Motorcycles

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1) Yamaha Motor

Overall Trends

1 Introduction

Japanese motorcycle production in 2012 fell by 6% to 595,000 units. Although increasing on a global basis, production within Japan is contracting because growth is centered in India and other emerging markets, and because Japanese manufacturers are continuing to shift production outside Japan.

Motorcycle shipments inside Japan in 2012 were virtually unchanged, falling slightly to around 400,000 units. The trend for the last two years indicates a bottoming out in the recent decline in shipments.

2 Production and Demand

2. 1. Production

As shown in Fig. 1, Japanese motorcycle production in 2012 fell by approximately 6% to 595,000 units. Exports also fell by approximately 6% to 470,000 units.

2. 2. Demand in Japan

Fig. 2 shows motorcycle demand in Japan based on engine displacement. There was a slight negative rebound from the increase in demand after the Great East Japan Earthquake, resulting in lower demand for class 1 and 2 motor-driven cycles. In contrast, demand for mini- and small-sized motorcycles increased from the previous year due to the launch of new models. Overall, demand remained virtually unchanged at 400,000 units (99.3% of last year).

2. 2. 1. 50cm^3 displacement motorcycles (class 1 motor-driven cycles)

In 2012, demand for this class fell by 4.3% to 246,000 units from the previous year. However, this is 6.5% higher than the level in 2010. Considering the fact that the figures for 2011 were boosted by a recovery in demand after the Great East Japan Earthquake, the results for 2012 indicate that the trend for falling demand since 2008 has bottomed out.

2. 2. 2. 51 to 125cm^3 displacement motorcycles (class 2 motor-driven cycles)

In 2012, demand for this class fell by 5.3% to 90,000 units. However, it is hoped that demand for motorcycles in this class will increase in the future due to advantages

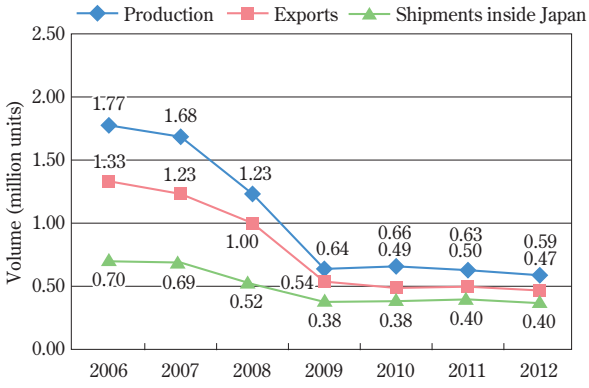

Fig. 1 Trends for production, exports, and shipments inside Japan.

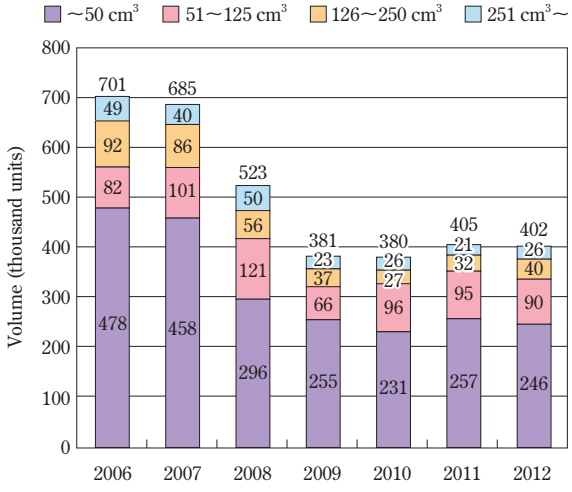

Fig. 2 Shipments inside Japan based on displacement.

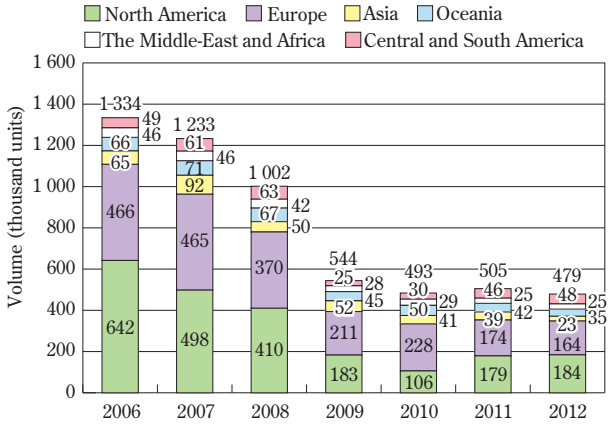

Fig. 3 Shipments per market.

such as low maintenance costs and favorable regulatory requirements.

2. 2. 3. 126 to 250cm^3 displacement motorcycles (mini-sized motorcycles)

In 2012, demand for this class increased by 25% to 40,000 units. Continuing the trend of the previous year, sales increased for the second successive year due to strong sales of new models produced outside Japan.

2. 2. 4. 251cm^3 or higher displacement motorcycles (small-sized motorcycles)

In 2012, demand for this class increased by 23.8% to 26,000 units. Demand recovered from the substantial 20% decrease of the previous year and returned to the same level as in 2010.

2. 3. Exports

As shown in Fig. 3, motorcycle exports in 2012 fell by 6% to 470,000 units. Although exports to North America recovered, there was a large fall in exports to Asia, partly due to the effect of financial policies in Indonesia.

2. 3. 1. North America

In 2012, exports to North America increased by 3% to 184,000 units. This was the second successive yearly increase and indicates that the export market is recovering. However, since exports remain at less than half the level of 2007, this result cannot be described as a fundamental recovery.

2. 3. 2. Europe

In 2012, exports to Europe fell by 6% to 164,000 units. Exports have fallen to roughly one-third of the level in 2007 (465,000 units) and there is no prospect of recovery as the European credit crisis continues.

2. 3. 3. Asia

In 2012, exports to Asia fell by 41% to 23,000 units. Exports were severely affected by financial tightening policies in the region, such as new credit regulations in Indonesia.

2. 3. 4. Oceania

In 2012, exports to Oceania fell by 17% to 35,000 units.

2. 3. 5. The Middle-East and Africa

In 2012, exports to the Middle-East and Africa remained unchanged at 25,000 units.

2. 3. 6. Central and South America

In 2012, exports to Central and South America increased by 4% to 48,000 units.

3 Design Trends

Centering on large sporty models, the development of individualistic structural designs with an emphasis on brand image is becoming a prominent trend. Various methods of expressing high-quality and precise feelings are being adopted, including elaborately shaped and colored component parts, as well as finely detailed functional parts. For medium displacement models, manufacturers are developing motorcycles in multiple categories using the same platform. As a result, design trends are becoming noticeable across categories.

In American-styled motorcycles, there is a growing trend for coloring schemes that express a strong degree of craftsmanship. In addition to conventional American-style tastes, designs that express tough and simple material textures are becoming more widespread.

4 Product and Technological Trends

4. 1. Product trends

Table 1 lists some representative models of motorcycles launched in Japan in 2012. The trend for commonization of body and engine platforms and the development of models in multiple categories has spread from the small-sized motorcycle class to larger displacement models. Following recent trends, various global models produced outside Japan were launched in the 250 cc and under class.

4. 2. Technological trends

Each manufacturer is continuing to focus on improving fuel efficiency through combustion and other basic technologies. From the standpoint of safety technology, motorcycles equipped with ABS are becoming more widespread in ASEAN nations and other emerging markets in addition to developed markets as the number of global models increases. This trend also reflects regulations in Europe to make ABS installation mandatory. In

Table 1 Details of main new motorcycles launched in 2012.

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
January		○	Yamaha	XVS400 Dragstar/XVS400C Dragstar Classic	Water-cooled/4-stroke/V2/SOHC/2-valve/FI
		○	Suzuki	RM-Z450	Water-cooled/5-stroke/single-cylinder/DOHC/4-valve/FI
		○	Honda	CB400 SUPER FOUR／CB400 SUPER BOL D'OR	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Honda	VT750S	Water-cooled/4-stroke/V2/OHC/3-valve/FI
		○	Honda	VT1300CX／CR／CS_VT1300CX／CR／CS〈ABS〉	Water-cooled/4-stroke/V2/OHC/3-valve/FI
		○	Honda	Shadow (750)/Shadow (750) ABS/Shadow Phantom (750)	Air-cooled/4-stroke/V2/SOHC/2-valve/FI
		○	Honda	CB1300 series	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	Address V125S	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Today/Today F	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Giorno/Giorno Sport	Air-cooled/4-stroke/single-cylinder/OHC/FI
		○	Suzuki	Address V125S Limited	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Address V50	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	SR400	Air-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	SEROW250	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Skywave 250 Type M/Type SS/Type S Basic/Limited	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	Skywave 400 Limited ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Honda	Benly 110/Benly	Air-cooled/4-stroke/single-cylinder/OHC/FI
February		○	Honda	Forza Z Special Edition	Water-cooled/4-stroke/single-cylinder/OHC/4-valve/FI
		○	Honda	Faze/Faze ABS/Faze TYPE-R	Water-cooled/4-stroke/single-cylinder/OHC/4-valve/FI
		○	Honda	ZOOMER	Air-cooled/4-stroke/single-cylinder/OHC/FI
		○	Honda	CBR1000RR race bace motorcycle	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	CBR600RR race bace motorcycle	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	Monkey/Monkey Limited	Air-cooled/4-stroke/single-cylinder/OHC/FI
		○	Yamaha	VOX XF50/VOX XF50D	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Vino XC50D	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Honda	VTR	Water-cooled/4-stroke/V2/DOHC/4-valve/FI
		○	Suzuki	Address V50	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Benly	Air-cooled/4-stroke/single-cylinder/OHC/FI
	○		Honda	NC700X/NC700X〈ABS〉	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
		○	Honda	CB1100/CB1100 BLACK STYLE	Air-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	Let's 4 Basket	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	Majesty YP250	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	YZF-R1 WGP50th Anniversary Edition	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	Cygnus-X XC125SR WGP50th Anniversary Edition	Air-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	MAXAM CP250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	GSX-R1000L2 race bace motorcycle	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	GSX-R600L2 race bace motorcycle	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
March		○	Kawasaki	D-TRACKER125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	W800 Special Edition	Air-cooled/4-stroke/parallel 2-cylinder/SOHC/4-valve/FI
		○	Kawasaki	KLX125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	VFR1200 F/Dual Clutch Transmission	Water-cooled/4-stroke/V4/OHC/4-valve/FI
		○	Yamaha	YZF-R1 race bace motorcycle	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZF-R6 race bace motorcycle	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	XP500 T-MAX	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Yamaha	XVS250 Dragstar	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	YZF-R1	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Honda	Supercub 110	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
		○	Suzuki	ST250 E Type	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Skywave400 Type S ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	Gladius 400 ABS	Water-cooled/4-stroke/V2/DOHC/4-valve/FI
		○	Suzuki	Bandit 1250 F ABS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
April		○	Kawasaki	Ninja 250R	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Yamaha	Vino XC50	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
	○		Honda	NC700S／NC700S〈ABS〉	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
	○		Honda	Integra	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
		○	Suzuki	Let's 4	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Gladius 400 ABS	Water-cooled/4-stroke/V2/DOHC/4-valve/FI
May		○	Honda	PCX	Water-cooled/4-stroke/single-cylinder/OHC/FI
	○		Honda	CRF250L	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	Skywave 650LX	Water-cooled/4-stroke/2-cylinder/DOHC/4-valve/FI
	○		Honda	Supercub 50	Air-cooled/4-stroke/single-cylinder/OHC/FI

Table 1 Details of main new motorcycles launched in 2012 (continued).

June	○		Honda	PCX150	Water-cooled/4-stroke/single-cylinder/OHC/FI
	○		Honda	NC700S Dual Clutch Transmission〈ABS〉	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
	○		Honda	NC700X Dual Clutch Transmission〈ABS〉／NC700X TypeLD	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
		○	Suzuki	Address V125	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	WR450F	Water-cooled/4-stroke/single-cylinder/DOHC/5-valve/FI
July		○	Kawasaki	KLX110L	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve
		○	Kawasaki	Ninja 250 R Special Edition	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	ESTRELLA	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	KX450F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	KX250F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	KX85	Water-cooled/2-stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX85-Ⅱ	Water-cooled/2-stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX65	Water-cooled/2-stroke/single-cylinder/piston reed valve
		○	Suzuki	Bandit 1250F ABS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	Bandit1250S ABS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	Axis Treet XC125E	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	250TR	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	YZ450F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250F	Water-cooled/4-stroke/single-cylinder/DOHC/5-valve/FI
		○	Yamaha	YZ85／YZ85LW	Water-cooled/2-stroke/single-cylinder/crankcase reed valve
August	○		Suzuki	GSR250	Water-cooled/4-stroke/2-cylinder/SOHC/4-valve/FI
		○	Kawasaki	W800 Chrome Edition	Air-cooled/4-stroke/parallel 2-cylinder/SOHC/4-valve/FI
		○	Kawasaki	VULCAN 900Classic	Water-cooled/4-stroke/V2 /SOHC/4-valve/FI
		○	Suzuki	Vanvan 200	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Gemma	Air-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	TOURING SERROW	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	WR250R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	ST250E Type	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
September		○	Kawasaki	KLX125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	D-TRACKER125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Supercub 50 Pro	Air-cooled/4-stroke/single-cylinder/OHC/FI
		○	Honda	Supercub 110 Pro	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
		○	Suzuki	Address V125S	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	YZ125	Water-cooled/2-stroke/single-cylinder/crankcase reed valve
October		○	Yamaha	BW'S	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Kawasaki	Ninja 400R／Ninja 400R ABS	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	ER-4n ／ ER-4n ABS	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Honda	CRF250R	Water-cooled/4-stroke/single-cylinder/OHC/4-valve/FI
	○		Honda	CRF450R	Water-cooled/4-stroke/single-cylinder/OHC/4-valve/FI
		○	Kawasaki	W800／W800 Special Edition	Air-cooled/4-stroke/parallel 2-cylinder/SOHC/4-valve/FI
November		○	Kawasaki	D-TRACKER X	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	KLX250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	RM-Z250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Honda	CB1300 SUPER FOUR〈ABS〉 Special Edition	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Honda	CB1300 SUPER BOL D'OR〈ABS〉 Special Edition	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Honda	CB400 SUPER FOUR Special Edition	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Honda	CB400 SUPER BOL D'OR Special Edition	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Honda	CBR250R／ CBR250R Special Edition	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Honda	CBR1000RR／ CBR1000RR Special Edition	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	CBR1000RR<ABS>／ CBR1000RR<ABS> Special Edition	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	VFR1200F／ VFR1200F Dual clutch Transmission	Water-cooled/4-stroke/V4 /OHC/4-valve/FI
December		○	Kawasaki	ZRX1200 DAEG/ZRX1200 DAEG Z 40th anniversary edition	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Ninja 400R Special Edition	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Honda	PCX Special Edition	Water-cooled/4-stroke/single-cylinder/OHC/FI
		○	Honda	Goldwing/Goldwing (airbag/navigation system)	Water-cooled/4-stroke/horizontally opposed 6-cylinder/OHC/FI
		○	Suzuki	Let's 4	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	CRF250L Special Edition	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	AddressV125 S Limited	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Address V 50	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI

addition, the development of technologies to reduce the burden on the rider and enhance comfort, such as dual clutch transmissions, is also advancing.

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Engines

1 Technological Trends in Japan

1. 1. Overview

Table 1 shows the new engines launched by each manufacturer in Japan in 2012. Only a few of the models with newly developed or improved engines for 2012 have been launched for particular regions. Most new models have been developed under the assumption of global release.

1. 2. Trends of each manufacturer

(1) Honda Motor Co., Ltd.

(i) VFR1200F Dual Clutch Transmission: This motorcycle is installed with a 1,236 cm^3, water-cooled, 4-stroke, OHC, 4-valve, V4 engine. The valve timing was optimized by modifying the camshaft. A refined ride was achieved by maintaining maximum power while improving torque at low and medium engine speeds, which is frequently required for riding in urban areas and touring. Fuel efficiency is 24.0 km/L (test value at steady speed of 60 km/h), creating an excellent balance between dynamic and environmental performance. The dual clutch transmission (DCT), which allows the rider to enjoy a refined and sporty ride with simple operation, achieves high speed shift control in manual transmission (MT) mode to greatly expand riding enjoyment. The automatic transmission (AT) mode improves usability with a new function that automatically resets the transmission to AT mode at the optimum timing while driving in accordance with the driving state, without having to operate the shift up/down function switch. The motorcycle adopts a new traction control system (TCS) that provides stability even on slippery unpaved roads and wet road surfaces. The system ECU calculates the rear wheel slip ratio during driving using signals from vehicle speed sensors at the front and rear wheel. At or above a predetermined slip ratio, engine torque is optimized using throttle-by-wire and fuel injection (FI) control to suppress wobbling of the body. Fig. 1 shows the external appearance of this motorcycle.

(ii) PCX150: The PCX150 is installed with a 152 cc, water-cooled, 4-stroke, single-cylinder engine, which is part of the eSP global engine series. Friction was thoroughly reduced through the use of offset cylinders, roller rocker arms, and shell-type needle bearings on the rocker arm shaft, in addition to intelligent power generation control.

Fig. 1 External appearance of VFR1200F Dual Clutch Transmission.

Table 1 Specifications of new engines in 2012.

Manufacturer	Name of model	Engine type	Displacement (cm^3)	Bore (mm)	Stroke (mm)	Maximum power (kW/rpm)	Maximum torque (Nm/rpm)
Honda	VFR1200F Dual Clutch Transmission	Water-cooled/4 -stroke/V4 /OHC-4	1 236	81.0	60.0	82.0/7 500	120.0/5 500
	PCX150	Water-cooled/4 -stroke/single-cylinder/OHC	152	58.0	57.9	9.9/8 500	14.0/5 500
	Benly 110	Air-cooled/4 -stroke/single-cylinder/OHC	107	55.0	55.0	5.8/7 000	8.6/5 000
Yamaha	YZF-R1	Water-cooled/4-stroke/inline 4/DOHC-4	997	78.0	52.2	107/11 000	99/10 000
	Soul GT (model for outside Japan)	Air-cooled/4-stroke/single-cylinder/SOHC-2	114	51.5	60.0	5.7/8 500	8.5/5 000
Suzuki	GSR250	Water-cooled/4-stroke/2-cylinder/SOHC-2	248	53.5	55.2	18.0/8 500	22.0/6 500
	V-Strom650	Water-cooled/4-stroke/V2/DOHC-4	645	81.0	62.6	49.0/8 800	59.0/6 500
Kawasaki	Ninja 250 (model for outside Japan * Indonesian specifications)	Water-cooled/4-stroke/parallel 2-cylinder/DOHC-4	248	62.0	41.2	23.5/11 000	21.0/8 500
	Z800 (model for outside Japan)	Water-cooled/4-stroke/parallel 4-cylinder/DOHC-4	806	71.0	50.9	70.0/9 500	76.0/8 000

Fig. 2 External appearance of PCX150.

In combination with the PGM-FI system, which optimizes fuel supply, the PCX150 achieves fuel efficiency of 49.0 km/L (test value at steady speed of 60 km/h). This motorcycle was also designed to emphasize environmental consideration through an idling stop system that automatically stops the engine at traffic signals, in congestion, and the like, as well as by reducing wasteful fuel consumption and lowering emissions. At the same time, the engine has more than sufficient power at all engine speeds. Fig. 2 shows the external appearance of this motorcycle.

(iii) Benly: The Benly is installed with a 107 cc, air-cooled, 4-stroke, OHC, single-cylinder engine, which uses a super-wide belt-type continuously variable transmission to achieve strong torque characteristics at low and medium engine speeds. The Benly also uses a clutch-less AT for simple operation. Due to fuel supply optimization by the PGM-FI system, it achieves fuel efficiency of 53.0 km/L (test value at steady speed of 60 km/h). Usability is improved by a combination of a high-capacity 10-liter fuel tank, which reduces time-consuming refueling, and other advantages such as excellent cold-startability. Fig. 3 shows the external appearance of this motorcycle.

(2) Yamaha Motor Co., Ltd.

(i) YZF-R1: The YZF-R1 is installed with a 997 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, inline 4-cylinder engine. This engine features a cross-plane crankshaft with neighboring crank pins positioned at a 90° phase to reduce fluctuations in inertia torque generated by changes in the rotation of the crankshaft. The driving force of the engine closely matches the throttle operation, achieving linear traction characteristics.

The 2012 model also features TCS, which provides optimum support for accelerator operations at start and while accelerating on wet road surfaces, unpaved roads, and the like. The TCS ECU uses the difference between vehicle speeds at the front and rear wheel to calculate the slip state of the rear wheel. If a slip is detected, the system performs integrated control of the ignition timing, injection quantity, and throttle opening angle to optimize the drive force at the rear wheel. The operation characteristics of the TCS are designed to be unobtrusive to prevent unnatural or uncomfortable sensations. The degree of TCS intervention can be set to seven stages (including OFF) in accordance with rider preference, the state of the road surface, and so on. As the Yamaha D-MODE system allows the rider to select from three riding modes, this enables a total of 21 (7 × 3) selectable control patterns. By combining the opening angle of the electronically controlled throttle (YCC-T), FI, and optimized ignition timing control maps, the YZF-R1 achieves excellent starting characteristics, better control in low and medium engine speed regions, and improved fuel efficiency. Fig. 4 shows the external appearance of this motorcycle.

Fig. 3 External appearance of Benly.

Fig. 4 External appearance of YZF-R1.

(ii) Soul GT (model for outside Japan): The Soul GT is installed with a 114 cm^3, air-cooled, 4-stroke, SOHC, 2-valve, single-cylinder engine. This engine features an improved FI system (YM-JET FI), which controls the

Fig. 5 External appearance of Soul GT.

Fig. 6 External appearance of GSR250.

mass of air in the sub-passages provided near the injectors. The overall FI system has also been reduced in size by specially designing it for a small displacement engine. Combustion efficiency has been improved by strengthening the in-cylinder flows through the FI improvements, increasing the compression ratio, narrowing the installation angle of the intake and exhaust valves, and improving cooling performance by adopting Yamaha's DiASil cylinder. Friction was reduced by adopting low-tension piston rings and roller rocker arms, as well as by lowering the engine speed by optimizing the cam profile and overlap. In addition, a newly developed single-phase AC/DC open control system and surplus power control reduces both the engine drive losses of the generator and battery weight. Body weight was lowered by revising the frame materials, reducing the size of brackets, and the like. This approach achieved greatly improved and class-leading fuel efficiency. Fig. 5 shows the external appearance of this motorcycle.

(3) Suzuki Motor Corporation

(i) GSR250: The GSR250 is installed with a 248 cm^3, water-cooled, 4-stroke, SOHC, 2-valve, inline 2-cylinder. It is positioned as a global model produced in China and for release in Japan. The long-stroke (53.5×55.2 mm) engine is mated with a 6-speed transmission with excellent acceleration performance. The power characteristics of the engine are particularly easy-to-use at low and medium engine speeds (around 4,000 rpm), which are frequently used when riding in urban areas and when touring. Vibration is reduced by the installation of a coupling balancer to the 180°-phase crankshaft, achieving a comfortable ride and silent operation. The engine also uses a FI system. Precise combustion control enables excellent starting, fuel efficiency, and environmental performance. At the same time, it also improves the throttle response. An engine speed indicator was added to the meter cluster with a light that blinks at engine speeds between 4,500 and 6,000 rpm and turns fully on at engine speeds above 6,000 rpm in ECO mode. This encourages the rider to drive economically. In normal mode, the light turns on at 8,000 rpm. Fig. 6 shows the external appearance of this motorcycle.

(ii) V-Strom650 ABS: This motorcycle is installed with a 645 cm^3, water-cooled, 4-stroke, DOHC, V2 engine. This engine features a wide power band, which was achieved by changing the cam profile to increase torque in low and medium engine speed regions to improve usability, and by allowing smooth transitions to higher engine speed regions. The engine also adopts the Throttle-body Integrated Speed Control (TI-ISC) system. While reducing size and weight, this system improves stability on cold starts and the like and reduces emissions at start. Featuring a high-speed (32-bit) CPU, it determines the FI quantity from the engine speed, negative intake pressure, and throttle position to achieve precise combustion control. This system improves fuel efficiency under the Worldwide Harmonized Motorcycle Emissions Certification Procedure (WMTC) by 10% (source: Suzuki). As well as improving fuel efficiency, this also allows the fuel tank capacity, which helps to create a slimmer body and improves agility and usability. In addition, air flow guides were added to the radiator to help improve cooling performance and rider comfort. Fig. 7 shows the external appearance of this engine.

(4) Kawasaki Motors Corporation

(i) Ninja 250: The Ninja 250 is installed with a 248 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. Innovations were adopted for main parts of the engine such as the crankcase, lightweight alumite-coated pistons, and large oil pan. As a result, this model fea-

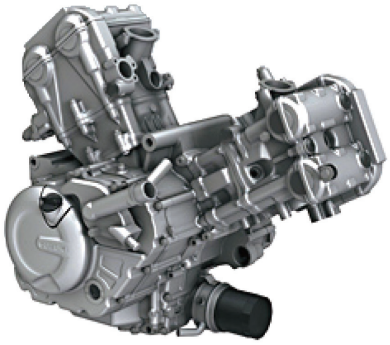

Fig.7 External appearance of V-Strom650 ABS engine.

Fig. 8 External appearance of Ninja 250 engine.

tures improved torque in low and medium engine speeds compared to the previous model. The engine features open-deck type, sleeveless aluminum die-cast cylinders with coated inner walls. These cylinders are both highly durable and lightweight and also help to improve cooling efficiency. The engine also features dual throttle valves. Precise control of the intake air increases combustion efficiency and, in combination with a FI system, the engine allows both improved dynamic performance and fuel efficiency. The engine response is linear and natural at all engine speeds. At low and medium engine speeds, the motorcycle is smooth and full of torque. At high engine speeds, the engine can be revved strongly, creating an exciting, and powerful feel that is easy-to-use in both touring and everyday applications.

Engine vibration was reduced by the partial use of rubber engine mounts. The engine also features advanced heat management through the use of a fan cover that transfers hot air that has passed through the radiator to the bottom of the engine. This measure helps to improve rider comfort. Fig. 8 shows the external appearance of this engine.

Fig. 9 External appearance of Z800 engine

(ii) Z800 (model for outside Japan): The Z800 is installed with an 806 cm^3, water-cooled, 4-stroke, 4-valve, inline 4-cylinder, DOHC, 16-valve engine. Engine displacement was increased from 748 cm^3 in the previous model to 806 cm^3. The use of 34 mm throttle bodies with sub-throttle valves and highly atomizing injectors creates easy-to-use and smooth engine characteristics. The engine uses newly designed coated aluminum die-cast cylinders. In combination with a switch to the open-deck style, the weight of the engine was reduced by 1 kg. Adopting short skirt pistons enabled the bore diameter to be increased while reducing weight by 10%. These measures helped to reduce the inertial mass of the engine. While maximizing length, the No. 1 and No. 4 and the No. 2 and No. 3 exhaust pipes were consolidated to improve performance at practical engine speeds. A new layout was designed that eliminates the center pipe and sets the silencer downstream of the manifold. This layout helps to concentrate the mass of the motorcycle and improves handling. Fig. 9 shows the external appearance of this engine.

2 Trends outside Japan

2. 1. BMW

C600 Sport: The C600 Sport is installed with a newly developed 647 cm^3, 4-stroke, parallel 2-cylinder, 4-valve engine that achieves maximum power of 44 kW (60 PS) at 7,500 rpm and maximum torque of 66 Nm at 6,000 rpm. The crankpins are offset by 90° and combustion takes place at 270° intervals. In addition, the cylinders are tilted by 70° to the front, reducing the center of gravity. The drive system of the C600 Sport is a chain-drive CVT that achieves smooth and comfortable acceleration.

2. 2. Ducati

Multistrada 1200: The Multistrada 1200 is installed with a newly designed water-cooled, 1,198 cm^3, L-shaped 2-cylinder, 4-valve, desmodromic engine called the Testastretta 11° DS. Maximum power is 110.3 kW (150 HP) at 9,250 rpm and 124.5 Nm at 7,500 rpm. Although these maximum power figures are the same as the previous generation, torque has been increased by more than 4%. This engine newly features a dual spark system with two spark plugs in each cylinder to shorten the combustion period. The injectors are installed on the back surface of the high-temperature intake valves to increase the speed of fuel gasification and to improve combustion stability. This engine also uses a similar secondary air system to that already adopted on other Ducati motorcycles. Ensuing that clean air passes into the exhaust duct accelerates the oxidation of unburned gases and reduces the amount of hydrocarbon/carbon monoxide emissions.

3 Research Trends

India and other emerging markets with expanding motorcycle demand have strong fuel efficiency requirements. The approach of each manufacturer is focusing on basic technologies to improve combustion efficiency and the like while also achieving improved combustion characteristics through the development of new devices such as idling stop systems. In addition, since both emerging and developed markets are planning to introduce environmental regulations, manufacturers are continuing to focus on the development of environmentally friendly technology. Other prominent trends include the installation of electronically controlled rider support systems such as TCS, electronic suspensions, and the like. In the future, it is likely that both motorcycles and four-wheeled vehicles will use electronically controlled devices to develop advanced support technologies for further enhancing performance and safety.

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