The Evolution of Environment-friendly Products and Services

The Evolution of Engines

Since it started production of the water-cooled horizontal-type oil engine Type A for agriculture and industry in 1922, Kubota has thoroughly pursued basic performance of industrial engines. Responding also to the increasingly tightened exhaust gas regulations of many countries in the world, Kubota engines have constantly satisfied the needs of the customers worldwide as the power source of various types of industrial machinery.

History of Engines

Year	Topics		
		Conformity to Exhaust Gas Regulations[*2]	Total production volume
1920	• Started production of the water-cooled horizontal-type oil engine Type A for agriculture and industry. (1922)		
1930	• Started production of diesel engines for land use. (1931)		
1950	• Started production of air-cooled gasoline engines. (1956) • Started production of water-cooled vertical type diesel engines. (1959)		
1980	• Succeeded in direct injection of small diesel engines. (1982)		• Reached 10 million units (1987)
1990		• EPA Tier1 (1999)	
2000	• Started accepting bio diesel fuels. (2008)[*1]	• EPA Tier2 (2004) • EPA Tier3 (2008)	• Reached 20 million units (2002)
2010		• EPA Interim Tier4 (2012) • EPA Tier4 Final (2015) • Europe StageV[*3] [Plan] (2019)	• Reached 25 million units (2011) • Reached 28 million units (2016)

*1 Please contact us if you use biodiesel.

*2 For exhaust gas regulations, the EPA (US exhaust gas regulations) regulations for the non-road diesel engines with output range of 56 to 75 kW are presented as the representative.

*3 For Europe StageV exhaust gas regulations (output less than 56 kW) are expected to be the world's most strict regulations for non-road diesel engines.

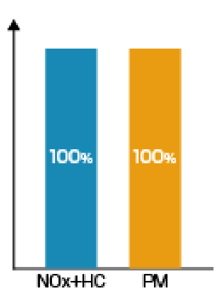
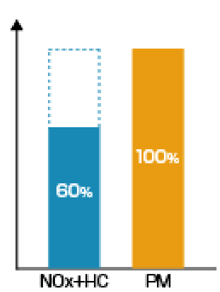
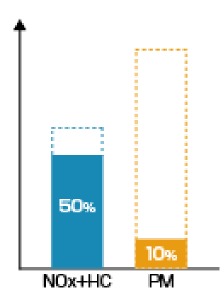
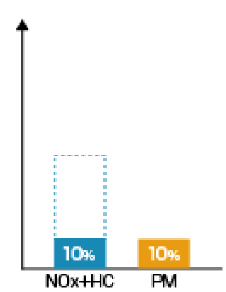
Conformity to Exhaust Gas Regulations

Kubota's engine technologies have evolved through undergoing improvements to conform to the exhaust gas regulations, which have been increasingly tightened year by year worldwide. Engines are required not only to satisfy the exhaust gas regulations but also to meet various performance requirements related to fuel efficiency, durability, etc. Kubota has developed basic performance based on its combustion control technologies, and selected the optimal parameters for the shape, materials, hardness, toughness, and other characteristics of each of the hundreds of parts constituting the engine, thereby pursuing the comprehensive improvement of the quality.

Kubota's engines have been highly evaluated for their compactness and high quality, boasting the largest share in the world market of industrial engines below 100 horsepower.

The following is the history of V3 Series, as the representative to show how the exhaust gas of Kubota engines have become cleaner.

History of Cleaning Exhaust Gas (engine output: 56 kW to 75 kW)

	From 2004	From 2008	From 2012	From 2015
Appearance				
Model	V3800DI-E2	V3800DI-T-E3	V3800-CR-TE4	V3800-TIEF4
Specifications	—	EGR	EGR+ CRS+ DOC+ DPF	EGR+ CRS+ DOC+ DPF+ SCR
Exhaust gas regulations	EPA Tier2	EPA Tier3	EPA Interim Tier4	EPA Tier4 Final
Exhaust gas regulation value* (g/kWh)				

* NOx (nitrogen oxides): Acidic substance that constitutes the cause of acid rain, bronchitis, etc.
HC (Hydrocarbon): is generated when mixture gas that was not burned due to incomplete combustion is discharged
PM (particulate matter): particulates generated in combustion, such as soot

Technologies Applied to Latest Engine

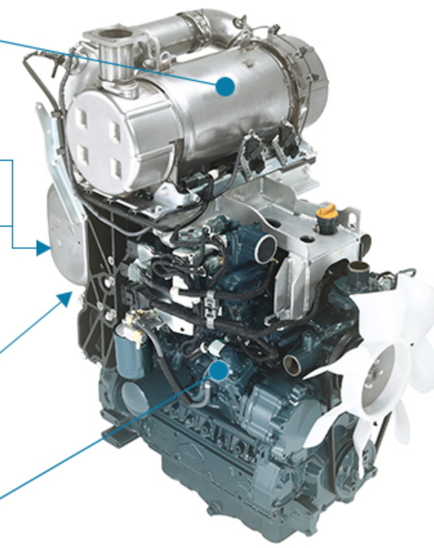
SCR: Selective Catalytic Reduction
Post-treatment equipment for diesel exhaust gas, which reduces NOx to harmless nitrogen and water

DOC: Diesel Oxidation Catalyst
Oxidizes unburned gases in the exhaust

DPF: Diesel Particulate Filter
Exhaust gas post-treatment equipment (filter) to collect particulate matter contained in the exhaust gas of diesel engines

EGR: Exhaust Gas Recirculation
A structure to reduce generation of NOx by returning a part of the exhaust gas into combustion air

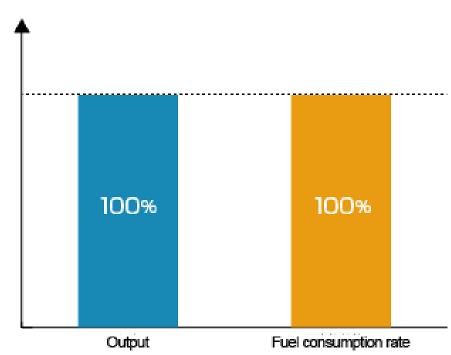
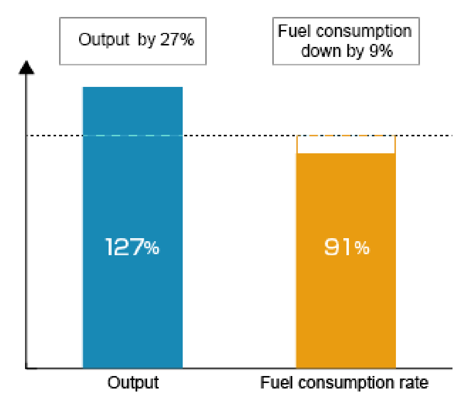
CRS: Common Rail System
Performs high-pressure injection of fuels multiple times, to improve combustion efficiency, achieving purification and high-power output of exhaust gas



Increasing Output and Improving Fuel Consumption Ratio

Kubota’s engines contribute to the realization of comfortable and environment-friendly operations, as the power source of diverse and various industrial machinery. So far, Kubota has worked on increasing the engine output without changing their appearance and shape, and also improving the fuel consumption rate. It is important to improve the fuel consumption rate while satisfying the exhaust gas regulations.

Increasing Output and Reducing Fuel Consumption

		1999 Original model（V3300-TE）	2015 Latest model（V3800-TIEF4）
Rated output (kW) Fuel consumption rate*1 (g/kWh)			
Improvements	(1) Output increased Bore diameter*2 × strokes Displacement	100% ø98mm×110mm 3318cc	127% ø100mm×120mm 3769cc
	(2) Changed combustion method	Swirl chamber type (mechanical type)	Direct injection type (electronic control type)
	(3) Compliant with exhaust gas regulations (Specifications)	Conforming to EPA Tier1 (No EGR)	Conforming to EPA Tier4 Final (EGR+ CRS+ DOC+ DPF+ SCR)

*1 Fuel consumption rate during rated output

*2 Cylinder internal diameter