

Introduction of Products

Hydraulic Excavators PC138US-11 and PC128US-11

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Focusing on higher levels of eco-friendliness, safety and Information and Communications Technology (ICT), hydraulic excavators PC138US-11 and PC128US-11 were developed based on Komatsu's Quality and Reliability, and launched in the market. These models are also compliant with Tier4 Final/Stage IV emission regulations.

This paper introduces the new products and describes the background of the development and the technologies used in these models.

Key Words: *Ecology, Safety, ICT, Reduction of fuel consumption, KomVision, Auto idle stop, Tier4 Final, Ultra-low noise (Japanese standard), Operator authentication, Ultra-small rear turning radius*

1. Introduction

The PC138US and PC128US (hereinafter represented by PC138US) are the core models of Komatsu's tight tail swing hydraulic excavator. This model is used in a variety of work sites including piping work in confined spaces and general civil engineering sites, and have received high rating for its excellent quality and reliability. As the reduction in environmental load such as CO₂ emissions has become more and more important in recent years, Tier4 Final / Stage IV emission regulations have been introduced in Japan, the United States and Europe since 2014. In this situation, we have developed the model PC138US-11 to meet those regulations while achieving eco-friendliness and providing benefits to customers. The new model has been launched in the North American and European markets. The outline of this model is described below (Fig. 1 and 2).



Fig. 1 PC138USLC-11 (North American version)



Fig. 2 Development concept

2. Aims of Development

The basic concept of the development was to achieve higher levels of eco-friendliness, safety and ICT based on Komatsu’s Quality and Reliability. In line with this concept, we worked to meet the requirements of compliance with the relevant environmental regulations, providing excellent controllability and significant reduction in fuel consumption (JCMAS ☆☆☆), while enhancing safety and taking advantage of ICT. This effort resulted in a great increase in marketability. The outline and features of the new model are described below.

(1) Ecology

- Compliant with Tier4 Final / Stage IV emission regulations of Japan, the United States and Europe
- 100% compliant with the JCMAS 2020 fuel efficiency standards (☆☆☆)
- 9% reduction in fuel consumption (PC128US vs. current model, comparison of average work patterns based on KOMTRAX analysis)
- Adoption of the auto idle stop function
- Fuel saving support by ECO guidance.
- Compliant with the ultra-low noise standard of the Japanese Ministry of Land, Infrastructure, Transport and Tourism, and EU Tier 2 noise regulation

(2) Safety

The following features have been added compared with the current models to develop a global machine featuring a safety design, which conforms to strict global safety standards.

- Lock lever auto lock function
- Lock lever auto lock status indication

(3) ICT

The following features have been added by further improving ICT technologies.

- Improved visibility around machine via KomVision
- Operator identification by operator authentication
- Diesel Exhaust Fluid (DEF) level indication
- Improved communications quality via 3G KOMTRAX communication network

(4) Others

- Easy to refill DEF
- Easy to service the DEF filter

3. Selling Points

Based on the above, the selling points of the PC138US-11 and the methods and technologies to achieve these features are described below.

3.1 Ecology

3.1.1 Compliance with emission regulations

The PC138US-11 complies with the Tier4 Final emission regulations of Japan, the United States and Europe. The regional emission regulations for the PC138US-class machines and their enforcement years are shown in **Table 1**.

Table 1 Comparison of emission regulations

	Regulatory values: Nox/PM (g/kW-h)			
	Tier 4 Interim regulation		Tier 4 Final regulation	
	Regulatory timeframe	Regulatory value	Regulatory timeframe	Regulatory value
Japan	in Oct. 2012	3.3/0.02	in Oct. 2015	0.40/0.02
U.S.	in Jan. 2012	3.4/0.02	in Jan. 2015	0.40/0.02
Europe	in Jan. 2012	3.3/0.025	in Oct. 2014	0.40/0.025

To provide good economy required of small models and allow maintenance-free operation while meeting the emission regulations mentioned above, various new technologies shown below have been incorporated in the engine (**Fig. 3**).

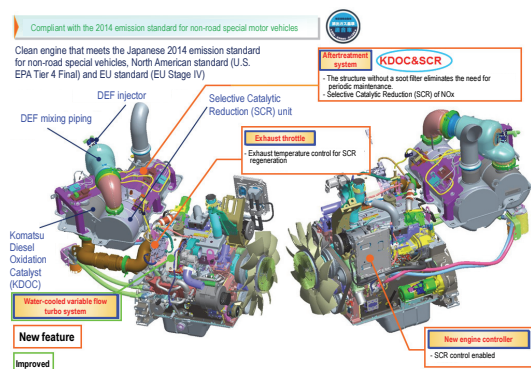


Fig. 3 Technologies incorporated in the new engine

- Exhaust gas aftertreatment system

A new Selective Catalytic Reduction (SCR) system has been introduced. By combining it with the Komatsu Diesel Oxidation Catalyst (KDOC) already introduced in the current models, particulate matter (PM) and NOx in the exhaust gas are dramatically reduced. The SCR system decomposes NOx into harmless nitrogen (N₂) and water (H₂O). It sprays DEF into the exhaust gas to cause the ammonia generated from DEF and NOx to react with each other via the SCR catalyst, decomposing them into nitrogen and water (Fig. 4).

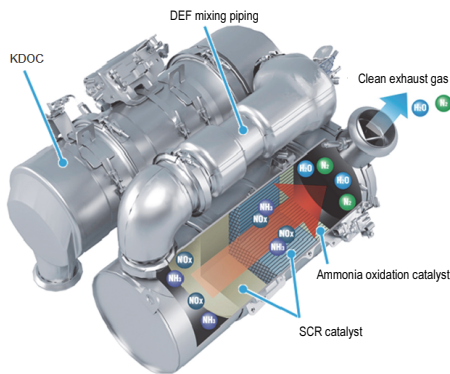


Fig. 4 Exhaust gas aftertreatment system

In addition, the high-efficiency KDOC has been further modified.

The simple structure without a soot filter eliminates the need for periodic maintenance to remove soot.

The addition of the above-mentioned SCR catalyst enables the elimination of the silencer in the KDOC introduced in the current models, while keeping the low noise level. This resulted in a smaller KDOC size (Fig. 5), which led to the improvement in maintainability and reparability of peripheral equipment.

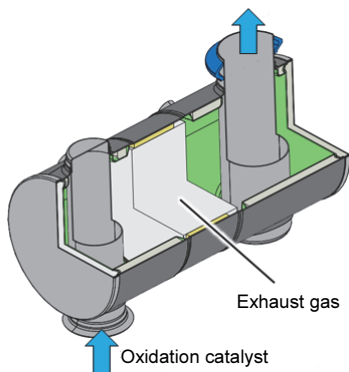


Fig. 5 Structure of Komatsu Diesel Oxidation Catalyst (KDOC)

- Variable Flow Turbocharger

The Variable Flow Turbocharger, which uses an electric flow control valve with a simple structure, optimizes air supply according to the load condition to improve the combustion efficiency, thus achieving both cleaner exhaust gas and better economy (Fig. 6).

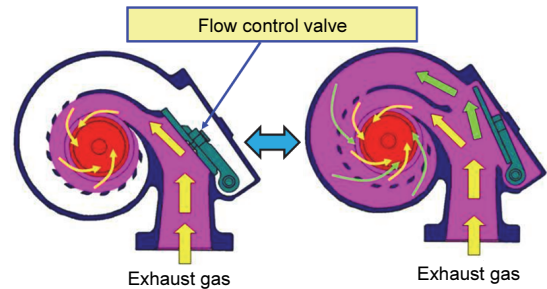


Fig. 6 Structure of Variable Flow Turbocharger

- Exhaust Throttle Valve

In addition to the Variable Flow Turbocharger, which was introduced in the engines to comply with Tier4 Interim emission regulations, an electric Exhaust Throttle Valve is used to allow optimum control of the exhaust temperature, thus optimizing the KDOC and SCR functions.

- Electronic control system

The new engine controller precisely controls the new SCR system, together with the electronic control common rail injection system introduced in the engines to comply with Tier4 Interim emission regulations, to achieve the optimum vehicle control.

Tier4 Final / Stage IV emission regulations specify a rule to restrict engine output when the DEF level becomes too low, which is called SCR inducement. To meet the SCR inducement requirement, the fault diagnosis system was further improved.

3.1.2 Reduction in fuel consumption

Incorporating the new technologies described below, the new engine is 100% compliant with the JCMAS 2020 fuel efficiency standards (☆☆☆).

The engine has also achieved 9% reduction in fuel consumption from the current model in the comparison of average work patterns based on KOMTRAX analysis (PC128US vs. current model).

1) New matching control of the engine and pump

The new matching control of the engine and pump is a technology to lower the engine speed in accordance with the input from the work equipment control lever and the pump pressure while ensuring sufficient pump discharge.

Taking advantage of the characteristics of the engine fuel consumption map which indicate higher fuel efficiency at lower engine speeds when compared at the same output power, low fuel consumption was achieved by utilizing low engine speeds (Fig. 7).

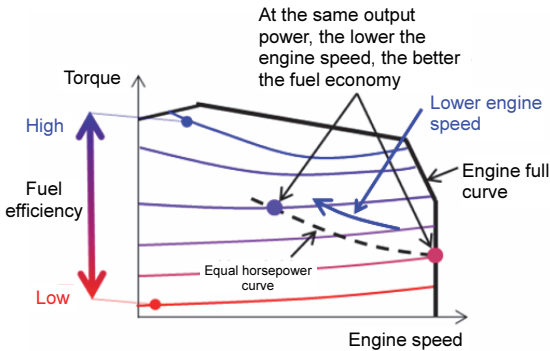


Fig. 7 Conceptual diagram of the engine fuel consumption map and lower engine speeds

2) Fan clutch control

The fan clutch that enables the fan speed control using a built-in fluid coupling has been introduced to lower the fan speed without deteriorating the heat balance. This reduces the fuel consumption by reducing the unnecessary horsepower consumption by the fan while ensuring the required horsepower (productivity).

3) Reduction in main valve loss

The hydraulic loss has been reduced to improve fuel consumption by optimizing the passages in the main valve (Fig. 8).

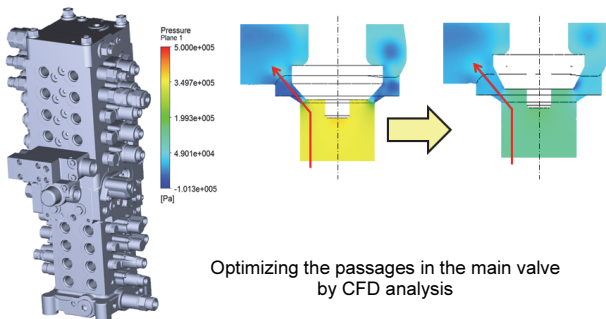


Fig. 8 Reduction in hydraulic loss in the main valve

4) Arm quick return valve

The arm quick return valve has been introduced to direct the oil return flow from the cylinder during the arm dump operation directly to the hydraulic oil tank, bypassing the main valve. This has eliminated the hydraulic loss that is caused when the return oil flows through the main valve, resulting in the reduction in fuel consumption (Fig. 9).

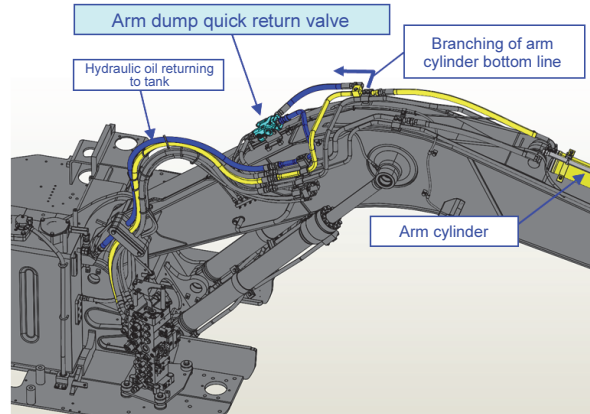


Fig. 9 Arm quick return valve

3.1.3 Auto idle stop function

The PC138US incorporates the auto idle stop function which automatically stops the engine when idling continues for specified period of time with the lock lever set in the lock position.

When idling continues until 30 seconds before the specified time period is up, the monitor changes to the count-down screen to announce the engine stop. When the specified time period is up, the engine stops automatically, thus reducing the idling time and fuel consumption (Fig. 10).

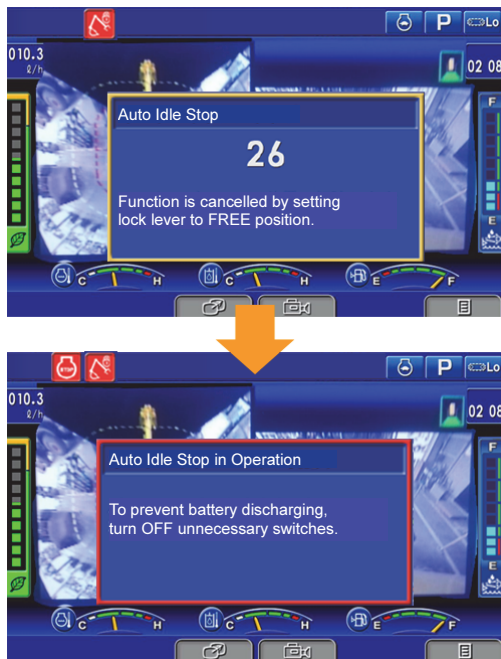


Fig. 10 Auto idle stop

3.1.4 Eco guidance

As in the current models, the function to display operational advice on the multi-monitor is provided to efficiently operate the machine and restrict unnecessary fuel consumption. If an operational state matches a certain condition, relevant advice message is displayed at the top of the multi-monitor screen.

3.1.5 Compliance with noise regulation

As in the current models, this model meets the noise regulation of the Japanese Ministry of Land, Infrastructure, Transport and Tourism and EU Tier 2 noise regulation. Major contribution for this is lowering of the engine speed by the new matching control of the engine and pump and by the fan clutch described above.

3.2 Safety

Safety has been further enhanced by adding the following features to the conventional safety and comfort design.

3.2.1 Lock lever auto lock function

The lock lever auto lock function prevents the work equipment or the machine from moving inadvertently when the lock lever is released with the work equipment operation lever, travel lever or attachment control pedal being operated.

When the auto lock activates, work equipment operation, swing, travel and attachment operation are automatically locked and a message is displayed on the monitor (Fig. 11).

The lock lever auto lock function further enhances operational safety.



Fig. 11 Display on the monitor when the lock lever auto lock function is activated

3.2.2 Lock lever auto lock status indication

When the lock lever is locked, a warning symbol appears in the upper left of the screen, informing the operator that the lock lever is locked (Fig. 12).



Fig. 12 Lock lever lock status indication

3.3 ICT

3.3.1 Improved visibility around machine via KomVision

Three cameras are installed on the machine cab (Fig. 13) and the newly introduced KomVision system displays the view around the machine by combining the images from these cameras (Fig. 14).



Fig. 13 KomVision cameras

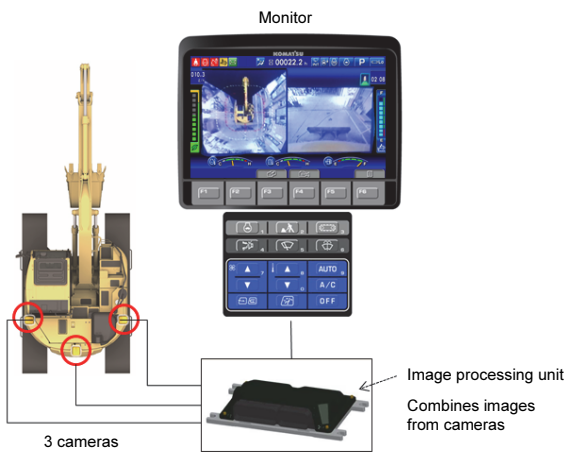


Fig. 14 KomVision system configuration

This function enables the operator to view around the machine where the operator cannot be seen directly at a glance. This reduces the load on the operator to check safety (Fig. 15).



Fig. 15 KomVision screen

The KomVision is a new technology of Komatsu. This feature is firstly introduced on the PC138US, and will be spread to other models.

3.3.2 Operator identification by operator authentication

By sending operational data of the machines with operator ID to KOMTRAX, it is possible to record the history of machine operation per operator, enabling the operational control by machine and by personnel (Fig. 16).



Fig. 16 Operator authentication screen

3.3.3 DEF level indication

Regulations require to restrict the engine power in the event of the DEF level becoming too low.

To ensure that DEF is effectively replenished, the current DEF level is constantly displayed on the right side of the monitor screen and reminder message is displayed when DEF level is becoming too low (Fig. 17).



Fig. 17 DEF level indication

DEF level can also be monitored and managed on KOMTRAX.

3.3.4 KOMTRAX communication upgraded to 3G

To improve the quality of communications, 3G terrestrial mobile communication networks are adopted for KOMTRAX communication standards.

Table 2 KOMTRAX communications standard

Region	PC138US-10	PC138US-11
Japan	Terrestrial mobile communication (2G)	Terrestrial mobile communication (3G)
U.S.	Satellite communication	
Europe		

3.4 Others

3.4.1 Easy to refill DEF

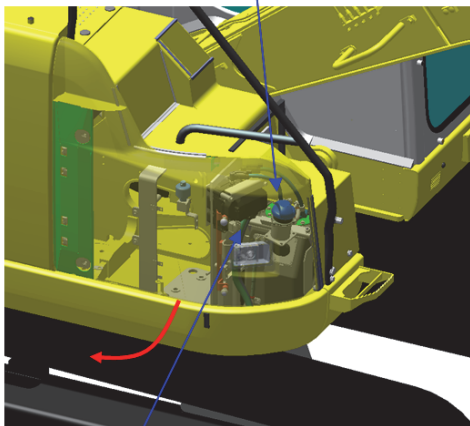
As described above, the SCR system uses DEF and it must be refilled regularly just like fuel. To ensure good accessibility, the DEF tank is located on the front right of the machine where the fuel tank is also located (**Fig. 18**).

3.4.2 Easy to service the DEF filter

The DEF pump is located beside the DEF tank on the front right of the machine. Operator can access the DEF filter (which must be replaced regularly) mounted on the DEF pump while standing on the ground (**Fig. 18**).

DEF tank filler port

Located inside the front right door for easy access



DEF pump filter added

To access the filter, open the door cover at the right of DEF tank.

Fig. 18 Refilling DEF and DEF filter

4. Conclusion

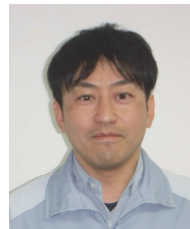
The PC128US and PC138US are among the key products in the small-size hydraulic excavator range of Komatsu. These models not only meet Tier4 Final / Stage IV emission standards, but have achieved a great reduction in fuel consumption (JCMAS☆☆☆) while retaining the excellent controllability of previous models favored by customers. Improved visibility using the Komatsu's first KomVision cameras has also contributed to the appeal of the product. Starting from the North American market, the product launch will continue in Europe and Japan. We believe that the new products will fulfill the customer's needs.

Introduction of the writers



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Joined Komatsu Ltd. in 1999.
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[A few words from writers]

With cooperation from relevant departments, we took the best advantage of the Komatsu's strengths, in-house development of components and expertise in combining these components, to optimally integrate the components into the new products.

We hope the strong sales features described above will be highly regarded in all markets.