of VIC and with 7% EGR could reduce CO by about 88%, HC+ NOx by 37% and PM by 90%. The Engine was successfully upgraded to meet proposed Bharat Stage –III emission norms with the combination of VIC and EGR with improved power and fuel consumption

20076520/2007-32-0020 (236914)

395cc Air Cooled HSDI Engine Development to Meet Proposed Bharat Stage - III Emission Norms

Syed Kaleemuddin, B.B. Asangihal, S.Bhattacharya, G. Amba Prasad Rao (Greaves Cotton Limited) - India

Abstract: Increase in automotive exhaust pollution and fuel prices have driven the nations to impose stringent emission norms for automotive engines. This has put enormous pressure on automotive industry to develop efficient and economical engine designs to compete with global market. In this regards at author's premises improvements are made in the 395CC single cylinder Natural Aspirated air cooled HSDI engine to meet proposed Bharat stage III emission norms. Modifications such as valve protrusion in cylinder head, reoriented higher velocity injection cam, with higher aspect ratio combustion bowl and added features in fuel injection system have been incorporated in the upgraded version of engine. Experimental engine optimization was done on engine dynamometer targeting for better power, bsfc and lower smoke which was achieved by optimization Finally emission optimization was done on chassis dynamometer for three wheeler vehicle on Indian driving Cycle (IDC).Engine dynamometer tests and emission tests have been recorded on both series and upgraded version of engine. Observed mass emission has given 27% reduction in HC +NOx, 53 % reduction in CO and 63% reduction in PM with the upgraded version without scarifying engine performance. Also engine was successfully upgraded to meet proposed Bharat Stage-III emission norms with ON- OFF EGR impingement. Analytical study was done for combustion pressure and heat release for predicting and validating the upgraded engine's performance.

TECHNICAL SESSION

Tuesday, October 30

< Room 201B >

14:00-15:30

Diesel Engine (Part 2 of 2)

Chair: Keita Naito (Kubota Corporation)

Co-Chair: Michael S. Brenner (Lubrizol Corp.)

20076522/2007-32-0022 (239265)

A Study of Combustion Characteristics for Spray Combustion by Multi Injection in a Closed Vessel

Kouichi Makino, Tadashige Kawakami (Hosei University) - Japan

Abstract: Internal combustion engines are the major source of air pollution. Especially, compression ignition engines in today's industrial and automotive general engines contribute the most to particulate emission and soot, and it is recognized that these emissions have a detrimental effect on human and earth environment. So, an improvement of spray combustion for diesel engines is of urgent necessity. Experiments have been conducted to obtain essential data on spray combustion are influenced by impinging injection in a closed vessel. The effect of the impinging injection on maximum burning pressure, total burning time and mean flame speed is investigated at condition of 300K of initial temperature and 0.1MPa of initial pressure.

20076523/2007-32-0023 (240213)

Influence of Blend Fuels on Combustion Characteristics for Small Diesel Engine

Hiroaki Sugiyama, Tadashige Kawakami (Hosei University) - Japan

Abstract: In practical diesel engines it is necessary to achieve a low emission and low fuel consumption with high load operation. Several techniques were developed for reducing the emissions and fuel consumption from diesel engines, such as EGR (Exhaust gas recirculation) and blend fuels. Nevertheless, there are only very few data available for reducing the emissions and fuel consumption in small diesel engines (100-250cc) by using blend fuels. As the first step of this study, experiments have been carried out to examine the influence of blend fuels on combustion characteristics in small diesel engine. The main conclusions are as follows: 1) The maximum burning pressure for water emulsion oil is smaller than that of light oil. 2) NOx emission of light fuel with coconut oil is higher than that of light oil.3) It is possible to improve the combustion behavior by using blend fuel for small diesel engines.

20076521/2007-32-0021 (237636)

Techniques for Higher Power Density and Lower Exhaust Emissions on Non-Road In-Direct Injection Diesel Engines

Takashi Onishi, Hiroshi Sasaki, Mitsugu Okuda, Keita Naito, Kozo Yoshida (KUBOTA Corporation) - Japan

Abstract: In recent years, exhaust emissions regulations is increasingly enhanced on the non-road diesel engines, which are mainly used for agriculture, industrial and construction applications in world-wide area, in order to prevent air pollution on the earth. On the other hand, customers demand higher power in a tight packaging constraint to be competitive on the product that the engine is installed. We developed the all-new 1.3 liter non-road In-Direct Injection (IDI) diesel engine, which realized to balance the strict exhaust emissions regulations and user needs such as compact and higher power. This paper reviews the technologies to achieve the targets, higher power density and lower exhaust emissions on the newly-developed small IDI diesel engines.

TECHNICAL SESSION

Tuesday, October 30

< Room 201B >

16:00-17:30

Fuel Supply System & Hybrid, Electric Drive & Fuel Cell

Chair: Takashi Mitome (Suzuki Motor Corporation)

Co-Chair: Michael S. Brenner (Lubrizol Corp.)

20076550/2007-32-0050 (240076)

Spray Characteristics of an Ultrasonic Gasoline Injector Using a Micro Nozzle Array

Mikiya Araki, Tomio Obokata, Tsuneaki Ishima, Seiichi Shiga (Gunma University), Masahiko Masubuchi, Tomojiro Sugimoto (Toyota Motor Corporation) – Japan

Abstract: Effects of horn geometry on the atomization characteristics of an ultrasonic fuel injector using a micro nozzle array were investigated experimentally. Micro nozzles whose exit diameter d = 3 μm are mounted on a thin metal film. The number of the micro nozzles is from 2.0 x 10^4 to 1.2 x 10^5. Using an ultrasonic oscillator, gasoline is periodically pushed out from the micro nozzles at a frequency from 62 to 65 kHz. A disk type PZT (Lead zirconium titanate) is used as an ultrasonic oscillator, and the oscillation is amplified using a step-type horn. The input voltage to the PZT is varied from 0 to 200 V. To increase the fuel flow rate, the horn small end diameter D_S is increased from 10.5 to 25 mm, while the large end diameter is fixed at 30 mm. To prevent forming a liquid film on the micro nozzle array, gutters are machined on the small end of the horn. It is shown that the *SMD* (Sauter mean diameter) of the spray is almost uniform around 10 to 14 μm. The fuel flow rate increases, at the maximum, 2.8 times larger when compared to the original horn geometry.

20076551/2007-32-0051 (240849)

Experimental Results of New Fuelling Strategies for High Frequency Low Cost Injection Systems for Small Engines

Jeffrey Allen, Tim Drake (Scion-Sprays Ltd) - U.K.

Abstract: With increasing pressures to reduce engine emissions in the small engines market there is a need to precisely meter the fuel flow into the engine under all running conditions. Therefore this cost competitive market requires a well engineered injection system that combines good control of fuel metering at all speed / load conditions, and meets the markets competitive pricing requirements. It must also offer the potential to allow these engines to meet stringent future legislation, leading to the addition of closed loop control with 3 way catalysts. This paper presents an experimental investigation into the effect of wall wetting and fuel injection strategy on a small engine. The engine was fitted with a novel form of port fuel injection, Pulse Count Injection (PCI) [1.] This novel high frequency digital fuelling system allows rapid oscillation of the fuel quantity from one engine cycle to the next. The result of the investigation is a novel fuelling strategy that enables good fuelling control under no load idle conditions where very fine fuelling control is most desired.

20076612/2007-32-0112 (238305)

Evaluation of Direct Methanol Fuel Cell Systems for Two-Wheeled Vehicles

Yasuyuki Muramatsu, Kazuyoshi Furukawa, Shuhei Adachi (Yamaha Motor Co.,Ltd.) - Japan

Abstract: Yamaha Motor Co., Ltd. succeeded in the development of a direct methanol type fuel cell (DMFC) powered motorcycle named the FC-me in 2005. (1) One of these models was leased to the Shizuoka prefectural government office in September of that year. During the course of this leased use a number of changes were observed in the performance of the fuel cell and the emissions, etc. As a result, it was learned that the cycle of starting and stopping had a major effect on the efficiency of the fuel use. In this report we introduce the results of the period of leased use and observations about the ideal format of the next-generation fuel cell motorcycle based on those results.

TECHNICAL SESSION

Tuesday, October 30

< Room 301A >

11:00-12:30

NVH Technology (Part 1 of 2)

Chair : Kazuyuki Shiomi (Honda R&D Co., Ltd.)
Co-Chair : Jay S. Meldrum (Michigan Technological University)

20076603/2007-32-0103 (240153)

Updating of Analytical Models for Vibration Prediction of Two-Wheelers

Vamsi Krishna Balla, Kannan Marudachalam, Mahabaleshwar Hegde (TVS Motor Company Ltd) - India

Abstract: In this work, a finite element modal analysis of motorcycles in various configurations – frame only, frame with engine, frame with engine and handlebar – is carried out using general purpose FE software. Experimental modal analysis (EMA) is performed on the actual physical systems in the above configurations. The results from the analytical FE models are compared with those derived from the experimental models. Good correlations are demonstrated for the analytical models up to 250 Hz using modal parameters – natural frequencies and mode shapes. Techniques for updating the finite element models that yield improved correlation with test data are explored. Further, it will be shown that good quality component models are necessary, but not sufficient, for realizing full-vehicle models that could predict vibration responses accurately. It is demonstrated that the connector modeling is very essential in building good assembly level models. It is shown that the complete vehicle model of motorcycle that is built with updated assemblies can be effectively used to trouble shoot problems, thus reducing the product development time.

20076605/2007-32-0105 (240423)

Analytical Prediction and Measurement of Engine Mount Forces

Kannan Marudachalam, Nilesh Choudhari, Vamsi Krishna Balla (TVS Motor Company Ltd),
Chandramouli P (Indian Institute of Technology) - India

Abstract: The demand for quieter vehicles is increasing with not only the advent of stringent Noise, Vibration and Harshness (NVH) norms but also because of customer expectations. In motorcycles, tactile point vibration – handle bar, rider footrest, passenger footrest, and pillion handle – is a metric that characterizes the vibrational behavior. As engine is the most predominant source of vibration and noise, it is crucial to understand the dynamics of the engine and the transfer of engine forces from the engine to the structure supporting it. This paper discusses a method of modeling the engine to predict mount forces, which are correlated with the experimentally measured data. The engine under study is a four-stroke single cylinder engine. Multi-body dynamics approach is used to predict the crank bearing loads and mount forces. A fully coupled engine model is built to capture the interaction between the piston-crank mechanism and the engine casing. The effect of modeling the crank bearing stiffness on the bearing loads is investigated and compared against those obtained using a simplistic assumption of a rigid crankshaft mounted on rigid crank bearings. The effect of engine casing flexibility on the bearing loads and mount forces is also investigated. An engine-mounting fixture with multi-axis load cells has been built to measure the mount forces in a dynamometer test cell. Typically, accelerations are measured on the engine and the mount……

20076601/2007-32-0101 (233858)

Vibration Isolation Mount for Scooter Powerunit

Taketoshi Sano, Akimitsu Takeuchi (Yamaha Motor Co., Ltd) - Japan

Abstract: This paper reports the new design method of vibration isolation mount for the scooter powerunit. In the conventional design, while the engine vibration is efficiently isolated by the link mechanism, the time lag induced by the movement of the link mechanism spoils the riding quality when the rider operates the steering or the throttle. To solve the problem, a new design without the link mechanism was proposed. The optimized combination of the crank balance and the single-axis balancer was used to control the orbit of the powerunit vibration. First, the new equations were introduced to balance the inertial forces and moments at the target position by optimizing the amount and the phase of the crank balance and the balancer. Then, some results from the experimental tests were reported to validate the numerically optimized design. Using this new design method, the riding pleasure can be enhanced without unpleasant mechanical vibration.

TECHNICAL SESSION

Tuesday, October 30

< Room 301A >

14:00-15:00

NVH Technology (Part 2 of 2)

Chair : Izumi Takagi (Kawasaki Heavy Industries, Ltd.)

Co-Chair : Jay S. Meldrum (Michigan Technological University)

20076604/2007-32-0104 (240224)

Application of Inverse Boundary Element Method to Vibration Identification of Co-Generation System

Hiroshi Uehara, Masahiro Saito (Yanmar Co.,Ltd.), Takayuki Koizumi, Nobutaka Tsujiuchi (Doshisha University) - Japan

Abstract: This paper describes the application of inverse boundary element method (Inverse BEM) to vibration identification on surface of Co-generation System enclosure. This method is a kind of matrix inversion using singular value decomposition. Therefore it is significant to select proper tolerance in order to identify vibration accurately. In this study, the tolerance selection method is proposed. First step, the surface velocity of numerical model with unit input was obtained by Finite Element Method. The sound pressure around the model was obtained by BEM. Second step, random noise was mixed with obtained sound pressure. Third step, by using Inverse BEM, the surface velocity was identified from the sound pressure with noise. Next, the error between the identified velocity and the velocity obtained by FEM were evaluated and the tolerance is selected to minimize the error. Final step, surface velocity in operational condition was identified from measured sound pressure and the selected tolerance by Inverse BEM. As a result, a good agreement was observed between measured velocity and identified velocity.

TECHNICAL SESSION

Tuesday, October 30

< Room 301B >

11:00-12:00

Materials (Part 1 of 3)

Chair : Yasuhito Tanaka (Suzuki Motor Corporation)

Co-Chair :James N. Carroll (Southwest Research Institute)

20076581/2007-32-0081 (236670)

Development of Plastic Forming Using Fm Forming Method For Spline

Hideyuki Okumura,（Yamaha Marine Company Limited) - Japan

Abstract: In manufacturing, the term “processing” refers to the various processes for changing the dimensions, shape and qualities of a material to fit the required specifications for use in a product. One processing method is machining, which involves cutting away portions of the material to achieve the desired dimensions and shape. This machining method has some inherent demerits, such as the fact that it naturally produces chips etc., depending on the material involved, which end up as waste and are thus environmentally undesirable. Another disadvantage is that machining often involves a longer processing time, which increases cost. In an ideal form of “product creation,” the material forming and fabrication process would produce the net shape of the product without a need for machining, and thus reduce cost and eliminate the waste of chips. The plastic (plasticity) forming method is an alternative to machining that makes it possible to achieve a more ideal form of manufacturing. Although in reality it is difficult to completely eliminate the need for machining, plastic forming technologies can greatly reduce the need for machining. It is reported in this paper to develop a plastic forming method for the spline portion of an outboard motor shaft using an FM (Frequency Modulated) forming method to replace the existing machining method as the first step toward achieving net shaping of the entire shaft portion of the outboard motor, including the drive shaft and the propeller shaft.

20076587/2007-32-0087 (239289)

Development of High Strength and Low Cost Motorcycle Transmission Shafts

Hitoshi Kinoshita, Atsushi Murakami (Honda R&D Co., Ltd.), Toru Takayama (Sumitomo Metal Ind., Ltd.), Takanari Hamada（Sumitomo Metals (Kokura), Ltd.） - Japan

Abstract: Evolution continues for small, light weight and high output engines for motorcycles. As a result, high strength steel is a necessity for internal engine parts, including mission shafts. The transmission shafts must have sufficient torsional and bending strengths to withstand the higher torque, along with intermittent sharp torque inputs, and higher bending force. From a production point of view, using a coil fed cold forge process results in superior productivity. This productivity cannot decrease by changing to a high strength material. Also, there needs to be a balance of high strength versus post carburizing straightening. A new class of steel was developed by adding boron and adjusting Cr content of a conventional case hardening steel to produce a flat quench curve (Jominy curve). A flat Jominy curve is desired to increase core hardness and reduce variability. An increase in core hardness results in higher torsion strength and the reduced variability results in a more consistent final product. In order to maintain the ability to straighten the transmission shafts, a maximum internal hardness value was set. This value is controlled by carbon, boron and Cr contents. Additionally cost reduction was realized through the elimination of a post cold forge normalizing process by the addition of Ti and Nb grain refiners. With the implementation of the newly developed steel, a higher strength transmission shaft was achieved at a lower cost.

TECHNICAL SESSION

Tuesday, October 30

< Room 301B >

14:00-15:30

Materials (Part 2 of 3)

Chair : Yasuhito Tanaka (Suzuki Motor Corporation)
Co-Chair :James N. Carroll (Southwest Research Institute)

20076585/2007-32-0085 (238506)

Lifetime Prediction of a Crankpin Using a Ball-on-Disk Type Rolling-Contact-Fatigue Life Testing

Tsuyoshi Kubota, Yasuyuki Yamashita, Hiroshi Yamagata (Yamaha Motor Co., Ltd) – Japan

Abstract: This paper describes an experimental method to predict the rolling contact fatigue life of a crankpin in a market vehicle engine. The fatigue life up to pitting was evaluated by two laboratory tests including a fatigue life measurement using a ball-on-disk test machine and a crankpin durability measurement by an engine bench test. The surface observation after the tests revealed that the surface dent triggers pitting in both tests. The Weibull plot of the percent failure vs. cycle to failure as a function of the contact stress was presented. In order to directly evaluate the effect of the contact stress on the lifetime, the lifetime values measured at L50 are plotted in the diagram showing the contact stress vs. cycle to failure. The obtained relation can predict the lifetime under the controlled condition in which the number of maximum torque points is countable. A method to place the lifetime of the market vehicle engine on the Weibull plot of percent failure vs. cycle to failure is developed. The established relation between the contact stress and travel distance can include the laboratory test data as well as the market vehicle engine data. The proposed method is able to predict the lifetime of the crankpin of the market vehicle engine using the laboratory ball-on-disk test data.

20076583/2007-32-0083 (237975)

Development of the DLC Film for Front Fork's Inner Tube

Sadaaki Hara, Toshiyuki Koga, Shinji Katou (KYB Corporation) - Japan

Abstract: Because of its low coefficient of friction, DLC(Diamond Like Carbon)-coating is recognized as one of the effective ways to reduce machine friction. On the other hand, sliding smoothness of motorcycle's front fork is requested to progress, therefore reducing friction of front fork is significant. From our considering whether DLC coated inner tube would be a good idea to reduce friction of front fork, we decide to build the mass-production process for the DLC coated inner tube. But there are two issues about the function of the DLC film, those are "how to improve resistance against peeling" and "how to get well-flattened DLC surface".

20076582/2007-32-0082 (237794)

Wear of Coated and Uncoated Primary Clutch Sheaves in a CVT

David Adam Mower, Robert H. Todd (Brigham Young University) - U.S.A.

Abstract: In research conducted at Brigham Young University, four coatings were tested for their ability to increase the wear life of primary clutch sheaves made of A390 die-cast aluminum used in continuously variable transmissions (CVT). The coatings tested were: hard chrome, electroless nickel metal, hard coat anodizing and composite ceramic coating. A wear test stand was developed to duplicate wear found on CVTs currently in use. The wear was evaluated using four methods. The test first method characterized the shift delay properties of the worn CVTs while running on the wear test stand. As the CVT was run on the wear test stand a delay in shifting would develop during the unloading cycles. The second method used an ATV and chassis dynamometer to evaluate the change in performance with wear. The third method used a profilometer to evaluate the amount of material lost, through wear. Finally a scanning electron microscope was used to identify wear scar and wear morphology to determine the dominate mechanism of wear in the sheave material. The hard chrome coated primary clutches had a 22% lower shift delay than the uncoated clutches in the shift delay test. Statistical analysis was done on the dynamometer test results. This analysis showed that the coatings were a significant factor in the performance of the ATV over time. However due to high variance the analysis was not able to differentiate between coatings. Profilometer test showed that the hard chrome coated clutches had an average of 47% less wear than the uncoated clutches. These tests also showed that the electroless nickel coated clutches had more wear than the uncoated clutches. From the SEM scans the dominate wear mechanism in the hard chrome and the uncoated clutches was adhesive wear and surface fatigue wear in the electroless nickel coating. The hard coat anodized and ceramic composite coatings were eliminated early in testing because of poor performance.

TECHNICAL SESSION

Tuesday, October 30

< Room 301B >

16:00-17:00

Materials (Part 3 of 3)

Chair : Yasuhito Tanaka (Suzuki Motor Corporation)

Co-Chair :James N. Carroll (Southwest Research Institute)

20076584/2007-32-0084 (238492)

Developments and Application of Expendable Salt Core Materials for High Pressure Die Casting to Apply Closed-Deck Type Cylinder Block

Youji Yamada, Hiroshi Yoshii, Akihito Fujiwara, Toshiiku Suzuki, Hiroyuki Fukui, Yoshitaka Noda (Yamaha Motor Co.,Ltd.), Jun Yaokawa, Koichi Anzai (Tohoku University) - Japan

Abstract: This paper describes a technique of manufacturing expendable salt cores developed to form undercut shaped aluminum closed deck cylinderor crankcase components block by high pressure die casting (HPDC) process.with, head, transmission and some applications The salt cores are comprised of Potassium Chloride–Sodium Chloride–Sodium Carbonate–Potassium Carbonate (KCl – NaCl – Na2CO3 – K2CO3) system whose liquidus point is between 873 and 973K. The bending strength of the developed salt core was more than 30MPaand also withstand to high metal-melt-static pressure. The manufacturing process of the salt cores was the HPDC similar to the process for metallic alloys. This process offered high dimensionality and productivity of the salt cores.

20076586/2007-32-0086 (238516)

Electrodeposition Painting to Outboard Motor

Tetsuya Aoki (Yamaha Marine Co., Ltd.) - Japan

Abstract: Outboard motors use aluminum die-cast components extensively to cut down their weight. They are also cooled directly by the raw water including saline water. Corrosion protection is the critical issue for outboard motors because of these characteristics. Currently, the coating is the primary measures taken to assure the corrosion resistance and to give originality to the appearance. However, the complicated cooling passages cannot be coated appropriately with the spray-paint process. Such disadvantages can be compensated by the electrodeposition coating technique. In the case of electrodeposition coating, the coating film is generated electrically in the coating material bath by means of deposition. The process is widely applied to the automobile bodies made of steel plate, because it provides higher transfer efficiency and lower VOC (VOLATILE ORGANIC COMPOUNDS) emission. However, the traditional electrodeposition coating material presented various issues when it comes to the application to the aluminum components. These issues are attributable to the behavior of the coating film in the course of deposition process. The new electrodeposition coating material has been developed to deal with these issues, and has been applied to the outboard motor components. The new coating material gives higher anticorrosion property to the components, and also allows the reduction of VOC emission and the elimination of hexavalent chromium. This report describes the efforts made to work out the engineering issues for applying the new electrodeposition coating material to the actual production process.

TECHNICAL SESSION

Tuesday, October 30

< Room 302A >

11:00-12:30

Emissions (Part 1 of 3)

Chair : Yukio Matsushita (Yamaha Marine Co., Ltd.)
Co-Chair : Jeff J. White (Southwest Research Institute)

20076552/2007-32-0052 (235786)

Beyond 3 Star Emission Capability for Outboard Engines

Greg Bell, Simon Brewster, Steven Ahern (Orbital Corporation Limited) - Australia

Abstract: This paper investigates strategies intended for development towards Super Ultra Low emission levels (4 Star) from the existing 3 Star emission status for 2 stroke Direct Injection and 4 stroke outboard engines. The current 5 Mode ICOMIA outboard emission status is considered for Hydrocarbons, Nitrogen Oxides and Carbon Monoxide. From these a gap analysis is developed and possible strategies to close the gaps are considered. The potential of these strategies for 2 stroke air assisted Direct Injection outboards is reviewed together with supporting data where appropriate. Initial data show high potential for reduction of emission levels beyond the 3 Star standard, whilst further work will confirm the levels that may be feasible in a production outboard engine.

20076557/2007-32-0057 (239436)

New Generation of Metallic Substrates for Catalytic Converters in Small Engine Application

Alfred Reck, Friedrich Wilhelm Kaiser, Francois Jayat, (EMITEC GmbH-Germany), Matjaž Korman, Roland Kirchberger, Mario Hirz (Graz University of Technologies) - Germany

Abstract: The new generation of metallic substrates for catalytic converters used in the two and three wheeler industry is capable of improving conversion behavior even with smaller catalyst size. The lowering of production costs due to less use of precious metal is possible. This novel technological application in motorcycle vehicle class improves exhaust emission performance and introduces a new competitive product on the market. Specially developed foil structures, which transform a laminar exhaust gas flow to a turbulent one, significantly improve exhaust gas mixing behavior in the catalyst. This publication is dealing with the analysis of different metallic substrate foil structures for the catalyst conversion performance and the light–off characteristics for the leading state of the art four stroke 150 cm3 motorcycle technology developed for the Asian market. The impact of standard compared to turbulent substrate foil structures tested under Indian (IDC) and European (ECE R40) driving cycles will be discussed in depth. Especially turbulent catalytic converters with transversal, longitudinal and perforated substrate foil structures and the influence of the catalyst volume and different coating on conversion have been treated.

20076554/2007-32-0054 (237025)

Innovative Metallic Substrate Technology to Meet Future Emission Limits

Bernd Van Eickels, Hans Peter Dummann (KTM Sportmotorcycle AG), Lorenzo Pace, Alfred Reck (Emitec G.m.b.H.) - Germany

Abstract: Exhaust after-treatment systems will have to become increasingly efficient in order to comply with the strict emission limits that will apply in the European Union and worldwide in future. Moreover, space constraints, weight and low pressure drop are just some of the issues that have to be addressed by an EU III-compliant catalytic system. The development of metallic substrates over the past few years has shown that turbulent-like substrates increase specific catalytic efficiency. This has made it possible to enhance overall performance for a specific catalytic volume or reduce the volume while keeping catalytic efficiency constant. This paper focuses on the emission efficiency of standard, TS and PE metallic substrates. A simulation tool and flow bench measurements were used to develop a test matrix with catalyst similar pressure drop in order to examine different cell densities, substrate lengths and coating technologies. Emission tests were carried out on a KTM 990 Adventure motorcycle to evaluate substrates based on standard, TS and PE technology. The LC8 EFI engine is a state-of-the-art, typical high-performance engine with electronic injection and lambda sensor control. Results confirm that compared to standard catalysts PE technology increases the emission efficiency of the catalyst without any adverse effect on pressure drop. On the other hand, TS technology as applied in high mass-flow engines is less efficient than PE technology, provided the PE and TS substrates have the same pressure drop. Engine performance measurement has been carried out at the end of emission test to check the influence of catalyst pressure drop on power output.

TECHNICAL SESSION

Tuesday, October 30

< Room 302A >

14:00-15:30

Emissions (Part 2 of 3)

Chair : Yukio Matsushita (Yamaha Marine Co., Ltd.)
Co-Chair : Jeff J. White (Southwest Research Institute)

20076560/2007-32-0060 (239021)

Performance and Emission Characteristics of a Partially Ceramic Coated Diesel Engine Using Water Diesel Emulsion

Venkanna Krishnamurthy Belagur (Sri B.V.V.S Basaveshwar Engineering College), Venkataramana Reddy C (Vivekananda Institute of Technology and Science) - India

Abstract: The performance and emissions of an engine can be improved by accelerating the mixing process. This can be achieved by secondary atomization (micro explosion) and hot (ceramic coated) combustion chamber. An attempt was made to study the effect of water diesel emulsion on a ceramic coated [plasma sprayed zirconia (PSZ) coated cylinder head and valve faces] diesel engine. 5% decrease in brake specific fuel consumption (BSFC) for 10 volume percent of water in the case of conventional engine and a 21% decrease in BSFC for 18 volume percent of water in water diesel emulsion in the case of partially ceramic coated engine (BSFC, for 15 and 18 volume percent of water in emulsion, being same) was obtained compared to conventional engine fueled with neat diesel at 100% load. Hence, ceramic-coated engine permits use of 8% more water in water-diesel emulsion. Partially ceramic coated diesel engine for neat diesel has shown marginal decrease in BSFC at higher loads and no change at lower loads. Exhaust gas temperature (EGT) decreased throughout the entire load range and it was marginally higher for coated engine compared to conventional engine. A 29%, 21% and 40% reduction in CO, SD and NOx emission was obtained in case of ceramic coated diesel engine corresponding to 18 volume percent of water in emulsion compared with conventional engine fueled with neat diesel at 100% load.

20076555/2007-32-0055 (239023)

Experimental Investigations on Reduction of Co and HC in SI Engine with Catalytic Converter

Swati Bhimasenrao Wadawadagi (Sri B.V.V.S Basaveshwar Engineering College), Venkataramana Reddy C (Vivekananda Institute of Technology and Science) – India

Abstract: Catalytic bed have been developed by coating copper and silver as catalyst on 13-X zeolite as base element and its activity in reducing oxides of nitrogen (NOx) and oxidizing carbon monoxide (CO) and hydrocarbon (HC) in an petrol engine exhaust has been tested. The silver coated 13-X zeolite catalyst studied here, exhibits significant NOx, CO and HC reduction at a space velocity of 15000 h-1 and 13-X zeolite and silver in the ratio of 20:3 by mass. A maximum reduction of 60% in CO and 74% in HC has been observed at higher load. A maximum reduction of 44% in NOx has been observed at higher load for 13-X zeolite and silver in the ratio of 15:3 by mass. Power loss due to back pressure (BP) is negligible. Repeatability tests were conducted after 10 h, 20 h, 30 h and 40 h of use of the catalysts. The deviation in catalytic activity was negligible. A negligible change in the brake specific fuel consumption (BSEC) was observed with catalytic converter (CC) compared with without CC (muffler).

20076556/2007-32-0056 (239297)

Exhaust Gas Turn Flow Construction in Catalyst Unit for Improvement of Purification Rate by Metal Honeycomb Substrate

Yuuhi Nakagawa, Yasuhiro Takada, Nobuhiro Shimada, Yoshihiko Kumagai, Makoto Ogasawara (Honda R&D Co., Ltd.) - Japan

Abstract: All over the world, stronger controls are being imposed on exhaust gas emissions from automobiles, and thus, more evolutionary catalyst unit technology is being demanded. Specifically, this trend creates the need for small, low-cost catalyst units. To meet this need we have developed a catalyst unit, mounted in the middle of the exhaust pipe, which has a pathway to turn motorcycle exhaust gas in the catalyst (referred to as a “turn flow catalyst unit”). The objective of this development was to miniaturize the catalyst unit and to decrease the amount of catalyst used in the unit. This newly designed catalyst unit is about 30% lesser in volume than the straight-mounted catalyst units commonly used in motorcycles of the same displacement.

TECHNICAL SESSION

Tuesday, October 30

< Room 302A >

16:00-17:00

Emissions (Part 3 of 3)

Chair : Tetsuya Ohira (Suzuki Motor Corporation)

Co-Chair : Jeff J. White (Southwest Research Institute)

20076553/2007-32-0053 (235640)

Evaporative Emissions Control System for Walk Behind Lawnmowers

Andrew Bejcek (Walbro Engine Management) - U.S.A.

Abstract: This paper discusses an evaporative emissions control system which significantly reduces diurnal evaporative emissions in walk behind lawnmower engines equipped with float carburetors. The system also maintains engine startability, run quality, and a simplistic user interface. The system consists of low-permeation fuel line and a multi-layer fuel tank using an EVOH barrier as well as a carbon canister integrated in the lawnmower's push-handle and an Automatic Bowl Drain System (ABDS). A prototype of the system resulted in a 90% reduction in diurnal evaporative emissions when compared to a pre-regulation walk behind lawnmower using the CARB TP-902 sealed housing for evaporative determination test. This paper demonstrates a practical solution to reduce diurnal evaporative emissions and hydrocarbon running losses below the level emitted from a state of the art, float carbureted, walk behind lawnmower engine.

20076559/2007-32-0059 (259324)

The Feasibility of Meeting CARB/EPA 3 Emission Regulations for Small Engines

Roy Douglas (Queen's University), Stephen Glover (Fjölblendir ehf) - U.K.

Abstract: With annual worldwide production of over 100 million units, small off-road engines (SORE) have been recognised as a major source of air pollution. It is estimated that non handheld SORE products in circulation annually produce over 1 million tonnes of HC+NOx and over 50 million tonnes of CO2. These SORE did not have to meet any emissions control legislation until its introduction in the USA in 1995. Since then the gradual implementation of several stages of increasingly more severe legislation has resulted in a decade of intensive emissions control development for utility engines. New carburetted stratified charge 2-stroke engines and catalytic after-treatment are being developed for the handheld products where weight and multi-orientation operation are key requirements. For the non-handheld 4-stroke dominated market, manufacturers are looking at improved fuel system design, improved engine design and the use of after-treatment to meet current and future legislative requirements. The bulk of the total 4-stroke SORE engine market, at around 65%, is taken up by single cylinder 4-stroke gasoline engines of under 6hp or under around 160cc. In this, the largest segment of the market, manufacturers must look to more conventional or new technologies that can be applied without significant add on cost or more preferable with a cost reduction. This paper presents the rational for the proposed EPA / CARB approach to meeting Phase 3 legislation with SORE and considers several possible alternative strategies.

20076558/2007-32-0058 (240290)

Solid and Volatile Particle Emission Behavior from a Small Non-Road Diesel Engine

Rahman M. Montajir, Yoshinori Otsuki, Kaori Inoue, Ichiro Asano, Nobutaka Kihara (Horiba Ltd) - Japan

Abstract: Behavior of particle emission from small non-road engines is still unknown which may have some unavoidable health risk. Investigation of particle emission from small non-road engine has made the main objective in this study. For this purpose a particle counting system has been developed according to the PMP protocol. The investigation was limited to only number counting of solid and volatile particle emission from a small diesel powered electric generator set. Especially the relative emission of solid and volatile particles for different load conditions has been investigated. Measurement was attempted by controlling the dilution air temperature and temperature of an evaporation unit installed inside the particle counting system. It was found that the small diesel engine used in the generator set emits huge number of volatile particles depending on operating condition. Solid particle emission increases and volatile particle emission decreases from the generator engine with increases in operating load.

TECHNICAL SESSION
Tuesday, October 30
< Room 302B >

11:00-12:30

Alternative Fuel (Part 1 of 4)

Chair :Koji Yoshida (Nihon University)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

20076571/2007-32-0071 (240357)

Organic Exhaust Analysis from Ethanol Mixture Fueled Small Engines

Manqun Lin, Bin Jia, Xicheng Yan, Shun Zhang, (Tianjin Internal Combustion Engine Research Institutes) – China

Abstract: Ethanol as oxygen additive has potential dangerous that might make poisonous organic compound exhaust more than that from pure gasoline fueled engines. This paper was concerned to methods research of sampling, separating and analysis of unconventional HC exhaust emission. Aimed at the difficult problem of formaldehyde measurement, author enriched formaldehyde by water and then measured by means of ultraviolet-visible spectrometer. The minimum measuring limits of formaldehyde was remarkably promoted to 0.02×10^{-6} (V/V). Furthermore, Solid-Phase Extraction Column which was pre-coated by dinitrophenylhydrazone (DNPH) was selected to catch aldehyde and ketone by chemical reaction which is so called ramification, and then measured by Liquid-chromatography. Up to now, more than 8 different organic have been determined. It was shown that formaldehyde as high toxicity exhaust emission was much more than that from gasoline fueled engine.

20076572/2007-32-0072 (240424)

Internal Combustion Engine Vehicle: Emissions and Performance Using Blends of Natural Gas and Hydrogen

Wouter Dalhuijsen, Hans Bosma, Menno Merts, Lejo Buning (HAN University) - The Netherlands

Abstract: Using blends of natural gas (NG) and hydrogen as an alternative to gasoline in Internal Combustion Engines (ICEs) has the potential of a major reduction in CO_2 and other harmful emissions, besides giving insight into the use of gaseous biofuels, rich in methane and hydrogen, and offering a transition scenario towards a hydrogen economy. To investigate the consequences of using blends, the performance of a 240cc stationary ICE and a Yamaha Majesty YP125FI scooter, converted to run on a large variety of blends of hydrogen and NG, have been investigated at HAN University, Netherlands. The effect of the air-to-fuel ratio and the composition of the blend on the performance and the emissions have been studied. This paper gives insight into those effects. Main conclusions: With only minor modifications a large variety of blends can be used. By adding H_2 to NG: CO_2, CO, and HC emissions are reduced; NOx emission is increased; high λ is possible, which can eliminate high NOx ; power and efficiency drop approximately 10%.

20076573/2007-32-0073 (242412)

Effects of EGR on Rapid Lean-Burning and NOx Emission of Spark Ignition LPG Engines

Chunming Hu, Na Liu, Wei Li, Xijuan Song (Tianjin University) - China

Abstract: Exhaust Gas Recirculation (EGR) is an extensively applied approach for the engine emission control, which is the most effective for reducing NOX emissions. However, as increasing EGR rate, the burning velocity of LPG mixture will be slow that it impacts the complete combustion and combustion stability. The effects of EGR on the rapid lean-burning and NOX emissions of the LPG engine with EFI is introduced in this paper. Test data showed that the dual-spark plug ignition-based rapid burning system could increase the combustion rate of LPG mixture, and improve the rapid burning process of the LPG engine with EGR. Meanwhile, the excess air rate Φa limits of LPG lean-burning will be largely extended within the whole effective range of EGR rate. At the equivalent running conditions of LPG engine, largely extended EGR rate could restrain the formation of NOX emissions by the high combustion temperature. As a result, due to the increases in burning velocity and heat efficiency, the LPG engine could realize the Φa limits in lean-burning process with a higher EGR rate. The highest REGR in the rapid burning process increased from 5% of the normal combustion process to 8.11%. Additionally, Coefficient of Variation (CoV) in the LPG combustion process was under control effectively.

TECHNICAL SESSION

Tuesday, October 30

< Room 302B >

14:00-15:00

Alternative Fuel (Part 2 of 4)

Chair : Hideo Shoji (Nihon University)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

TECHNICAL SESSION

Tuesday, October 30

< Room 302B >

16:00-17:30

Alternative Fuel (Part 3 of 4)

Chair : Tadao Okazaki (Kubota Corporation)
Co-Chair : Hideo Shoji (Nihon University)

20076564/2007-32-0064 (236093)

Investigations on Low Heat Rejection Diesel Engine with Carbureted Methanol and Crude Jatropa Oil as Alternate Fuels

Naga Sarada S, Sudha Rani G, Murali Krishna M.V.S, Kalyani Radha K (Jawaharlal Nehru Technological University) - India

Abstract: Investigations have been carried out on low heat rejection engine(LHR) consisting of 3.2mm air gap insulated piston with superni(a low thermal conductivity nickel alloy material) crown and 3.2mm air gap insulated liner with superni insert by using alternate fuels viz. carbureted methanol and crude jatropha oil at varied injection pressured. Methanol is inducted through variable carburetor jet at different percentages of diesel flow rate by mass basis, installed at the inlet manifold of the engine during suction stroke and vegetable oil is injected through injector. LHR engine with carbureted methanol and crude jatropha oil showed improved performance and decreased pollution levels in comparison with conventional engine with pure diesel fuel and the performance is further improved with the increase of injection pressure with dual fuel operation.

20076575/2007-32-0075 (239071)

Experimental Investigation of Performance and Emission Parameters of a Small Diesel Engine Using CNG and Biodiesel

Talal Yusaf (University of Southern Queensland), Gholamhassan Najafi, Barat Ghobadian, (Tarbiat Modares University), Bahman Najafi, Vahab Pirouzpanah (Ardebil & Tabriz University) - Australia

Abstract: The use of compressed natural gas (CNG) in diesel engines can be considered one of the optimum alternative solutions for reducing fuel consumption rate and pollutant emissions components from diesel engine. CNG can ideally replace diesel fuel; a 90% diesel was replaced by CNG, while remain 10% was used as a pilot fuel. Biodiesel was used as a pilot fuel in this research. Methyl ester of sunflower oil was the main component of the biodiesel that used in this project. The results of the engine tests on the basis of ECR-49 standard showed that increasing biodiesel percentage in pilot fuel compound resulting in reducing the combustion chamber peak pressure, exhaust engine temperature and ignition delay. The inherent biodiesel property CO and NOx emissions were seemed to be decreased; however UHC was found to be increased, this was due to incomplete combustion of B10% fuel compound.

20076565/2007-32-0065 (238248)

The Application of Coconut-Oil Methyl Ester for Diesel Engine

Yusuke Soma, Masato Nakajima, Koji Yoshida, Hideo Shoji, Akira Iijima (Nihon University) - Japan

Abstract: The coconut-oil methyl ester is made from coconut oil and methanol, and both cold start performance and ignition characteristics of coconut-oil methyl ester are experimentally investigated by using a diesel engine. In experiments, diesel fuel and coconut-oil methyl ester are used and the blended ratio of coconut-oil methyl ester to diesel fuel is changed. The test is conducted at full load and 3000 rpm. The diesel engine can be run stably with any mixing ratio of coconut-oil methyl ester, however the power is slightly reduced with increasing the mixing ratio of coconut-oil methyl ester. In the cold start condition, when the mixing ratio of coconut-oil methyl ester increases, the combustion chamber wall temperature rises early and the ignition timing is improved. Therefore, the coconut-oil methyl ester has superior compression ignition characteristics and reduces exhaust gas emissions, so that the coconut-oil methyl ester is good alternative fuel for diesel engines.

TECHNICAL SESSION

Wednesday, October 31

< Room 201A >

8:30-10:00

Engine Technology (Part 4 of 5)

Chair : Tomoo Shiozaki (Honda R&D Co., Ltd.)

Co-Chair : Robert Fleck (Queen's University of Belfast)

20076503/2007-32-0003 (237426)

Research on Extended Expansion General-Purpose Engine - Heat Release and Friction -

Hibiki Koga, Sei Watanabe (Honda R&D Co., Ltd.) - Japan

Abstract: The combustion and efficiency of an extended expansion general-purpose engine employing a multiple linkage system with that of a conventional engine consisting of the same component parts, with the exception of the linkage system. The results show that this extended expansion increases indicated thermal efficiency from 29.6% to 33.2%. In addition, as the piston speed near the compression top dead center of this engine is slow, mass fraction burned depends upon the change in the cylinder volume, relative to the combustion chamber volume during the combustion period. The change of the minimum spark advance for best torque (MBT) timing relative to load is smaller than that of the conventional engine. In addition, measurements of drive loss during motoring operation show that the friction of this engine is approximately the same as that of a conventional engine. As a result, brake thermal efficiency of the test engine was increased by approximately 13%, from 20.1% of the conventional engine to 22.7%, under the EPA mode with fixed ignition timing operation.

20076507/2007-32-0007 (239713)

Reduction of Fuel Consumption on Single-Cylinder General Purpose Engine

Yoshikazu Sato, Mashu Kurata, Gaku Naoe, (Honda R&D Co.,Ltd.) -Japan

Abstract: An air-cooled 4 stroke single-cylinder general purpose engine with 438 cm^3 of displacement was researched to improve fuel efficiency. As a technique for improving fuel efficiency, 1) Intake valve were narrowed and spark plug was moved closer to the bore center. As a result, the new engine shortened the mass combustion rate by 13%, compared to existing engines, and improved fuel efficiency in the EPA general-purpose mode by 1.1%.2) Taking aim at reducing the piston system friction, piston ring tension was lowered 45% compared to that of existing engines in the same class by using a centrifugal casting sleeve with the air-cooled engine. This has resulted in a 5% reduction in friction mean effective pressure, and improved fuel efficiency in the EPA general-purpose mode by 0.9%. 3) Electronic control technology was used, and ignition timing was decided based on engine speed and throttle opening data. This has improved fuel efficiency in the EPA general-purpose mode by 1.1%, while at the same time piston noise was reduced. Totally fuel efficiency was improved 3.1% by these three technologies. Additionally revising the carburetor setting and auxiliary equipment, the newly developed engine increased fuel efficiency in EPA general-purpose mode by 15% over that of existing engine.

20076511/2007-32-0011 (240262)

Development of Electronically Controlled CVT Focusing on Rider's Intention of Acceleration and Deceleration

Toshio Unno, Masaya Sakaue, Kazutoshi Ishioka, Ryousuke Asaoka, Hiroyuki Aoki (Yamaha Motor Co.,Ltd.) - Japan

Abstract: Recently electronically controlled transmissions have been adopted in motorcycles, especially scooters. By such CVT (Continuously Variable Transmission), various shift modes and the manual control of the speed ratio are offered, and the rider can select the appropriate ratio according to the running situations and can draw the performance of the vehicle to the maximum. On the other hand, however, the rider's operation such as selecting modes tends to become complex. Due to the characteristic that two-wheeled vehicles require the rider to steer and control speed both by hands, it is preferred that the shifting systems should be operated as easily as possible so that the rider can concentrate on the driving operation. Therefore, we developed the electronically controlled belt-type CVT system for two-wheeled vehicles with a new concept that was able to achieve changing the speed ratio according to the rider's intention with only simple operation at the auto shift mode.

TECHNICAL SESSION

Wednesday, October 31

< Room 201A >

10:30-12:00

Engine Technology (Part 5 of 5)

Chair : Yoshiro Tokunaga (Kawasaki Heavy Industries, Ltd.)
Co-Chair : Robert Fleck (Queen's University of Belfast)

20076505/2007-32-0005 (238593)

Determination of Operating Ranges of Marine Engines

James N. Carroll, Kevin J. Brunner (Southwest Research Institute), John McKnight (National Marine Manufacturers Association), Rich Waggoner (Indmar Products Co., Inc.), Daniel Jeffery Ostrosky (Yamaha Motor Corporation USA), Mark Riechers (Mercury Marine), Joseph E. Klak (Bombardier Recreational Products Inc.) - U.S.A.

Abstract: This paper summarizes work performed to define the range of recreational boat engine operation for the National Marine Manufacturers Association (NMMA). Sixteen boats were tested on-water with data acquisition systems to measure engine parameters. Boat types included sterndrive and inboard (SD/I), outboard (OB), and personal watercraft (PWC). Each boat was tested with low loads and at its rated load carrying capacity. Each boat was run at prescribed engine speeds from low to maximum speed during data collection. Maps of each boat's engine operation were produced in order to identify the lowest and highest engine load at each engine speed, based on intake manifold depression (for SD/I and OB) or throttle position (for PWC). Each engine type was then installed in a test cell where the lowest and highest engine loads from on-water testing were duplicated in order to measure the engine's output. The engine's low- and high-load torque was corrected to standard conditions and then normalized in order to compare its operation to the United States Environmental Protection Agency and the California Air Resources Board's emission test cycle.

20076506/2007-32-0006 (239578)

Double Clutch Transmission for Motorcycles

M. Geieregger, A. Mair, B. Pollak (AVL List GmbH), Andreas Bilek (KTM – Sportmotorcycle AG) - Austria

Abstract: Until now automatic or automated transmissions are not common in motorcycles whereas in passenger cars a clear trend towards various types of automatic shifting transmissions could be observed during the recent years. For 2-wheelers CVT drives are well known for 50 cc scooters and in the scooter class a trend towards CVTs for bigger displacement vehicles is obvious. Evidence for this is the introduction of scooters with a displacement up to 800 cc which use CVT drives. Reflecting the overall CO2 targets and their impact on individual transportation and the demand for sportiveness in the area of motorcycles dual clutch transmissions (DCT) are certainly a valid alternative. Meanwhile automated manual transmissions (AMT, clutch actuation and gear shifting by actuators) are available in series production. Other than in the most passenger car applications the shifts are initiated by the rider. As in the car area a full "by-wire" interface is utilized. From its driving performance a double clutch transmission (DCT) would fit very well into motorcycle applications. Compared to an automated manual transmission (AMT) a double clutch transmission does not have any interruption of the tractive force during the shifting and a DCT features instantaneous acceleration and the feeling of a …

20076515/2007-32-0015 (262501)

The Potential of a New Type of Carburettor to Assist SORE in Meeting EPA / CARB Phase 3 Legislation

Roy Douglas (Queen's University, Belfast), Stephen Glover (Fjolblendir ehf), Kristjan B Omarsson (Fjolblendir ehf.)

Abstract: Small off-road engines (SORE) have been recognised as a major source of air pollution. It is estimated that non handheld SORE annually produce over 1 million tonnes of HC+NOx and over 50 million tonnes of CO2. The fuel system design and its operating AFR are of key importance with regard to engine operation and engine out emissions. The conventional low-cost float carburettors used in these engines are relatively ineffective at atomising and preparing the fuel for combustion requiring a rich setting for acceptable functional performance. EPA and CARB have confirmed that Phase 3 limits are achievable for a "durable" engine fitted with a conventional well calibrated and manufactured "stock rich setting" float carburettor together with catalytic oxidation after-treatment and passive secondary air injection. The EPA and CARB strategy for meeting Phase 3 only considers the use of conventional float carburettors that operate at rich AFR's over their entire engine operating range as no other cost effective alternative fuel system is yet available on the market. A cost effective alternative to the conventional carburettor that enabled leaner or optimised AFR operation with load and improved combustion performance would open the door to alternative strategies to meeting the phase 3 limits..…

TECHNICAL SESSION

Wednesday, October 31

< Room 201B >

8:30-10:00

Two-stroke Engine (Part 1 of 3)

Chair : Yuh Motoyama (Yamaha Motor Co., Ltd.)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

20076532/2007-32-0032 (240255)

Application of Exhaust Pipe Restriction Technique to a Small Two-Stroke Engine

Finlay L. Watson (Victa Lawncare Pty Ltd.), Guang Hong (University of Technology, Sydney) – Australia

Abstract: A simple method to reduce HC emissions caused by fuel short-circuiting in a two-stroke engine is to apply a certain restriction to the exhaust gas flow in the exhaust pipe. This technique, developed for motorcycles, vehicles and outboards, has been applied to a small off-road two-stroke engine with a constant speed operating condition. In order to assess the feasibility and effectiveness of this technique for the reduction of HC and CO emissions in such an engine, a butterfly valve was installed in the exhaust pipe next to the exhaust port. Based on test results using the butterfly valve, a cylindrical restrictor was developed to generate various restrictions to the gas flow in the exhaust pipe and consequently reduce the fuel short-circuiting. The effectiveness of the restrictor on emission reduction was further improved by leaner air/fuel mixture. The experimental results showed improved engine performance including the best 24% reduction of total weighted HC and 25% reduction of total weighted CO when the exhaust pipe restriction was 50%. Additionally, Mota, a two-stroke engine simulation program, was used to simulate the engine performance with reduced diameter of the exhaust pipe. The outcomes of this simulation support and explain the experimental results.

20076530/2007-32-0030 (239679)

Reed Valve, Crankcase and Exhaust Models Coupled to 3D Fluid Domains for the Predictive CFD Simulation

Rainer J. Rothbauer, Gunther Grasberger, Zainal Abidin, Raimund A. Almbauer (Graz University of Technology) - Austria

Abstract: The development and optimization of two stroke engines, especially the development of internal mixture preparation and the combustion process, require effective and reliable simulation in order to shorten the development time and to reduce prototype and test bench costs. CFD (Computational Fluid Dynamics) is a state of the art tool to optimize and visualize the fluid processes, e.g. scavenging, in-cylinder charge motion, spray formation, mixture preparation or combustion. The drawback of full 3D CFD simulation is the required time for grid generation and calculation of the model, especially for the simulations in the early development phase or in the concept phase as the available time for simulation is limited. Additionally, two stroke specific models e.g. for the reed valve, are not available in commercial 3D CFD codes. In previous investigations [SAE 2005-32-0099] the strategies and the requirements for a predictive simulation have been discussed. Consequently, a new methodology which bases on the combination of 3-dimensional (3D) and 0/1-dimensional (0/1D) CFD simulation has been presented. This methodology uses a new multidimensional interface technology which…

20076529/2007-32-0029 (239607)

An Integrated 3D CFD Simulation Methodology for the Optimization of the Mixture Preparation of 2-Stroke DI Engines

Stephan P Schmidt, Oliver Schogl, Rainer J Rothbauer, Helmut Eichlseder, Roland Kirchberger (Graz University of Technologies) - Austria

Abstract: For the development of high-performance 2-stroke engines with internal mixture preparation it is essential to know about the interaction between charge motion and injection spray. With no prototypes available conceptual investigations can only render such information by using 3D CFD simulation. In this way an optimization of mixture preparation and charge motion can be achieved by varying the transfer and boost ports. To allow for the influence of these modifications on the mass balance (volumetric and trapping efficiency), the entire system of the loop-scavenged two-stroke engine has to be investigated. The state of the art calculation domain for 2-stroke 3D CFD simulation is bounded at the inlet of the crankcase (reed valve) and sometimes also at the outlet of the cylinders. The reasons lie in the so far not sufficiently reproducible components (e.g. reed valve) as well as in the reduction of calculation time. Beside the possibility of a coupled 1D and 3D simulation (SAE Paper No. 2005-32-0099 and SAE Paper No. 2006-32-0059), it is possible to apply a methodology with adaptive boundary conditions for the evaluation of the entire engine in order to overcome these restrictions. …

TECHNICAL SESSION

Wednesday, October 31

< Room 201B >

10:30-12:00

Two-Stroke Engine (Part 2 of 3)

Chair : Yuh Motoyama (Yamaha Motor Co., Ltd.)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

20076527/2007-32-0027 (238337)

Time Resolved Scavenging Analysis for Two-Stroke Engines

Peter Stuecke, Bernhard Lehmann (West Saxon University), Matthias Heider (Forschungs- und Transferzentrum) - Germany

Abstract: A detailed knowledge of the scavenging process becomes necessary during the development process, when the performance and in particular the emission output of two-stroke engines needs to be qualified and evaluated. This paper presents an experimental approach to describe the composition of the flow at the exhaust port by means of flow visualization and to quantify the relative changes of the scavenging losses imposed by design changes. The experimental set-up has been described in previous SAE papers and has been expanded by a transparent exhaust port, which gives optical access to the flow through the exhaust port. The gases in the cylinder are represented by differently colored water-based fluids. Typically, the burnt gas is clear and the fresh charge is colored to visualize its progress during the scavenging cycle and its distribution inside the cylinder. The flow through the exhaust port is captured with a digital camera together with timed markers to synchronize the movie with the crank angle during the cycle. Hence, the amount of colored liquid in the transfer port indicates the concentration of fresh charge. The gray scale value or the hue angle of the color can be correlated to the concentration by applying the Lambert and Beer's law, which allows a relative quantification of the scavenging …

20076525/2007-32-0025 (233596)

R&D of a New G.D.I. 2-Stroke Engine with Unidirectional Scavenging Flow and Force Feed Lubrication System

Patrizio Nuccio, Mario Rocco Marzano (Politecnico Di Torino) - Italy

Abstract: P reliminary bench tests have been carried out on an original-design 2-stroke single-cylinder prototype engine, which is equipped with an electronically controlled gasoline direct injection apparatus. The main design and operating features of the engine concern: a unidirectional airflow during the scavenging process (from the inlet ports near the BDC to overhead cam-actuated valves), an external air pump (a Roots volumetric type driven by an electric motor) and a force-feed lubrication system, like those usually exploited in mass-produced 4-stroke engines. Experimental bench tests were carried out under low load, intermediate rotational speed operating conditions. The performances were compared to those obtained from a commercial crankcase-scavenged 2-stroke engine using an indirect injection fuel feeding system. Encouraging results were obtained as far as fuel consumption and pollutant emissions are concerned. Other improvements are expected thanks to scheduled modifications regarding a new piston design along with a new arrangement of both the spark-plugs and the injector position.

20076528/2007-32-0028 (239460)

Monitoring Piston Temperature of Two-Stroke Cycle Engines in Testing Operation

Hiroaki Otani, Masaho Fukasawa, Junichi Hasegawa, Kazumi Iida (Yamaha Marine Co.,Ltd.) - Japan

Abstract: This report describes a thermometric method utilizing an infrared fiber. The method is used for monitoring the piston temperature of the two-stroke cycle engine mounted on an outboard motor while the engine is in testing operation. The piston temperature measurement is an essential part of the engineering work for developing the reliability of the piston. Traditionally, the piston temperature measurement was performed utilizing a thermocouple embedded in the piston. Every time the piston reaches the bottom dead center, the electrical signal from the thermocouple was picked up intermittently via a mechanical contact. However, uncertainty associated with the durability of the mechanical contact has restricted the running time of continuous measurement. The method described in this report was developed to address such difficulty. In principle, the infra-red energy emitted by the piston depending on its temperature is detected via the infra-red fiber. Thus, the need for providing the contact was eliminated. The appropriate structure was configured for mounting the infrared fiber in the cylinder block, and the reproducibility tests have demonstrated the effectiveness of the method as the practically viable tool. The method allows real-time measurement of the piston temperature with assured durability. The piston temperature measurements are taken in the form of ample mapped data, which enables quick and accurate evaluation for proper settings as well as their optimization.

TECHNICAL SESSION

Wednesday, October 31

< Room 301A >

8:30-10:00

Design & Simulation (Part 1 of 4)

Chair : Katsumi Nagai (Suzuki Motor Corporation)

Co-Chair : Roy Douglas (Queen's University of Belfast)

20076591/2007-32-0091 (239078)

Numerical Predictions for Can Type Muffler of a Motorcycle

Motohiko Nishimura, Yoshiharu Nonaka, Takashi Hiraga, Yuichi Kawamoto (Kawasaki Heavy Industries, Ltd.) – Japan

Abstract: To attain high performance and low emission at the same time, computational fluid dynamics was incorporated into a design optimization stage of the muffler. Splitters were equipped at the short bend just upstream of the catalyst to suppress flow separation and mal-distribution within the catalyst region. Design screening had been done for the splitters based on result from the steady states CFD. Then the unsteady CFD for the selected splitter design showed uniform flow field within the catalyst region even when the flow rate was abruptly changed due to intermittent exhaust process.

20076589/2007-32-0089 (237186)

Model-Based Analysis and Evaluation of the DCP System

Tsutomu Nakamura, Kenichi Hazu, Shigeru Yamazaki (Mikuni Corporation) - Japan

Abstract: Until recently, development and evaluation of the Discharge Pump Type Fuel Injection System (hereafter referred to as DCP) has been implemented through measurement of various characteristics such as fuel flow and observation of each separate component's function during real-world testing. However, there are several characteristics that are difficult to evaluate. An evaluatable DCP system model was created for remedying this dilemma. With this DCP system model, we were able to achieve results comparable to testing done with the real-world DCP system. Furthermore, we were successful in identifying characteristics within the model that we were unable to measure with the real-world DCP system. From these results, we were able to verify the viability of employing the DCP system model for evaluation and improvement of the real-world DCP system.

20076592/2007-32-0092 (239123)

Index-Matching Technique for Effective Liquid Flow Diagnostics for Internal Combustion Engine

Koichi Nishino (Yokohama National University), Jang-Woon Choi (Flowtech Research Inc.) - Japan

Abstract: An effective technique for visualization and measurement of liquid flows in a model of internal combustion engine (ICE) is presented. The technique is based upon the use of index-controlled fluid and transparent plastic models that has the same index of refraction as the fluid. This index-matching method allows unblocked flow visualization of any locations deep inside the model, locations that could not be observed or illuminated by other techniques. This advantage is enhanced by the use of rapid prototyping in which any complex geometry of the model can be fabricated directly and effectively from 3-D CAD data or 3-D surface data of the model. The technique is applied to the study of a liquid flow inside a water jacket of ICE. The model is made by the laser fabrication technique and therefore it is made of transparent epoxy resin. Very complex flow geometry is faithfully reproduced in the model. A liquid flow inside the model is driven by a pump and the flow rate is controlled to achieve a comparable Reynolds number to an actual operation condition. Both two-component particle image velocimetry (PIV) and three-component stereoscopic PIV are used for the measurement of liquid flow inside the model. The flow is seeded with metal coated spherical particles 20μm in diameter. The flow is illuminated with a double-pulsed frequency-doubled Nd:YAG laser. The measurements are made for flow patterns inside the water jacket. Special attention is paid to the evaluation of the flow rate through each hole made in the gasket that is inserted between the cylinder head and the cylinder body. The stereoscopic PIV is used for this evaluation. It is found from the present measurement that the flow pattern through the hole is far from uniform even though the hole diameter is small (around 5mm) and that the pattern is dependent on the location of the hole in the gasket. The flow rate through the hole is evaluated from the velocity profile measured in the cross-section and it is discussed from the viewpoint for an optimum design of water jacket. It is concluded from the present study that the index-matching technique proposed here is quite effective and useful for flow diagnostics at locations deep inside the model of ICE such as water jacket model and that this technique can be used for a variety of diagnostics of liquid flows inside and outside complex geometry.

TECHNICAL SESSION

Wednesday, October 31

< Room 301A >

10:30-12:00

Design & Simulation (Part 2 of 4)

Chair : Izumi Takagi (Kawasaki Heavy Industries, Ltd.)
Co-Chair : Yasuhiro Sugimoto (Honda R&D Co., Ltd.)

20076595/2007-32-0095 (240020)

Development of Generic Load Cases for Motorcycle Components for Design Optimization

Ravi V Kharul, Sivakumar Balakrishnan, Anil V Singanamalli, Bapanna K Dora, (T.V.S Motor Company Ltd.) – India

Abstract: A methodology is presented to obtain loads coming on the handle bar of a motorcycle of one model and calculating generic loads from the same for all other motorcycle models. The handle bar of a motorcycle of model M1 was instrumented with strain gages and calibrated for vertical and horizontal loads. The instrumented handle bar was assembled on the vehicle and data was collected on the test rig in laboratory. The vertical and horizontal loads acting on the handle bar, on test rig was obtained based on the calibration performed. The loads thus obtained are for a particular motorcycle model M1 and is dependent on the wheel loads of that motorcycle. These loads were converted into generic load cases, which are applicable for all models of motorcycles. The generalized loads thus generated were used in predicting the fatigue life of handle bar of a different motorcycle model (M2) using FE analysis and MSC fatigue. The fatigue life calculated using FE analysis was observed to match with the actual life of handle bar of motorcycle model M2 tested in laboratory thereby validating the generic load cases that were arrived at.

20076596/2007-32-0096 (240027)

Estimation of Wheel Loads Using a Mathematical Model and Correlation with Vehicle Measurements on Motorcycles

Sivakumar Balakrishnan, Chandan B Chavan, Karthikeyan Srinivasan, Ravi V Kharul, Rakesh Chandra P.H. (T.V.S. Motor Company) – India

Abstract: This paper aims at the estimation of dynamic wheel loads of a two-wheeler through mathematical modeling that will aid during the initial stages of product development. A half car model that represents a two-wheeler was used for this purpose. Road displacements were given as input to the model and the wheel loads estimated. Actual road data obtained from two-poster rig was used as input to the model thereby making it possible to calculate the wheel loads for different customer usage conditions on different roads. In this paper, a severe rough road was chosen for verification of the model with that of the rig as the rider dynamics on such roads are the most difficult to simulate even on the rigs. The estimated values from model were verified with those measured using a two-poster rig for the same road displacement. Attempt has been further made to establish a correlation between the ride comfort predictions from the model and the two-poster rig. The acceleration levels on the frame were considered for assessment and comparison of comfort. The fact that both the estimation of wheel loads and ride comfort optimization can be accomplished much before building complex multibody models for simulation makes the approach very cost effective and faster. Also, the advantage of predicting the fatigue life of various components that go into a vehicle based on dynamic wheel loads even before the part is made makes this a very useful exercise.

20076597/2007-32-0097 (240155)

Development and Application of Control-Oriented Power Train Model for a Variomatic Scooter

Manish Garg, G.S. Deshpande (TVS Motor Company), Jesse B. Gohl, S.A. Sundaresan (Emmeskay Inc., USA) - India

Abstract: Competitive environment of scooter market demands for new improved products with minimum development time. Computer simulations are very useful in reducing the development time through virtual prototyping and testing the system on computers rather than making the hardware prototypes and testing on road. Particularly, lumped parameter modeling provides reasonably accurate results for predicting vehicle performance characteristics in short span of time. This is very useful when various system level targets have to be achieved and when trade-offs have to be made to obtain optimal results. In this work, a system-level powertrain model has been developed for small variomatic scooters with a mechanically actuated Continuously Variable Transmission (CVT). The modeling and simulation technology developed in this work can aid in designing a scooter CVT system to provide the desired performance characteristics. Further, it can be very useful if one is contemplating to develop an electronically controlled CVT for scooter applications. The approach used in this work highlights the paradigm of model-based engineering and elucidates its use in a product development environment.

TECHNICAL SESSION

Wednesday, October 31

< Room 301B >

9:00-10:00

Engine Control (Part 1 of 3)

Chair : Ryozo Okita (Yamaha Marine Co., Ltd.)

Co-Chair :James N. Carroll (Southwest Research Institute)

20076544/2007-32-0044 (234818)

Electronic Throttle Control for Motorcycles

Jörg Wengert (Robert Bosch GmbH), Dierk Rommel, Ronny Krzok(Bosch Engineering GmbH) - Germany

Abstract: Gasoline engines use throttle valves to control the intake air flow and thereby power and torque output. Throttle valves in today's motorcycles are mechanical; they are linked to the accelerator hand grip by a throttle cable. In cars, this type of system has mostly been replaced by electronic throttle control (ETC). An electronic throttle device is controlled by an electronic control unit (ECU) based on the input from a sensor in the accelerator pedal. In the motorcycle market, the first ETC systems that have appeared on the market have been intermediate solutions with remaining mechanical links. Detailing benefits of an ETC system without these mechanics, the paper proposes a full ETC system without mechanical links for motorcycles. Components required for the realization of an ETC system are an electronic throttle device or a throttle actuator, an accelerator hand grip sensor and an ECU. A study has been conducted on a mass production on-road sport motorcycle in order to prove feasibility of an ETC system. Exemplary evaluation results show improvements in emission technology (catalyst heating) and driveability. The paper points out that a task remaining is the definition of an industry wide motorcycle ETC safety concept for detection of malfunction and proper failure reaction.

20076547/2007-32-0047 (238150)

A Study of Intake Air Pressure Sampling Position in a Throttle Body Module

Li Huiqiang, Wang Zhensuo, Xi Gang, Wu Xiang, Li Liwei, Manuel Schoepke, Harald Neumann (United Automotive Electronic Systems Co., Ltd.) - China

Abstract: In electric fuel injection (EFI) systems the intake air pressure is used as system load signal for calculating injection and ignition parameters together with engine speed. Part of an EFI system for motorcycles is a throttle body module with integrated pressure sensor. As motorcycle systems require smaller components than automotive applications the target for engineering is to minimize the component size and still fulfill other system requirements. Therefore the pressure sensor sampling point should be as close as possible to the throttle shaft to reduce the module size but with a sufficient distance to avoid signal distortion by unsteady flow. This paper describes how to find a suitable sampling position by combining static bench testing, dynamic vehicle testing and CFD analysis.

TECHNICAL SESSION

Wednesday, October 31

< Room 301B >

10:30-12:00

Engine Control (Part 2 of 3)

Chair : Ryozo Okita (Yamaha Marine Co., Ltd.)
Co-Chair : Takashi Mitome (Suzuki Motor Corporation)

20076543/2007-32-0043 (236675)

Practical Use of the Engine Testing Dyno with the Vehicle Simulation for the MotoGP Race Engine Development

Kimihisa Matsuyama, Masamitsu Sugi, Noboru Yabe (Yamaha Motor Co., Ltd.) - Japan

Abstract: MotoGP is the pinnacle of motorcycle racing, with the world's top riders racing 800cc prototype machines at leading venues around the world. The riders compete against each other to win the title and show their superiority. The manufacturers have improved the engines every year to gain a high power with low-fuel consumption. The percentage of the duration in fully open throttle is less than 20% of the race, but the partial throttle is used as much as 80%. Moreover, when the rider accelerates the machine, the front tire is easy to be lifted from the ground. In the mid of corner, the rider cannot open the throttle fully because of the tire slip. Therefore, it is the most important factor to appropriately control a throttle in the partial area. The Drive-By-Wire (DBW) system is one of the solutions for the force control. The vehicle simulation in the engine dyno test helped efficiently to evaluate the DBW. As a result, a controllable engine was developed and the development costs were saved lower.

20076545/2007-32-0045 (237769)

Fuel Behavior Model-Based Injection Control for Motorcycle Port-injection Gasoline Engines

Hiroki Tanabe, Masaki Torigoshi, Shigeho Sakoda (Yamaha Motor Co., Ltd.) – Japan

Abstract: Today, environmental issues have become major global issues. Under these social circumstances, restrictions on vehicles powered by internal-combustion engines have become increasingly stringent. While, many models of motorcycle are intended for hobbyists, and enjoyment is a major factor in the appeal of these products. So it is necessary to simultaneously realize improved environmental performance and heightened enjoyment. Therefore, the authors focused on controlling the richness of the mixture, the air-fuel ratio. In the case of intake port-injection engines, it is common these days to control fuel injection using a fuel model that takes fuel adhered in the intake port into consideration, in order to control the air-fuel ratio. When this method of control is used, it is necessary to derive the ratio of injected fuel that adheres inside the intake pipe and the ratio of adhered fuel that is drawn into the cylinder. However, it is difficult to actually measure these values, and the ratios need to be estimated. Therefore, the authors developed appropriate technologies to derive the fuel adhesion ratio and fuel removal ratio statistically using the system identification approach, thereby achieving highly accurate air-fuel ratio control.

20076549/2007-32-0049 (240261)

In-Situ Residual Gas Concentration Measurement near a Spark Plug in a Motorcycle SI Engine

Nobuyuki Kawahara, Eiji Tomita, Hidenobu Yasuda (Okayama University) – Japan

Abstract: This paper describes the development and application of a spark plug sensor using an infrared absorption technique to quantify the instantaneous residual gas concentration near the spark plug. The residual gas fraction inside engine cylinder is assumed to be proportional to CO2 concentration. The relationship between CO2 concentration and absorption strength of CO2 was determined for various pressures and temperatures in advance using a constant volume vessel with electric heating system. The spark plug sensor for in-situ CO2 concentration measurement was applied to a compression-expansion engine and also to a port injected motorcycle SI engine. It was possible to qualify the CO2 concentration inside residual gas during the compression stroke using the developed optical system with new spark plug sensor in compression-expansion machine. Cycle-resolved measurements were made to investigate the effects of the residual gas concentration near the spark plug on the combustion characteristics of the commercial motorcycle engine. It was possible to measure the cycle-resolved CO2 concentration near the spark plug and investigate the cycle-to-cycle fluctuations of mixture formation to achieve stable operation using the newly developed spark plug sensor.

TECHNICAL SESSION

Wednesday, October 31

< Room 301B >

13:30-14:30

Engine Control (Part 3 of 3)

Chair : Toshimi Kobayashi (Kawasaki Heavy Industries, Ltd.)
Co-Chair : Jeff J. White (Southwest Research Institute)

20076570/2007-32-0070 (240244)

Investigation on Cold Starting and Warming Up of Gasoline Engines with EFI

Chunming Hu, Xijuan Song, Na Liu, Wei Li, (Tianjin University) – China

Abstract: The cold starting and cold-state running cycle (i.e. engine warming up) of gasoline engines are the key points of exhaust emissions formation of modern engines, and also one of the very important targets for the increasingly stringent emissions regulations. The combustion stability in gasoline engine cold starting and warming up will impact the formation of its exhaust emissions. This paper introduces the improvement in cold starting and warming up combustion process for the motorcycle gasoline engine by high-energy, dual-spark plug based rapid burning system. Test results showed that the high-energy, dual-spark plug based rapid burning system was very helpful to rapid ignition under the engine cold starting condition. Meanwhile, because of increasing the burning velocity of the engine mixture, this solution can realize the larger ignition retard and stable combustion process under the engine warming-up condition. As a result, it was very helpful to increase the exhaust gas temperature and shortened the light-off time of TWC to achieve the improvement exhaust emission performances for gasoline engines with EFI.

20076548/2007-32-0048 (238500)

Application of Hardware-in-the-Loop for Developing the Engine Management System

Yuh-Yih Wu, Bo-Chiuan Chen, K.D. Huang, (National Taipei University of Technology) - Taiwan

Abstract: This paper established a hardware-in-the-loop (HIL) system for developing the engine management system (EMS) of a motorcycle, which combines xPC target real-time simulator and PC based controller. An engine model of 125cc four-stroke gasoline engine that included the calculation of cylinder pressure is employed to be a control plant. A proposed control strategy developed with application of this HIL is verified to be superior to the conventional EMS of motorcycles. The proposed controller can send fuel injection and spark ignition control signals every two revolutions accurately via stroke identification method. During the engine running period, perhaps the ignition coil or other electronic equipment will conduct noise that interfere crankshaft tooth signal. Therefore, a Kalman filter is designed to improve the robustness of controller. Under interference, the performance of proposed controller is more satisfied than that without Kalman filter. Finally, a real engine is used to verify the controller by real tooth signal.

TECHNICAL SESSION

Wednesday, October 31

< Room 302A >

8:30-10:00

Collegiate Events (Part 1 of 3)

Chair : Akira Iijima (Nihon University)

Co-Chair : Jay S. Meldrum (Michigan Technological University)

20076615/2007-32-0115 (238252)

Improvement of Middle Engine Speed Torque By Using Resonance Effect For Restricted 600cc Four-Stroke Engine

Makoto Ito, Hiroyuki Yano, Yasufumi Oguri, Takashi Suzuki, (Sophia University) - Japan

Abstract: This research focuses on the improvement of torque at the middle engine speed of a motorcycle engine with resonance supercharging. The resonance supercharging intake system is realized with a simple modification to the intake collector geometry. A one-dimensional computational model is employed to simulate the pressure wave propagation and to optimize the configuration of it. The experiments confirmed the increase in the engine torque for the entire operation range and the maximum gain of 33% was achieved at 8500rpm. The resonance effect is further investigated through three-dimensional simulation, in which the intake airflow rate, static pressure distribution are analyzed.

20076616/2007-32-0116 (238408)

Simplification of the Shift/Clutch Operations for the Formula SAE Vehicles

Hiroshi Enomoto, Hironari Morita, Yousuke Fukunaga (Kanazawa University), Naoki Uota (Kado Corporation) - Japan

Abstract: The simplified shift/clutch operation system, KF-TOS-P, was driven by DC motors (DC12V driven) with a microprocessor. Two rotary sensors detected the positions of the shift lever and the clutch lever. In FSAE rules, the simple throttle-by-wire is prohibited and the engine speed was controlled by the drivers. The custom steering wheel, KF-SW07 as the human machine interface, was designed and manufactured with CFRP by VaRTM (Vacuum assisted Resin Transfer Modeling) method. The shift operation time of KF-TOS-P was half of the manual operation and the clutch engagement time of that was 25msec. KF-SW07 was 22.6% weight and 16.7% cost (calculated by FSAE rules) of the commercial steering wheel of the race use.

20076618/2007-32-0118 (238437)

The Package of the Turbo Charged Engine for the FSAE Vehicle with the Custom Lubricant System

Hiroshi Enomoto, Hiroyuki Motoi, Kyohei Takahashi, Koichiro Saito (Kanazawa University), Masahiko Yashiro (Honeywell) - Japan

Abstract: The turbocharged 4-stroke internal combustion engine was developed for FSAE, the annual collegiate racing competition. The dry sump lubricant system with the custom scavenge pump, KF-SC07, was designed. The crank axle height was 192mm, 76.5% of KF2004. Custom cam-shafts were designed making the torque fluctuation decreased less than 50% of KF2005. The compression ratio was changed. And the maximum boost pressure and the maximum torque gain were 25kPa (0.25 kgf/cm2) and 11%, respectively.

TECHNICAL SESSION

Wednesday, October 31

< Room 302A >

10:30-12:00

Collegiate Events (Part 2 of 3)

Chair : Shunichi Kometani (Yamaha Motor Co., Ltd.)
Co-Chair : Jay S. Meldrum (Michigan Technological University)

20076617/2007-32-0117 (238412)

Development of Electronically Controlled Shock Absorber Using Magneto-Rheological Fluid

Toshihiko Komatsuzaki, Hiroshi Enomoto, Hiroshi Nishimura, Michinao Hiramatsu, Yosuke Fukunaga (Kanazawa University) – Japan

Abstract: The electronically controlled shock absorber with magneto-rheological fluid, KF-MRS07, was developed for the Formula SAE (FSAE), which is an annual collegiate racing competition. The KF-MRS07 has been newly developed based on KF-NS06, a mono-tube type shock absorber produced in 2006 incorporating commercial oil. The KF-NS06 is a low cost product but hard to adjust the damping property. On the other hand, the KF-MRS07 can be controlled electronically whose damping force is changeable instantaneously while running. The equivalent viscous damping coefficient, the measure for evaluating the shock absorbers, is changed about 99% with 1.0A applied current. On-track test results show that the yaw rates can be changed from an oversteer condition to an understeer one with a simple threshold control.

20076620/2007-32-0120 (238524)

Development of the C-FRP Monocoque Front Impact Attenuator for FSAE with VaRTM

Hiroshi Enomoto, Yusuke Miyazaki, Hiroshi Mizuo, Eiji Hirano, Satoshi Kitayama, Koetsu Yamazaki (Kanazawa University), Naoki Uota (KADO Corporation) - Japan

Abstract: The Formula SAE (FSAE) rules require mounting an impact attenuator (IA) to the front part of the formula car. The IA is necessary to take fully into account not only lighter weight of the parts but also cost effectiveness as the total cost and the workability of manufacturing have much value to win the FSAE. In this paper, three different IAs, 1) a space frame structure with steel pipes (SSF), 2) a monocoque structure with aluminum (AM) and 3) a monocoque structure with Carbon Fiber Reinforced Plastic (CFRPM), were manufactured and compared with respect to the weight and the cost effectiveness under FSAE rules. The FEM simulations for the AM were performed and the calculated results showed good agreements with the experimental ones. However, the AM could not absorb the impact energy experimentally. The CFRPM could absorb the required impact energy with lighter structure compared to other IAs. The weight was half of the experimental SSF and 1/5 of the calculated AM.

20076619/2007-32-0119 (238442)

Development of the Traction Control System with the Custom Electrical Control Unit for the Formula SAE Car

Hiroshi Enomoto, Hitoshi Nakao, Yosuke Fukunaga, Taira Maeda (Kanazawa University), Toshiyuki Sakai, Masahiro Kontani (Honda R&D Co., Ltd.) - Japan

Abstract: The Traction Control Systems (TCS) for the FSAE car were developed with the Fuel/Ignition Cut (FIC) method and the Ignition Retard (IR) method. A slip speed was used for the TCSs and a custom Engine Control Unit (KF-ECU07) was developed with commercial devices. With the FIC TCS, the engine was stalled and the IR TCS worked better. KF-ECU07 was 7.6% of the commercial high-quality ECU in price and contributed to the cost event point gain in FSAE. The driver load was evaluated with the duration ratio of the partial throttle aperture. The duration ratio of the partial throttle aperture was 52% with the IR-TCS compared with 64% without IR-TCS and 19% driver load was decreased.

TECHNICAL SESSION

Wednesday, October 31

< Room 302A >

13:30-14:30

Advanced Combustion

Chair : Tetsuya Ohira (Suzuki Motor Corporation)

Co-Chair : Roy Douglas (Queen's University of Belfast)

20076535/2007-32-0035 (238236)

Study of Diffusion Combustion by Using the High-Voltage Electrical Discharge

Takaaki Mifune, Koji Yoshida, Akira Iijima, Hideo Shoji (Nihon University) - Japan

Abstract: A new combustion method which is using the characteristic of plasma jet ignition is proposed. This new combustion method has features of diffusive combustion, however the fuel is injected and ignited by the electrical discharge. In the procedure of plasma jet ignition, a high-voltage electrical discharge is generated from the electrode to the orifice and then the gas in the cavity is transformed to a plasma state. When the cavity is filled with liquid fuel, the fuel plasma jet spreads into combustion chamber and is mixed with air in combustion chamber, and then the diffusive combustion occurs. Tests are carried out with four kinds of fuel by using a constant volume vessel. All kinds of fuel are surely injected by the electrical discharge and are certainly ignited and burned by this combustion method. The diffusion flame development process is influenced by fuel properties and is affected by the orifice diameter size.

20076534/2007-32-0034 (238117)

Effects of Uniform and Non-Uniform Electric Field on Premixed Combustion

Shinichi Moriya, Koji Yoshida, Hideo Shoji, Akira Iijima (Nihon University) – Japan

Abstract: The purpose of this study is to elucidate the flame propagation behavior under the electric field application by using the constant volume vessel. The laser induced breakdown applies the ignition and Nd:YAG laser is used. A homogeneous propane-air mixture is used and three equivalence ratios, 0.7, 1.0 and 1.5 are tested. In the uniform electric field, the premixed flame rapidly propagates toward both upward and downward directions and the flame front becomes a cylindrical shape. The maximum combustion pressure decreases with an increase of input voltage because of an increase of heat loss to the electrode, however the combustion duration is hardly affected by the input voltage. In the non-uniform electric field, the flame propagation velocity of downward direction increases. The combustion enhancement effect is remarkably when the input voltage is larger than 12 kV because the brush corona occurs and intense turbulence is generated on the flame front.

TECHNICAL SESSION

Wednesday, October 31

< Room 302B >

8:30-10:00

Alternative Fuel (Part 4 of 4)

Chair : Felipe Ronald M. Argamosa (Technological University of the Philippines)
Co-Chair : Michael S. Brenner (Lubrizol Corp.)

20076568/2007-32-0068 (239596)

Combustion Characteristics of a DI Diesel Engine with Palm Kernel Oil Biodiesel and Its Blend (B20)

Thet Myo, Eiji Kinoshita, Hidenori Tsuru, Kazunori Hamasaki (Kagoshima University) - Japan

Abstract: The fuel properties, the diesel combustion and the exhaust emissions of palm kernel oil methyl ester (PKME) and a blend of 20% PKME with 80% JIS No.2 gas oil (PK-B20) were investigated. In this study, the fuel properties were measured by laboratory analyses and the engine experiments were carried out by using a single cylinder direct injection diesel engine. To make comparison between biodiesels and conventional diesel fuel, palm oil methyl ester (PME), coconut oil methyl ester (CME), and the gas oil (JIS No.2) were also used as test fuels. From the fuel property analyses and the engine experimental results; the pour point of PKME was -5^0C which was the same as that of CME and the pour point of PK-B20 was -10^0C, the brake thermal efficiency of PKME was the same as the other test fuels, the ignition ability of PKME was better than that of the gas oil and the exhaust emissions (CO, HC, NOx and smoke) from PKME were almost the same as those of CME and lower than those of the gas oil. Specifically, at 100% load condition, about 47% reduction in smoke emission was found in PKME compare to that of the gas oil.

20076569/2007-32-0069 (239750)

Combustion analysis in the small compression ignition engine with DME low pressure injection

Tatsuaki Suzuki, Hiroaki Yonetani, Itaru Fukutani (Polytechnic University) – Japan

Abstract: Experiments of combustion observations and radical measurements in DME compression ignition engine were significant for the elucidation of DME combustion. There have been several reports on combustion observation studies of DME compression ignition engines. All of these reports were experimented with the same method observed due to the bottom view, and none of these studies was targeted on low pressure injection and/or small compression ignition engines. In this research, the combustion analysis of the small compression ignition engine with DME low pressure injection was attempted by the top view observation using the wide angle view engine scope. As a result, DME combustion using the ordinary diesel engine's piston chamber shape and material was observed. The production of the exhaust elements (OH, CHO, NO) was obtained to the time series on combustion process of the small compression ignition engine with DME low pressure injection.

20076574/2007-32-0074 (242842)

Experimental Study of Emission Characteristics of a Small Hydrogen S.I. Engine

Tetsuya Ohira (Suzuki Motor Corporation), Kenji Nakagawa, Kimitaka Yamane (Musashi Institute of Technology), Masahiro Shiojii (Kyoto University) - Japan

Abstract: In an attempt to grab potential issues with a hydrogen direct injection lean burn engine to have similar power output to a gasoline-fuelled engine, emission characteristics of a hydrogen engine was investigated. It is demonstrated that low NOx emission can be achievable without any catalytic converter. Two major issues, however, have been recognized, that is, combustion instability at low load conditions and too low temperature of exhaust gas to get enough boosting pressure. Hydrogen concentration heterogeneous of the mixture was focused in the CFD and visualization study. Hydrogen jet design of an injector could contribute to improvement of mixing.

TECHNICAL SESSION

Wednesday, October 31

< Room 302B >

10:30-12:00

Engine Component

Chair : Toshimi Kobayashi (Kawasaki Heavy Industries, Ltd.)
Co-Chair : Jeff J. White (Southwest Research Institute)

20076563/2007-32-0063 (240412)

Design and Dimensioning of Centrally Fastened, Friction-locked Connections in Auxiliary Drive Assemblies

Volkhard Walther, Erhard Leidich (Chemnitz University of Technology) - Germany

Abstract: A simple and cost-effective approach to connect the sprocket wheels or belt pulleys of the engine's auxiliaries drive system to the crank-shaft is fastening the parts using a central bolt. In this case, load transmission is carried out exclusively by the friction among the parts' frontal contact surfaces. Consequently, such connections are typically dimensioned according to the torque load and the governing coefficient of friction. The auxiliaries' increasing power demands involve much higher loads on such connections which may lead to severe failures, such as relative motions between the timing-sprocket and the crank-shaft. In order to understand and avoid those problems, the transmission behaviour of the contact surfaces has been investigated by means of analytical, experimental, and finite-element analyses. As shown in this contribution belt and chain forces lead to additional bending loads and shear forces in the frictional contacts that reduce the transferable torque dramatically. The "torque-only" dimensioning approach neglects these loads and, therefore, underestimates the required clamp load of the bolt. Theoretical considerations lead to a new analytical calculation model that allows the calculation of required axial pre-tension force bolt taking the additional bending and shear load components into account. As a result, the connections can now be dimensioned precisely avoiding both critical failures and unnecessarily high safety factors.

20076562/2007-32-0062 (239824)

Powder metal materials for gear applications

Senad DIZDAR, Pernilla Johansson, Toste JONSÄTER(Höganäs AB, Sweden), Koki KaNno(Höganäs Japan K.K.)- Japan

Abstract: This presentation reviews recent achievements in gear tooth bending strength and rolling contact fatigue resistance of powder metal materials in comparison to wrought steel materials for automotive applications. Prototype powder metal gears and rolling contact fatigue (RCF) rollers were pressed from commercially available low-alloyed iron powder mixes, sintered, surface densified, case hardened and optionally hard finished using commercially available equipment for all manufacturing steps. The reference gears and rollers were machined from common wrought steels. The results evaluated on the prototypes show that powder metal materials meet wrought machined materials' gear tooth bending strength and RCF-resistance.

20076561/2007-32-0061 (239472)

Development of Air-Cooled Cylinder Utilizing Baffle Pates Between Fins with Cooing Ports

Kohei Nakashima, Takuya Toda (Meijo University), Masao Yoshida (Aichi University), Soichi Ishihara, Masago Yamamoto (Meijo University) – Japan

Abstract: Several techniques facilitate the cooling of air-cooled motorbike engines. Baffle plates, mounted between cooling fins symmetrically with respect to a plane through the axis of the cylinder, maximize the distance that the cooling air follows the cylinder surface before it separates from the cylinder, when the motorbike is in motion. Cooling ports, drilled in the fins parallel to the axis of the cylinder, induce natural convection in the cylinder, when the motorbike is stationary. We produced cylinders with baffle plates between the fins, and with cooling ports, in order to improve cylinder cooling while motorcycles are both moving and stationary. We investigated experimental cylinders with baffle plates, cylinders with fins with cooling ports, and cylinders with both baffle plates and fins with cooling ports, all over a range of air velocities between 0 and 60 km/h. Results indicated that the cylinder with baffle plates was cooler than the cylinder without baffle plates, at air velocities between 20 and 60 km/h. Furthermore, the cylinder with fins with as many cooling ports as possible in the rear was cooler than a cylinder without cooling ports, at all air velocities. Finally, the cylinder with both baffle plates and fins with as many ports as possible in the rear had the greatest improvement in cooling at all air velocities.

TECHNICAL SESSION

Wednesday, October 31

< Room 302B >

13:30-14:30

Vehicle Dynamics & Safety (Part 1 of 3)

Chair : Masayuki Baba (Honda R&D Co., Ltd.)

Co-Chair : Akira Hasegawa (Yamaha Motor Co., Ltd.)

20076607/2007-32-0107 (238720)

Simulation of Fluctuation Behavior during Motorcycle Acceleration

Hirohide Matsushima, Masashi Sakata(Kawasaki Heavy Industries, Ltd), Ryo Suzuki (Kawaju Techno Service Corp.) – Japan

Abstract: Motorcycles are vehicles regarding which users have extremely strong preferences, so riding comfort determines a large portion of their commercial value. In order to provide the high level of riding comfort sought by motorcycle owners, we must select the most effective settings for the engine and the drive train. This paper concerns fluctuations in longitudinal acceleration when a motorcycle is accelerated, which is one of the benchmarks for evaluating riding comfort. This phenomenon consists of fluctuations in longitudinal acceleration during acceleration that cause an uncomfortable feeling for the rider, so the fluctuations in acceleration must be moderate. In composing the simulation model, we modeled the entire drive train from the crankshaft to the tire into a model. By comparing the results of the simulation model and of field tests, we confirmed that it is possible to simulate fluctuations in the revolutions of the drive train. Based on the results of the simulation, it was possible to posit that fluctuations in the longitudinal acceleration were attributable to play in the dog clutch. We then employed that simulation model to study potential methods for reducing fluctuations in longitudinal acceleration during acceleration. We carried out sensitivity analysis by varying the mechanical properties of the drive train, such as moment of inertia, spring characteristics, and damping characteristics. As a result, we were able to conduct studies on potential improvement methods in various combinations prior to the field tests. We then conducted riding tests to confirm the effects of the improvement measures. We recorded the longitudinal body acceleration data during the riding tests with an accelerometer mounted on the fuel tank, and the effects of improvement were quantitatively confirmed. As a result, by conducting the necessary studies prior to carrying out field tests, we were able to focus on the most promising improvement method, and we were able to provide a far more comfortable riding feeling, thereby receiving a more positive rider's evaluation of longitudinal acceleration.

TECHNICAL SESSION

Thursday, November 1

< Room 201A >

8:30-10:00

HCCI (Part 1 of 2)

Chair : Minoru Iida (Yamaha Motor Co., Ltd.)

Co-Chair : Hideo Shoji (Nihon University)

20076540/2007-32-0040 (238232)

Using Auto-Ignition to Improve Cycle-to-Cycle Variations of a Small Two-Stroke Engine

Janitha Sumadhawa Wijesinghe, Guang Hong (University of Technology, Sydney) - Australia

Abstract: Cycle-to-cycle variations occur frequently in small two-stroke engines as a result of irregular combustion and misfire due to the presence of the charge with incorrect air to fuel ratio and burnt gas adjacent to the spark plug. Under normal operating conditions burnt gasses inhibit the flame propagation that initiates from the spark plug. In this paper auto-ignition has been investigated as a means of overcoming the above problem by converting the presence of burnt gas from a disadvantage to an advantage. Under the current investigation trapping exhaust gas using a butterfly valve installed in the exhaust manifold was adopted as a method of realising auto-ignition in a small single cylinder two-stroke engine. Within the operating region of auto-ignition a significant reduction in cycle-to-cycle variations was achieved.

TECHNICAL SESSION

Thursday, November 1

< Room 201A >

10:30-12:00

HCCI (Part 2 of 2)

Chair : Minoru Iida (Yamaha Motor Co., Ltd.)

Co-Chair : Robert Fleck (Queen's University of Belfast)

20076538/2007-32-0038 (233115)

A Spectroscopic Analysis of Homogeneous Charge Compression Ignition Engine

Hiroki KASUYA, Yoshifumi YAMAZAKI, Seiji OKAMURA, Akira IIJIMA, Hideo SHOJI (Nihon University) – Japan

Abstract: Homogeneous Charge Compression Ignition (HCCI) combustion offers the advantages of high efficiency and low emissions of pollutants. However, ignition timing control and expansion of the stable operation region are issues remaining to be addressed in this combustion process. Detailed analyses of ignition and combustion characteristics are needed to resolve these issues. HCCI combustion of a low octane number fuel is characterized by two-stage heat release attributed to a cool flame and a hot flame, respectively. In this study, spectroscopic techniques were used to investigate the effect of exhaust gas recirculation (EGR) on ignition and combustion characteristics using a low octane number fuel, which is apt to give rise to a cool flame. The reaction mechanism of a cool flame produces formaldehyde (HCHO). Measurements were made of spontaneous light emission and absorption at wavelengths corresponding to the light emitted at the time HCHO was produced. The light emission intensity and absorbance ……

20076541/2007-32-0041 (239603)

Analysis of the Combustion Characteristics of a HCCI Engine Operating on DME and Methane

Yujiro Tsutsumi, Katsuhiro Hosina, Akira Iijima, Hideo Shoji (Nihon University) - Japan

Abstract: The Homogeneous Charge Compression Ignition (HCCI) engine has attracted much interest in recent years because it can simultaneously achieve high efficiency and low emissions. However, it is difficult to control the ignition timing with this type of engine because it has no physical ignition mechanism. Varying the amount of fuel supplied changes the operating load and the ignition timing also changes simultaneously. The HCCI combustion process also has the problem that combustion proceeds too rapidly. This study examined the possibility of separating ignition timing control and load control using an HCCI engine that was operated on blended test fuels of dimethyl ether (DME) and methane, which have vastly different ignition characteristics. The influence of the mixing ratios of these two test fuels on the rapidity of combustion was also investigated. Moreover, as a basic research subject, the behavior of formaldehyde (HCHO), an intermediate that is produced by cool flame reactions, ……

20076539/2007-32-0039 (238053)

Enlargement of Auto-Ignition Regions by Applying a Stratified Charge Concept

Kenji NISHIDA, Takahiro KIMIJIMA, Hisashi SAKUYAMA, Yasuo MURAKAMI

(Honda R&D Co.,Ltd. Motorcycle R&D Center)- Japan

Abstract: The auto-ignition attracts researchers as an ultimate combustion method that could simultaneously reduce fuel consumption and NOx emissions. The authors have studied auto-ignition combustion in the two-stroke gasoline engines aiming at vehicle engine applications. However, our attempts were in an impasse with the onset of irregular combustion in the lower speed and the extremely lower load range. As a solution for this problem, this paper proposes a new auto-ignition concept, i.e. Stratified Charge Auto-Ignition (SCAI), which focuses on the thermal distribution and mixture formation in the combustion chamber. Visualization of the direct injection spray formation was conducted first, and then a combustion chamber design was determined by using a CFD simulation, so as to form a mixture at the hottest spot in the combustion chamber. As a result, the auto-ignition regions were remarkably enlarged toward the lower speed and lower load, and the HC emissions decreased by 20% while the……

TECHNICAL SESSION

Thursday, November 1

< Room 201B >

8:30-10:00

Lubricants (Part 1 of 2)

Chair : Akihiro Ohashi (Nippon Oil)
Co-Chair :Joe Timar (Chevron)

20076578/2007-32-0078 (240125)

Development of an Environmentally Friendly Two-Stroke Engine Oil for Power Equipment

Moritsugu KASAI, Motoharu ISHIKAWA, Katsuhiko NAKAJIMA, Takeshi MATSUOKA (Idemitsu Kosan Co., Ltd., Idemitsu Lube Techno. Co., Ltd.)-Japan

Abstract: Two-stroke engines have been normally used for power equipment such as bush cutters and lawn mowers because of their compactness and cost-performance. However, their exhaust smoke is often put in question for causing a poor working environment. Therefore, it is important to develop an environmentally friendly two-stroke engine oil. In this paper, the development of a two-stroke engine oil with low smoke performance and its evaluation results are reported. If dilution ratio of a two-stroke engine oil with gasoline is increased in order to reduce the exhaust smoke, the lubricity becomes poor because of the decrease of base oil ratio in the oil. A two-stroke engine oil that copes with both low exhaust smoke and anti-seizure performance for pistons, has been developed by using a carefully selected polymer ester. The oil showed excellent anti-seizure performance in actual engine tests. In addition, it was also confirmed that it had better low……

20076579/2007-32-0079 (240169)

Development of new engine oil technology designed to bring more benefits to the boat owner than passenger car motor oils can provide

Brent Dohner (The Lubrizol Corporation Wickliffe, Ohio USA)- U.S.A.

Abstract: Several engine manufacturers are offering 4-stroke marine engines in order to meet 1998 US EPA emissions regulations requiring a 75% hydrocarbon reduction by 2006. These 4-stroke marine engines have been lubricated with passenger car motor oil in the past; however, the environment in which these engines operate is quite different from a passenger car engine. Perhaps the biggest differences are that marine engines do not use a closed loop cooling system, and they often operate in a corrosive salt water environment. They may be operated for extended periods of time at low speed while trolling, allowing build-up of water and fuel in the engine oil. For these reasons, oil used in this application should have corrosion inhibiting properties that are much better than what is found in passenger car oil. In addition, boats are often used seasonally and stored for long periods of time during the winter. This can lead……

20076577/2007-32-0077 (238125)

Four-Stroke Motorcycle Lubricant Performance: An Application-Specific Engine Test Development.

Mark F. WILKES, Nigel J. BRITTON, Christopher TRAVIS, Richard C. CHADWICK (Lubrizol Limited, Hazelwood, UK.)- U.K.

Abstract: In response to increasingly stringent emissions legislation, rapid advances in four-stroke hardware technology are leading to the development of new lubricant appetites and severities, primarily due to the motorcycle lubricant being common to the gear-box and clutch in addition to the crankcase. These changes are driving motorcycle and passenger car lubricant performance needs in different directions. Ultimately, this divergence of performance requirements may result in the need to use lubricants specifically formulated for motorcycle hardware, and a requirement for application specific performance tests. This paper describes the development of a high-performance motorcycle engine test to generate application-specific lubricant performance data, including data logging a motorcycle on a race-track, designing a test-rig to run a dynamic cycle, and finally, replicating the race severity logged cycle in the engine test. This work is presented as a first step in a series of test developments to investigate, develop and provide proof of performance……

TECHNICAL SESSION

Thursday, November 1

< Room 201B >

10:30-11:30

Lubricants (Part 2 of 2)

Chair : Ryou Yamada (Idemitsu Kosan)

Co-Chair : Michael S. Brenner (Lubrizol Corp.)

20076576/2007-32-0076 (238471)

Frictional Analysis of a Small Two-Stroke Utility Engine via Tear-Down Testing

Zaidi Mohd. RIPIN, Horizon GITANO-BRIGGS, Mohd. Zulkifly ABDULLAH (University Science Malaysia) – Malaysia

Abstract: Two stroke engines are popular power sources for ambulatory applications because of their superior power to weight ratio. Due to fuel short-circuiting however, they suffer from poor fuel economy and high levels of emissions. Small utility two-stroke engines are typically tuned rich to improve ignition stability and cooling. Additionally the presence of fuel in the crankcase requires high rates of two-stroke oil usage to insure proper lubrication. Given rising petroleum prices and concern for the environment, reducing the fuel consumption and emissions of two-stroke engines is of increasing importance. With the extreme price sensitivity of small two-stroke engines more sophisticated options such as direct fuel injection, are not possible. Instead, the best starting point for fuel consumption improvement is to insure proper carburetor tuning and lubrication of the engine and optimization of the engine's intake and exhaust tuning. For this study a typical small utility engine was mounted to a motoring dynamometer. The engine was operated at a standard speed for a given length of time with various oil/fuel ratios. Once the engine ran dry the ignition was switched off and the frictional torque was measured as the engine cooled. Frictional measurements were analyzed as a function of lubricant quantity and engine temperature. Finally friction was measured as the engine was progressively dismantled, removing the exhaust system, carburetor, spark plug, piston and connecting rod. Frictional contributions from each source were then tabulated.

20076580/2007-32-0080 (259043)

Study of Eco-Friendly Four-Cycle Motorcycle Engine Oils

Akihiro OHASHI, Masatoshi AKAGI, Mitsuaki ISHIMARU, Kazuhiro YAGISHITA, Akira YAGUCHI (Nippon Oil Corporation, Honda R&D Co., Ltd.)– Japan

Abstract: With environmental issues at the forefront of the automotive industries, there is a clear need to improve the fuel economy and longer drain performance of four-cycle motorcycle engine oils. Evaluation of oil consumption in actual engines was used to clarify an optimal volatility for engine oils, and the feasibility of using zinc dialkyl phosphate, a sulfur-free additive, as an alternative to ZDTP for improved of fuel economy performance was studied. Engine oils with optimized additives demonstrated excellent friction characteristics and wet clutch performance.

TECHNICAL SESSION

Thursday, November 1

< Room 301A >

8:30-10:00

Design & Simulation (Part 3 of 4)

Chair : Katsumi Nagai (Suzuki Motor Corporation)

Co-Chair : Roy Douglas (Queen's University of Belfast)

20076599/2007-32-0099 (240228)

Numerically Modeling the Dynamics of a Piston-Mounted Passive Inlet Poppet Valve

Greg GIBBES, Guang HONG (University of Technology Sydney (UTS), Australia)– Australia

Abstract: A 2D axissymmetric CFD model of a prototype free-piston engine has been developed using a commercial code. The dynamics of a passive inlet valve mounted on the moving piston was the main interest in the investigation. Preliminary results of cylinder and compressor pressure show good agreement with experimental pressure data for both fired and motoring conditions. Insight into the probable lift characteristics of the passive inlet valve was obtained. The CFD model achieves the simulation of complex multi-body movement through structured mesh deformation. Momentum source terms are utilized to modify flow in certain domains in the model. The paper reports the difficulty of specifying appropriate loss terms for a 2D model of 3D flow. It concludes by assessing the suitability of simplified 2D CFD to model gas dynamics. In cases where the flow departs significantly from a 2D form, either 3D CFD or 1D gas dynamics is probably a better choice

20076598/2007-32-0098 (240175)

Numerical Analysis of Combustion and Flow Inside a Small Rotary Engine for Developing an Unmanned Helicopter

Takafumi YAMADA, Yasuo MORIYOSHI (Chiba University)– Japan

Abstract: For a disaster relief and automatic inspections, an unmanned helicopter is strongly expected. To develop this, a very high power density source is required. A Wankel-type rotary engine can be the best candidate for the power source. In this study, the development of a very small rotary engine with a displacement of 30 cc is targeted. In order to improve the combustion efficiency, gas exchange and stable ignition, a multi dimensional simulation inside the combustion chamber was carried out. At first, the effect of volumetric efficiency on the maximum power is mentioned. Secondly, the effect of scavenging efficiency is discussed. Thirdly, a blow off through a plug hole is described. The position of plug hole was found important to reduce the blow off amount. Finally, the effect of combustion speed on the engine performance is predicted. As a result, the proposed design will be tested using a proto-type engine. Also, future subjects to achieve a high power density with a displacement of 30 cc will be solved by the authors' research in progress.

TECHNICAL SESSION

Thursday, November 1

< Room 301A >

10:30-12:00

Design & Simulation (Part 4 of 4)

Chair : Kazuyuki Shiomi (Honda R&D Co., Ltd.)

Co-Chair : Ryosuke Ishikawa (Suzuki Motor Corporation)

20076593/2007-32-0093 (239166)

Development Process to Optimize Design and Performance of Small Gasoline Engines

Oliver Lang, Philipp Adomeit, Peter Schmitt, Christof Tiemann (FEV Motorentechnik Gmbh) – Germany

Abstract: The further optimization of modern gasoline engines needs sophisticated development tools to meet future emission legislation and fuel consumption targets. The multi-dimensional optimization process has to take into account parameters like

- cylinder head and port flow design
- valve train variabilities (e.g. camphasers, variable valve lift systems)
- in-cylinder charge motion and interaction with mixture preparation
- resulting combustion characteristics
- naturally aspirated and boosted operating conditions

The paper presents an advanced development process, where a dedicated interaction between

- gas dynamics and CFD simulation,
- optical analysis tools (3D-PIV) and
- engine test bench

is used……

20076600/2007-32-0100 (240358)

Investigation of thermally induced die cracking for H13 High Pressure Casting dies using simulation methods

Alastair Long, David Thornhill, Cecil Armstrong (Queens University Belfast), Makoto Kurokawa and Arthur Hendry (Ryobi Aluminium Castings (UK) Ltd.) - U.K.

Abstract: Die cracking is one of the most important life-limiting tool failure mechanisms in high pressure die casting (HPDC). Cracking is caused by thermal shock from sudden heating and then cooling of the die surface. Injection of molten aluminium, transfers heat to the die which results in compressive stresses on the die surface. After the casting has been extracted, the die is sprayed with releasing agent which generates tensile stresses on the surface of the die. These stress fluctuations result in heat check cracking or gross cracking forming on the surface of the die. Casting simulation software was used to simulate the casting process; metal filling the die cavity, solidification and thermal stresses in the die. For this paper a comparison was made between a simulation analysis and a cracked die slide. When the die cracks due to thermal fatigue, aluminium penetrates into the cracks which results in visual defects being formed in the casting and will further reduce the die-life. The simulation analysis shows a good correlation between the von Mises stress and the minimum principal stresses to the cracks seen on the surface of the die. The ability to predict the extent of cracking on a HPDC die is vital when designing the die, if the heat check cracking / gross cracking can be reduced by even a small percentage, this will increase the die-life ……

TECHNICAL SESSION

Thursday, November 1

< Room 302A >

8:30-10:00

Two-Stroke Engine (Part 3 of 3)

Chair : Yuh Motoyama (Yamaha Motor Co., Ltd.)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

20076533/2007-32-0033 (240402)

Analysis of Scavenging Flow in Cross-Scavenged Two-Stroke Engine

Soichi Ishihara, Kohei Nakashima (Meijo University) - Japan

Abstract: In a cross-scavenged two-stroke engine, a piston with a deflector is often utilized to flow the fresh charge toward the cylinder head and away from the exhaust port. But flow-visualization studies have shown that the fresh charge flows toward the cylinder head even without the deflector. To find why the fresh charge flows toward the cylinder head, we used Fluent, a general purpose computational fluid dynamics (CFD) software, to simulate two- and three-dimensional flows in a cross-scavenged two-stroke engine. While the fresh charge entered from the scavenging port into the cylinder and flowed across the cylinder, we investigated the instantaneous fresh charge flow, velocity, and pressure distribution in the cylinder. Results indicated that the fresh charge was forced toward the cylinder head by the "variable pilot vortex," that is the vortex formed above the fresh charge flow, and by the "variable deflect pressure," that is the higher pressure field formed……

20076524/2007-32-0024 (238451)

LPG Direct Injection: An Alternative Fuel Solution to the Two-Stroke Emissions Problem

Horizon Walker Gitano-Briggs, Yew Heng Teoh, Chang Yew Sew (University Science Malaysia) - Malaysia

Abstract: Despite high fuel consumption and poor emissions two-stroke engines are a popular power source in developing countries due to their high power to weight ratio and low cost. To meet more rigid emissions requirements some manufacturers have switched from carburetion to Direct fuel Injection (DI). DI greatly reduces the emissions while simultaneously improving fuel economy. An alternative to this is the direct injection of a gaseous fuel such as Compressed Natural Gas (CNG) or Liquid Petroleum Gas (LPG), both of which may cost less than the equivalent amount of gasoline. A gaseous fuel DI system may also cost less than an air-assisted gasoline DI system as the gaseous system does not require a fuel pump, air pump or liquid fuel injector. In this paper we compare gasoline and premixed LPG as an alternative fuel for retrofit application to a 110cc two-stroke motorcycle. Engine performance, emissions and fuel consumption are measured……

20076531/2007-32-0031 (240116)

Effect of Fuel injection Rate on the Performance of a 2-Stroke CNG Spark-Ignition Engine with Scavenging-Port Injection

Hiroshi Nakamura (Gunma University), Takenori Fukushima (Mitsuba Co., Ltd.), Hideo Kishimoto (Yamato Motor Co., Ltd.), Mikiya Araki, Seiichi Shiga, Hisao Nakamura, Tomio Obokata (Gunma University) - Japan

Abstract: The most serious problem in a 2-stroke spark-ignition engine is poor trapping of fresh charge. To solve this problem, a scavenging-port injection was applied, and a fuel injection pipe (FIP) was installed at the injector tip. In a previous study, it was shown that the BSFC and emission characteristics were drastically improved. In the present study, effect of increase in the fuel injection rate was investigated. It is shown that the BSFC and the THC emissions improved at high engine speeds, while they slightly deteriorate at low engine speeds. The increase in the fuel injection rate is effective particularly at high engine speeds, where the scavenging duration becomes shorter.

TECHNICAL SESSION

Thursday, November 1

< Room 302A >

10:30-12:00

Collegiate Events (Part 3 of 3)

Chair : Mikio Kato (Honda R&D Co., Ltd.)

Co-Chair : Jay S. Meldrum (Michigan Technological University)

20076613/2007-32-0113 (237926)

A Study on Intake and Exhaust System of Turbocharged Engine under the Regulations of Formula SAE

Syuhei Yamamoto, Shinya Matsumoto, Takeshi Ueda, Tomoaki Kodama, Yasuhiro Honda, Katsuhiko Wakabayashi (Kokushikan University) – Japan

Abstract: Formula SAE is one of the competitions of the manufacturing education for students, which is held by SAE. The competition consists of the static events and the dynamic events. The static events have three competitions of presentation, cost and design, and the dynamic events are acceleration, skid pad, autocross and endurance with fuel consumption. To get the higher rank in this competition, we must win the dynamic events with the high allotment points. For the purpose of the winning, we should have some advantages more than the other universities. We aimed at raising engine power and drivability. There are some ways to get engine power up such as the combustion improvement, the change of the cam profile and supercharging. We tried to install a commercial turbocharger to a normal aspirated multi-cylinder engine for Formula SAE under the SAE regulations. As the throttle and air restrictor must be located at upper streamside of the intake system, the piping from the exhaust manifold to the turbocharger is designed in order not to flow fuel into the turbocharger. Furthermore, we redesigned the intake air collector and the air restrictor in consideration of installation of the turbo charger to the standard engine. We considered sufficiently the results of the simulations using VES (Virtual Engine Simulation) and CFD (Computational Fluid Dynamics) simulation methods and verified them by the results of the experiments. As a result, we succeeded getting the higher engine performance by turbo charging than the normal engine, and the turbocharged engine can perform the higher and flat torque in the lower engine speed range, 5000r/min to 8000r/min. We made a Formula SAE vehicle that everyone can drive fast.

20076614/2007-32-0114 (233142)

Development of Snowmobile Technology for Operation on High-Blend Ethanol

Gregory W Davis, Jason Sanger, Brian Schickel (Kettering University) - U.S.A.

Abstract: Kettering University has developed a cleaner and quieter snowmobile using technologies and innovative methods which can be applied in the real world with a minimal increase in cost. Specifically, a commercially available snowmobile using a two cylinder, four-stroke engine has been modified to run on high-blend ethanol (E-85) fuel. Further, a new exhaust system which features customized catalytic converters and mufflers to minimize engine noise and exhaust emissions has developed. A number of additional improvements have been made to the track to reduce friction and diminish noise. This paper provides details of the snowmobile development the results of these efforts on performance and emissions. Specifically, the Kettering University snowmobile achieved reductions of approximately 72% in CO, and 98% in HC+NOx when compared with the 2012 standard. Further, the snowmobile achieved a drive by noise level of 73 dbA while operating on hard packed snow.

20076622/2007-32-0122 (240405)

The Development of Small Formula-Style Racing Car in Osaka university Formula RAcing Club

Junichi Fukui, Ryota Takahashi, Shingo Sasaki, Jun Aono, Shinichi Okunishi, Hajime Takeshita, Tatsuya Keida, Go Inoue, Kenji Yoshida, Fumiteru Akamatsu (Osaka University) – Japan

Abstract: A fuel supply system and characteristics of CVT (Continuously Variable Transmission) were changed to get better dynamic performance of an engine and axle output, respectively. A fuel supply system were changed from carburetor to fuel injection to improve an engine power. Engine power and torque with fuel injection system were higher than that with carburetor system by approximately 19% and 21%, respectively. In the power transmission system, the effect of spring constant of pressure spring and weight of flyweight on engagement speed and shift speed were investigated to improve an acceleration performance. Engagement speed and shift speed were higher as spring constant of pressure spring increases and weight of flyweight decreases, respectively.

TECHNICAL SESSION

Thursday, November 1

< Room 302B >

8:30-10:00

Vehicle Dynamics & Safety (Part 2 of 3)

Chair : Taro Sekine (Nihon University)

Co-Chair : Jeff J. White (Southwest Research Institute)

20076606/2007-32-0106 (236991)

Basic Research for Motorcycle Crashworthiness and a New Airbag System

Motoaki Deguchi, Shoji Kanbe, Yousei Hannya (Yamaha Motor Co., Ltd.) - Japan

Abstract: The computer simulation on motorcycle crashworthiness has been introduced to develop and evaluate a new airbag system for motorcycle. We chose MADYMO (multi-body dynamics) and PAM-SAFE (finite element method) for the basic simulation software. In addition to using these computer simulation tools, several full-scale tests were performed. This new airbag system has some features that are newly developed for motorcycle. This system has been shown to be promising by some simulations and tests. However there are still many technical issues to be investigated and solved in order to put the system to practical use. One of the most important issues is to investigate the effectiveness of the system in various collision configurations. (ISO13232, which stipulates research evaluation methods for motorcycle rider protective devices, requires 200 configurations of collision simulation for evaluating risk/benefit factors.)

20076609/2007-32-0109 (239624)

Vehicle Handling Comparison of Motorcycles and Bebek Vehicles

Venkata Mangaraju Karanam, Shivalik Ghosh, Anand Rb, Babu R, Venkatesan R (TVS Motor Company) - India

Abstract: Bebek is a category of step thru vehicles used predominantly in the South East Asian market. Bebek vehicle feels light in handling (more responsive) compared to the motorcycles but cannot afford to have stability problem even at 100 kmph. By virtue of certain design aspects, these Bebeks seem to have reduced level of trade-off between low speed responsiveness and high-speed stability, in contrast to the motorcycles. In an attempt of explore the reasons for this difference, a detailed and comprehensive comparative handling study of both Bebek and motorcycles is presented in this paper. The comparison of geometrical and Structural flexibility study is done. A multi body dynamic model is built for both configurations with thirteen kinematic degrees of freedom. The models are validated with experimental results and used to study the handling behaviour of both the vehicles. The key parameters that made Bebek vehicle handling different from motorcycle are identified through simulation on various tracks. These key parameters can be used to do parametric study to optimize vehicle handling upfront during product development.

20076608/2007-32-0108 (239292)

Enhancement of Motorcycle Seat Comfort Using 3D Mesh Cushion of Thermoplastic Elastomer

Mitsue Koyano, Tsutomu Takeuchi, Takeshi Ohara, Motoharu Yokoi (Honda R&D Co., Ltd. Motorcycle R&D Center) - Japan

Abstract: To reduce pain in buttocks while sitting on and riding a motorcycle over a long period, a 3D mesh cushion of thermoplastic elastomer (hereinafter referred to as “3D mesh cushion”) was used to develop a double layered seat cushion that would correspond to a cushioning action (the motion of the seat cushion, in response to impact from the road) and that would exhibit superior performance over time (deterioration of seat cushion). In addition, to clarify the differences in performance between the 3D mesh cushion and a conventional polyurethane foam cushion (hereinafter referred to as “foam cushion”), a ride comfort testing machine was fabricated to reproduce riding conditions, and evaluation methods were established for sensing the cushioning action of the seat in the low frequency range during comfort evaluation testing and for assessing seat cushion deterioration. The 3D mesh cushion and the foam cushion were compared using above-mentioned evaluation method. As a result, it was clarified that the cushioning action and the cushion deterioration of the 3D mesh cushion were improved, and the 3D mesh cushion effectively reduced pain in buttocks.

TECHNICAL SESSION

Thursday, November 1

< Room 302B >

10:30-11:30

Vehicle Dynamics & Safety (Part 3 of 3)

Chair : Akira Hasegawa (Yamaha Motor Co., Ltd.)

Co-Chair : Nagesh S. Mavinahally (Techtoronic Industries NA, Inc.)

20076610/2007-32-0110 (239672)

An Innovative Measurement System for Measuring Dynamic Wheel Forces and Moments of a Two-Wheeler

Karthikeyan Srinivasan, Rakesh Mk, Babu R (TVS Motor Company), H B Pacejka (Delft University of Technology) - India

Abstract: Tyres are the primary contact between the vehicle and the road. It serves as the medium of communication between the road and the rider, which it does in terms of road loads and displacements. Therefore, measurement of dynamic wheel forces experienced by a two-wheeler is crucial for tuning the ride and handling characteristics of the vehicle. Currently, there are standard wheel force transducers available in the market, which are extensively used in cars. However, mass of such a system is relatively high to be used on two-wheelers. Special wheels and adaptors increase the unsprung mass considerably, which changes the dynamics of the vehicle. Moreover, cost of such systems is exorbitantly high to be used for two-wheelers. This paper describes the development of an innovative and a highly versatile and low-cost alternative method for real-time measurement of dynamic wheel loads and moments of a two-wheeler when compared with the currently available systems in the market. The measurement system has a relatively simple architecture, which comprises of standard tri-axial load transducers fitted between the front fork and wheel assembly of the motorcycle. The simple architecture of the system makes it highly cost effective when compared to systems available in the market. The transducers were integrated with a standard data acquisition system to measure wheel forces and moments on a vehicle operating at different road conditions and the findings are presented. Possible future applications of the system have been identified and presented.

20076623/2007-32-0123 (239904)

Optimal Motorcycle Configuration with Performance Limitations

Moriyuki Sakamoto, Sadao Kubo, Tetsuya Kubota, Tadashi Inukai, (Kawasaki Heavy Industries, Ltd.)

Eiichi Yagi (Wakayama University) – Japan

Abstract: Motorcycle configurations, such as CG (center of gravity) location, have come to be fixed to the current ones by trial and error since motorcycle was born. Generally motorcycles' ratio of CG height to wheelbase is relatively higher than four-wheel cars'. We have analyzed the optimal motorcycle CG location with relatively simple formulas, which we have derived to calculate the maximum acceleration with three performance limitations and calculate the maximum speed and the shortest time to run through a course. The results show that the calculated speed is significantly close to actual sport motorcycle's and that the optimal CG locations for various courses are bounded in a certain limited area which is near actual sport motorcycle's.