

Introduction of Products

Introduction of Bulldozers D85EX/PX-18

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The new bulldozers, D85EX/PX-18, which conform to Tier4 exhaust gas regulations and secure maximum user benefits, have been developed and launched on the market under the concept of “environment”, “safety” and “ITC”. This report introduces the main features of the new models.

Key Words: *Bulldozer, Exhaust Gas Regulations, Sigma Dozer, Automatic Gear Shift, Power Tilt & Power Pitch, Auto Idle Stop, Safety*

1. Introduction

Komatsu D85, 30-ton class medium-size bulldozer, underwent a full model change as Type 15 in 2004, and demands from various markets of the world have been responded by meeting Tier3 exhaust gas regulations and other regulations based on Type 15. However, user demands for the operation environment such as operability and comfortability have been increasingly higher and a request for priority on safety is strong. As a result, regulations are being reviewed in various areas of the world.

Given this backdrop, stringent exhaust gas regulations have come into effect in Japan, U.S. and Europe. D85EX/PX-18 (Fig. 1), which are installed with a new generation engine conforming to Japanese 2014 Off Road Law, North American EPA Tier4 Final and EU Stage IV, have been developed and launched on the market. These models are inheriting Dantotsu productivity and economy established with D65 and D155, equipped with substantially improved operability and comfortability, and high safety.



Fig. 1 External view of Komatsu D85EX-18

2. Development Objectives

The basic concept of D85EX/PX-18 is pursuit of higher levels of “Environment”, “Safety” and “ICT (Information Communication Technology)” based on KOMATSU’s “Quality and Reliability”. Based on this concept, the product competitiveness has been substantially increased by complying with environmental regulations, improving the operation environment, pursuing safety and utilizing the ICT technology.

Features incorporated into D85EX/PX-18 are as follows.

2.1 Improvement in Economy and Work Efficiency

- 1) Automatic gear shift powerline
- 2) Setting of operation mode and power mode
- 3) Sigma dozer (EX only)

- 4) Power tilt & power pitch

2.2 Safety and Comfortability

- 1) ROPS and floor integrated wide cab
- 2) Full-auto air conditioner
- 3) Rear monitor system
- 4) Seat belt alarm
- 5) Battery disconnect switch
- 6) Secondary engine stop switch

2.3 ICT

- 1) High-resolution 7-inch LCD monitor
- 2) Support for reduction in fuel consumption by energy saving guidance
- 3) Expansion of KOMTRAX information
- 4) Operator identification function

2.5 Environment

- 1) Engine which conforms to Japanese, US and European Tier4 Final exhaust gas regulations

2.4 Others

- 1) Auto idle stop function
- 2) Support system ensuring safety and reliability

3. Main Features

3.1 Improvement in Economy and Work Efficiency

The optimal gear shift control according to a work condition which is realized by the automatic gear shift powerline and Sigma dozer (EX only) based on a new excavation theory have achieved, compared with conventional machines, an increase in an amount of work (m³/h) by 15%, a reduction in a fuel consumption amount (L/h) by 5% and an increase in fuel efficiency (m³/L) by 20%. (Fig. 2)

Some functions which have achieved the improvement in work efficiency are introduced.

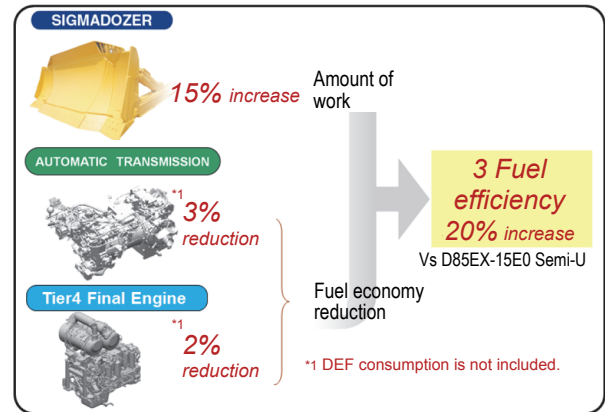


Fig. 2 Comparison of amount of work and fuel efficiency

- 1) Automatic gear shift transmission

The optimal transmission speed is selected. The auto decel function which decreases the number of engine revolutions at the time of auto shift-up is added, and it has mitigated gear shift shock and always enabled work with optimal efficiency by preventing machine rushing out due to sudden change of engine revolutions. (Fig. 3)

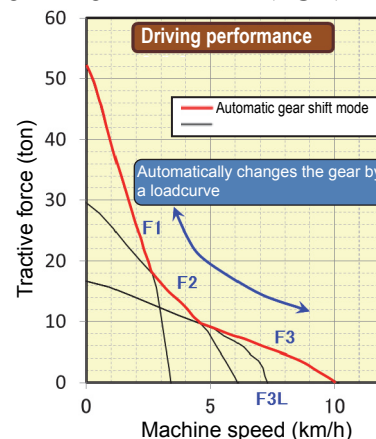


Fig. 3 Performance curve

The steering lever has followed the palm command control system lever with an established reputation. When the speed increasing or decreasing switch is pressed in the neutral position, the travel speed pattern in forward travel and rearward travel can be set. This is effective for leveling work of rough ground. As “3L” speed created by engine control has been added and the operation pattern has been increased to 6 ways, the optimal travel speed pattern according to preference of an operator or work can be selected. (Fig. 4)

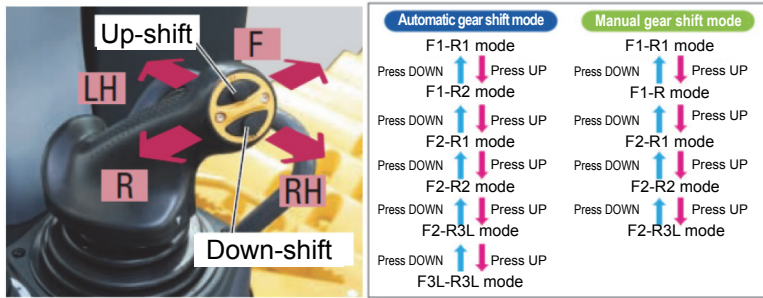


Fig. 4 Preset travel speed

2) Setting of operation mode and power mode

D85-18 is equipped with the following three modes.

Gear shift mode: “Automatic gear shift mode” which automatically accelerates or decelerates according to the magnitude of a load or “Manual gear shift mode”, same as

conventional machines, can be selected.

Operation mode: Full power “P: Power mode” or fuel saving “E: Economy mode” can be selected.

“Rearward travel slow mode” which can slow down rearward travel machine speed (Table 1)

Table 1 Feature of each mode

Gear shift mode	Feature
AUTO (Automatic gear shift mode)	<ul style="list-style-type: none"> Recommended for ordinary soil and work such as digging, soil carrying, ground leveling, placing and spreading. Optimum machine speed is selected automatically, free from troublesome gear shift operation in acceleration or deceleration.
MAN (Manual gear shift mode)	<ul style="list-style-type: none"> Recommended for digging work on rough terrain and for ripper work where the load readily varies. Recommended for tree root clearing and side cutting work where deceleration operation is necessary.
Operation mode	Feature
P (Power mode)	<ul style="list-style-type: none"> Generates full power and is recommended in work that requires moving large production volumes of earth or on an ascending slope.
E (Economy mode)	<ul style="list-style-type: none"> Select when a large amount of work is not required. Fuel consumption can be saved. Select when soil readily causes shoe slips and deceleration is necessary. Select when not much power is needed such as in dozing down work and leveling work.
Rearward travel slow mode	Feature
ON	<ul style="list-style-type: none"> Operate in this mode for comfortable ride during rearward travel in work on rough terrain or on soft rock ground.

3) Sigma dozer

Sigma dozer (Fig. 5) characterized by projection in the central portion has been adopted to increase the amount of work. Loss created between the blade and soil has been reduced by providing a projection to the center of the hollow shape of the conventional semi-U dozer (Fig. 6) to make the shape convex. Furthermore, spilling of soil over the sides has been reduced by providing bulges to the front shape and the blade can move while holding a certain amount of soil. Thus, a 15% increase in the amount of work has been achieved compared to that of the conventional semi-U dozer.

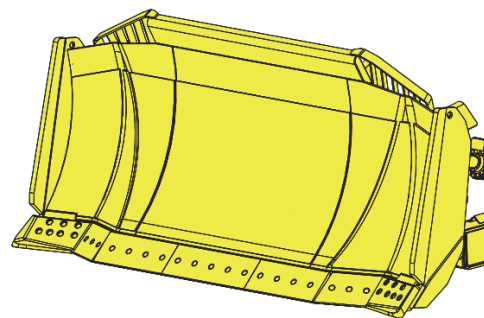


Fig. 5 Sigma dozer

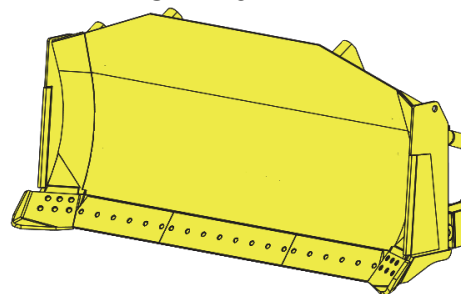


Fig. 6 Semi-U dozer (conventional)

4) Power tilt & power pitch

In Sigma dozer, the power tilt & power pitch function is installed as standard. This function enables the operator to change the cutting angle of the blade tip easily with operation of the switch and lever of the work equipment lever knob according to the work mode such as heavy duty digging, soil carrying/digging and ground leveling. The different strokes between the pitch/tilt cylinders have been adopted in which tilt operation can be performed even in a soil carrying work state (maximum pitch back). (Fig. 7)

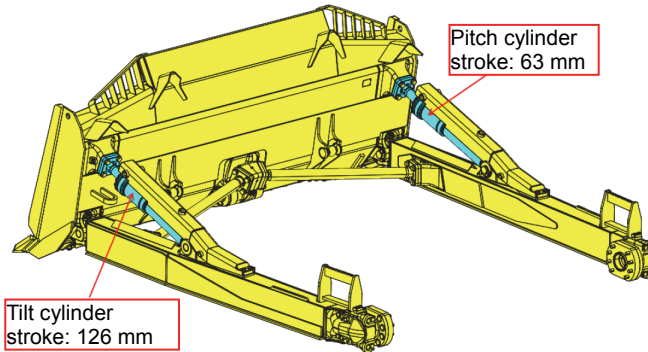


Fig. 7 Power tilt & power pitch cylinders

3.2 Safety and Comfortability

1) ROPS and floor integrated wide cab

Very high rigidity has been secured by integrating the cab, ROPS and the floor. In addition to the improvement in durability due to the above, the adoption of a hydraulic drive fan superior in quietness and low-noise engine contributes the reduction in noise at operator's ears. (Table 2) Besides, the side visibility has been substantially improved because pillars of ROPS are integrated with the cab. (Fig. 8)

Table 2 Comparison of noise at operator's ears

1 Fan rotation 70%

		Unit	D85-18	D85-15
Noise at operator's ears	Stationary	dB(A)	72.4	75
	Dynamic	dB(A)	78	80



Fig. 8 ROPS cab

2) Full-auto air conditioner

An outside air introducing type air conditioner for which an operator can make fine settings while looking at the large LCD screen is equipped. Furthermore, addition of A/C vents

and optimization of their position realizes keeping the head cool and the feet warm so that a comfortable interior environment can be kept all the year round. (Fig. 9)

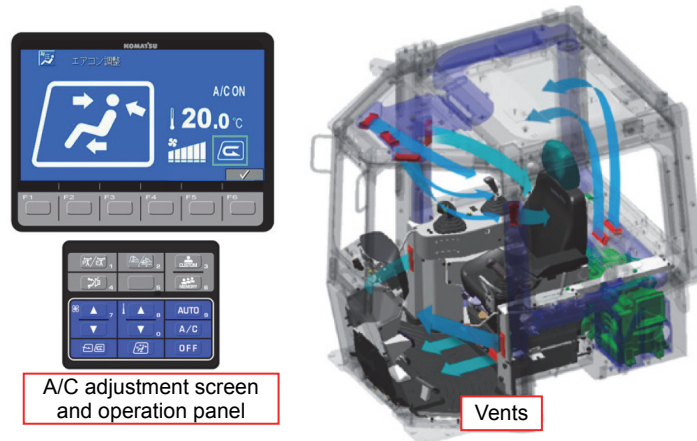


Fig. 9 Full-auto air conditioner

3) Rear monitor system

A camera for checking the rear of the machine is installed at the rear of the cab. The rear condition can be vividly checked with a high-resolution LCD monitor (Section (4)).

The guideline mode and automatic mode in which camera image is automatically displayed when the operation lever is moved to the backward position can be selected. (Fig. 10)



Fig. 10 Rear checking camera and camera image

4) Seatbelt alarm

When the seatbelt is not fastened, an icon illuminates on the upper left side of the monitor screen to urge the operator to wear the seatbelt. (Fig. 11)

6) Secondary engine stop switch

In preparation for a case in which the main switch cannot be operated and the engine cannot be stopped when an abnormality in the machine occurs, a switch to make an emergency stop of the engine is provided on the dashboard side near the right door of the cab. (Fig. 13)



Fig. 11 Seatbelt alarm



Fig. 13 Secondary engine stop switch

5) Battery disconnect switch

A switch to shut off the battery power supply circuit is provided to protect an operator and the machine body when the machine is not used for a long time, when electric circuits are repaired, or when electric welding is performed. (Fig. 12)

3.3 ICT

1) High-resolution 7-inch LCD monitor

A high-resolution liquid crystal display is newly used for the monitor screen. The visibility has substantially improved thanks to high resolution. The switch layout has followed the simple structure acknowledged in the conventional machines and the monitor system is now easy to use and is particularly easy to see. This monitor supports 33 languages. (Figs. 14, 15)



Fig. 12 Battery disconnect switch

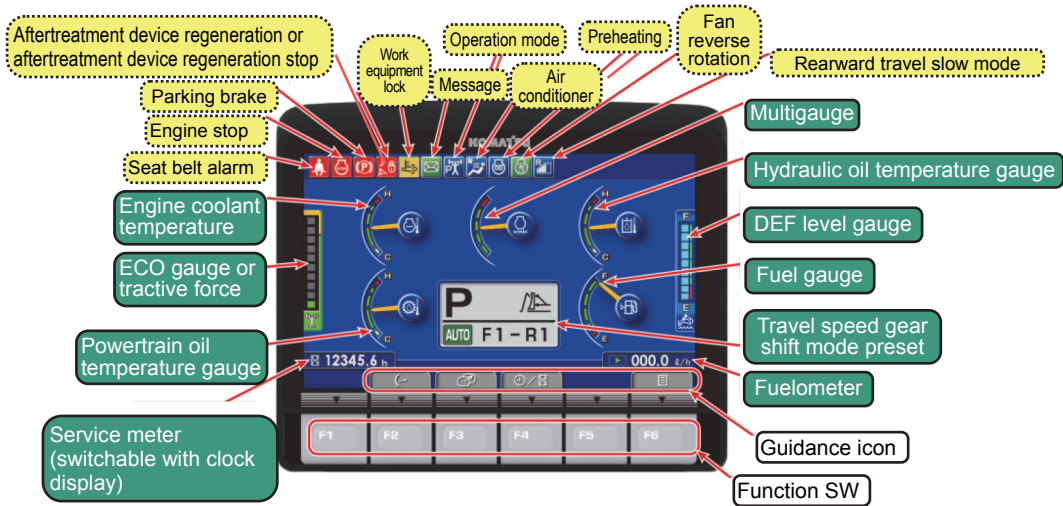


Fig. 14 High-resolution 7-inch LCD monitor

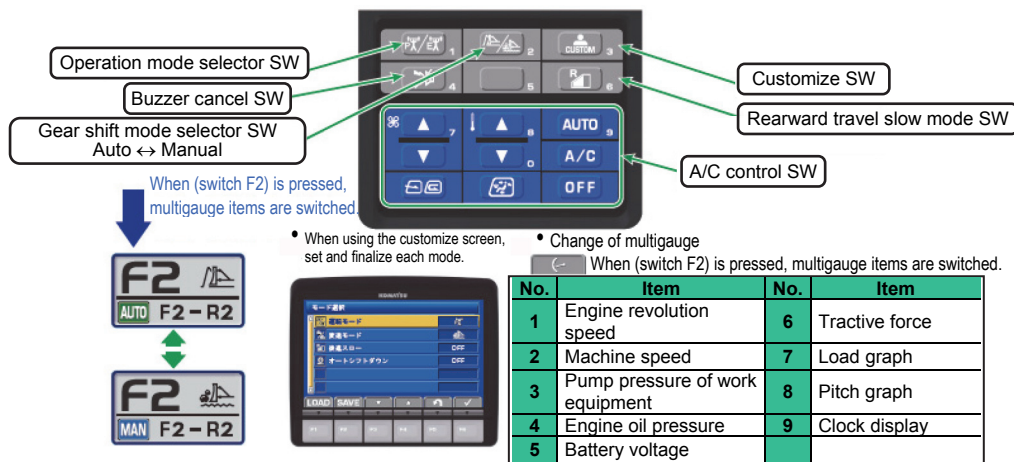


Fig. 15 Switch panel

2) Support for energy-saving operation

① ECO guidance, ECO gauge, fuelometer

Six types of ECO guidance such as “Let’s suppress hydraulic relief” and “The use of E mode is recommended” are pop-up displayed on the monitor screen in real time according to an actual operating condition and inform the operator of the situation timely to support energy-saving operation. In addition, ECO gauge and fuelometer which displays the average fuel economy are equipped to support energy-saving operation. (Fig. 16)

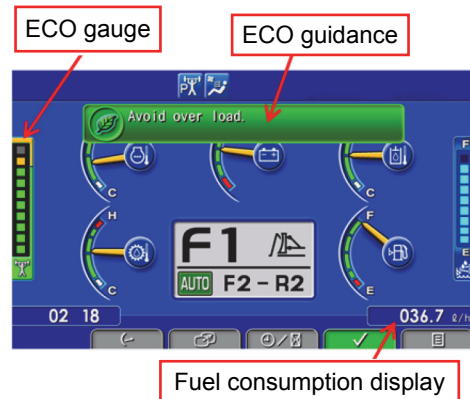


Fig. 16 ECO guidance, ECO gauge, fuelometer

② Operation result, fuel consumption history and ECO guidance record

With one touch from the energy-saving guidance menu (Fig. 17), Operation result screen (displaying operating time, average fuel consumption, idling time, etc. for one day or any split measured time) (Fig. 18), “Fuel consumption history

screen” (displaying fuel consumption of latest 12 hours for each hour with bar graph or displaying fuel consumption of latest one week for each day with bar graph) (Fig. 19), or “ECO guidance record” (displaying the frequency of pop-ups of each ECO guidance and one point advice for one day) (Fig. 20) can be checked.

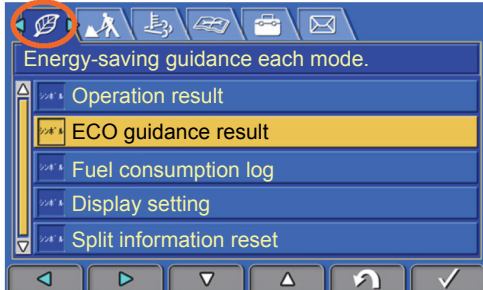
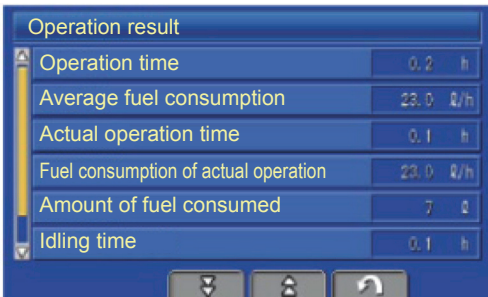


Fig. 17 Energy-saving guidance menu



Operation result
Fig. 18 Operation result



Fig. 19 Fuel consumption history

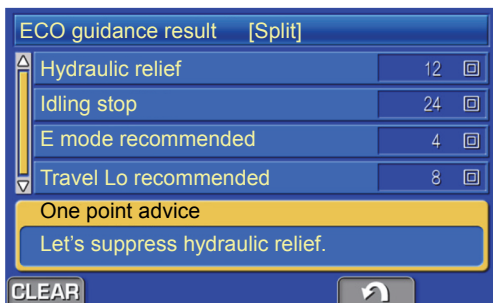


Fig. 20 ECO guidance

With regard to KOMTRAX highly evaluated as the fleet monitoring system which lets each machine send information such as the position, operating condition and machine condition and allows for grasping of the information at any time via the Internet without the need to go to the worksite, “provision of information of exhaust gas aftertreatment system” and “report of support for energy-saving operation” have been newly added. (Fig. 21)

If there is a problem with Komatsu Diesel Particulate Filter or Selective Catalytic Reduction which are added to cope with exhaust gas regulations, the support center can provide support quickly. Besides, the report provides useful information including fuel consumption (average and actual operation), amount of emission of CO₂, details of travel mode use condition and history of energy-saving guidance.



Fig. 21 Report of support for energy-saving operation

4) Operator identification function

Operation data by operator is recorded with the ID key (option) individual operators use and operation history by operator can be referred to by KOMTRAX. Thus, work management becomes possible from both sides of the machine and operator. (Fig. 22)

3) Expansion of KOMTRAX information

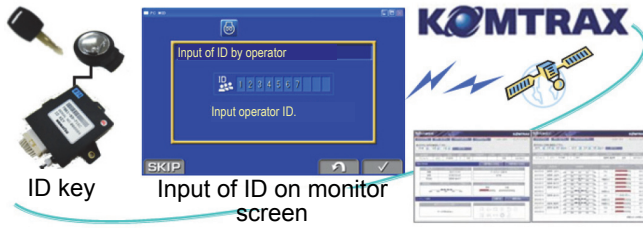


Fig. 22 ID key and KOMTRAX communication

3.4 Environment

The amount of emission of NOx (nitrogen oxides) and PM (particulate matter) has been considerably reduced by mounting a new generation engine “Komatsu SAA6D125E-7” combining our unique technologies which have been accumulated for long years, and this new model has passed the 2014 Off Road Law. New technologies adopted for this engine (Fig. 23) are introduced below.

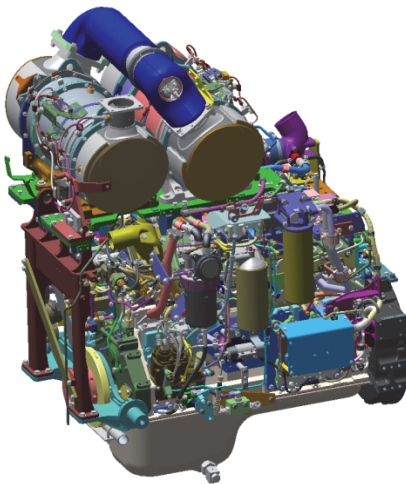


Fig. 23 External view of engine

1) Combustion system

The combustion system has followed the new combustion chamber and the electronically-controlled common rail injection system with the maximum injection pressure of 200 MPa, developed for the engine conforming to the Tier4 Interim exhaust gas regulations, and its performance has been tuned.

2) Exhaust gas aftertreatment system for construction machinery

“Komatsu Diesel Particulate Filter” is a continuous regeneration type filter system in which the oxidation catalyst is arranged at the pre-stage of the soot filter. It captures soot including PM and purifies exhaust gas, and at the same time, it burns captured soot continuously in normal operations to regenerate the filter. It is also installed with a control system which automatically detects an accumulated condition of soot

via the temperature sensor and pressure sensor and forcibly burns soot. Thus, this is a system in which the filter can be regenerated under various operating conditions. (Fig. 24)

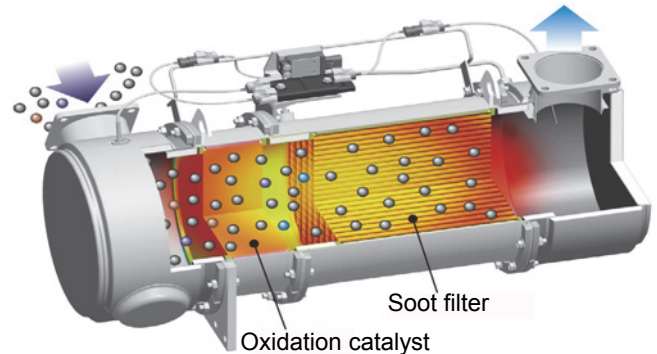


Fig.24 Internal structure of Komatsu Diesel Particulate Filter

To cope with Tier4 Final exhaust gas regulations, “Urea Selective Catalytic Reduction System” which reduces NOx emitted from the engine to 1/5 or less is newly installed in addition to “Komatsu Diesel Particulate Filter”. This system decomposes NOx in the exhaust gas into harmless nitrogen (N₂) and water (H₂O). It injects urea water into the exhaust gas and reacts ammonia formed from urea water with NOx by a catalyst to decompose it into nitrogen and water. (Fig. 25)

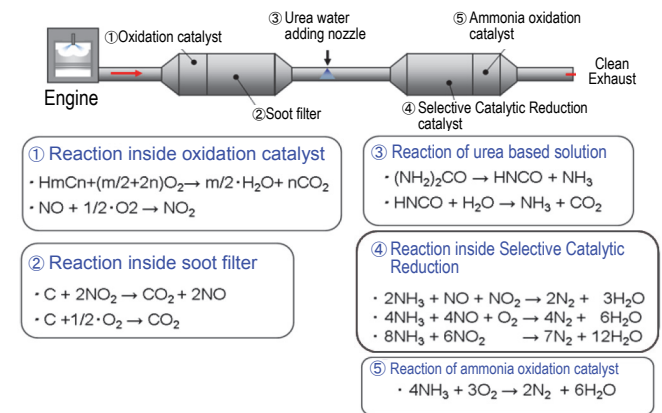


Fig. 25 Chemical reaction of NOx reduction

This system is broadly composed of the urea water supply system which injects urea water into the exhaust gas, urea water mixing piping which decomposes injected urea water into ammonia and disperses it in the exhaust gas and the selective catalytic reduction assembly with a built-in catalyst which promotes decomposition reaction of NOx. (Fig. 26)

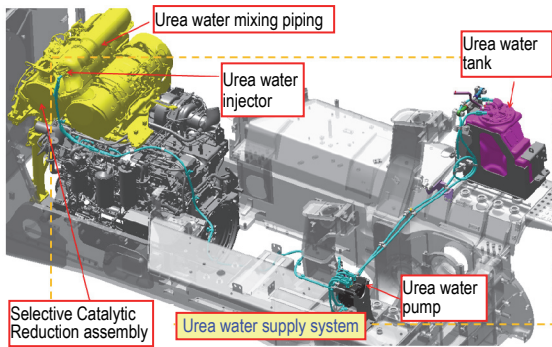


Fig. 26 Urea Selective Catalytic Reduction

① Urea water supply system

The urea water supply system is composed of a urea water tank, urea water pump and urea water injector. Urea water pressurized by the urea water pump is injected into the exhaust gas from the urea water injector. If an amount of the solution injected is too little, NO_x is not sufficiently decomposed, resulting in an increase of NO_x emitted. On the other hand, if an amount of urea water is too much, a deposit of urea is formed inside the exhaust pipe or excess ammonia which is not used for decomposition of NO_x is discharged. While a construction machine is in operation, engine speed or output constantly fluctuates according to a load of the machine and thus, an amount of NO_x in the exhaust gas changes constantly. The urea water supply system is equipped with a control system which detects an operating condition of the engine and a condition of the selective catalytic reduction assembly and can always inject a proper amount of urea water.

Urea water freezes at -11°C . In construction machines which operate in the low temperature environment, unfreezing and heat preserving functions of urea water are essential to actuate this system. A urea water hose for connection piping of each device of the urea water tank and pump has built-in heater wire, which is controlled to properly unfreeze and preserve heat with respect to the surrounding temperature.

② Urea water mixing piping

In the urea water mixing piping, urea water which is injected into the exhaust gas is decomposed into ammonia before it reaches the catalyst and is uniformly dispersed in the exhaust gas. If the internal structure is made complicated to disperse ammonia uniformly, a deposit of urea can be formed in the internal structure. The internal structure of the urea water mixing piping is optimally designed utilizing CFD flow analysis so that ammonia can be uniformly dispersed efficiently in limited installation space of a construction machine. (Fig. 27)

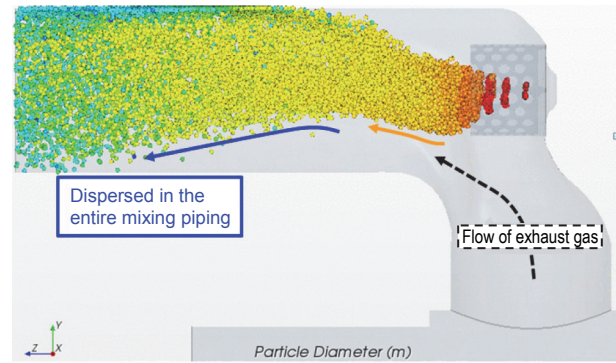


Fig. 27 Example of CFD analysis of urea water mixing piping

③ Selective Catalytic Reduction assembly

This assembly has a built-in catalyst which selectively reacts NO_x in the exhaust gas with ammonia formed by decomposition of urea water and promotes decomposition into harmless nitrogen and water. In the reaction process, ammonia is adsorbed in the catalyst and adsorbed ammonia reacts with NO_x in the exhaust gas. (Fig. 28) Therefore, more NO_x can be decomposed by adsorbing a lot of ammonia in the catalyst. Installed sensors always monitor a condition of the assembly during operation of a machine, assume an amount of ammonia adsorbed in the catalyst and determine the optimal injection amount of urea water to supply necessary ammonia according to an amount of ammonia consumed in the catalyst and an amount of NO_x flowing from the engine. Ammonia oxidation catalysts are arranged in the downstream of the catalyst to prevent excess ammonia from being discharged in the atmosphere from the exhaust pipe.

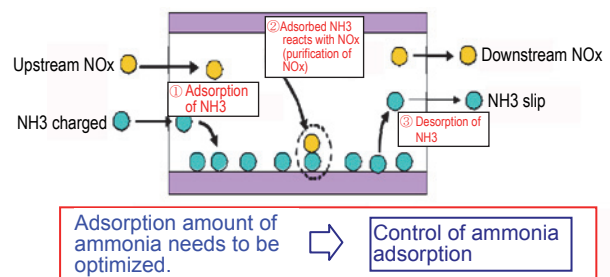


Fig. 28 NO_x reduction of catalyst

These catalysts, as with oxidation catalysts and soot filter built in “Komatsu Diesel Particulate Filter”, are supported on a ceramic-made base material, and the base material is held on a mat made of special fiber with high heat resistance and is built in a metal casing. This type of structure is similar to that of “Komatsu Diesel Particulate Filter” which has market-proven records from 2011 and has sufficient reliability and durability even in the severe use environment of construction machinery where big impact is applied. (Fig. 29)

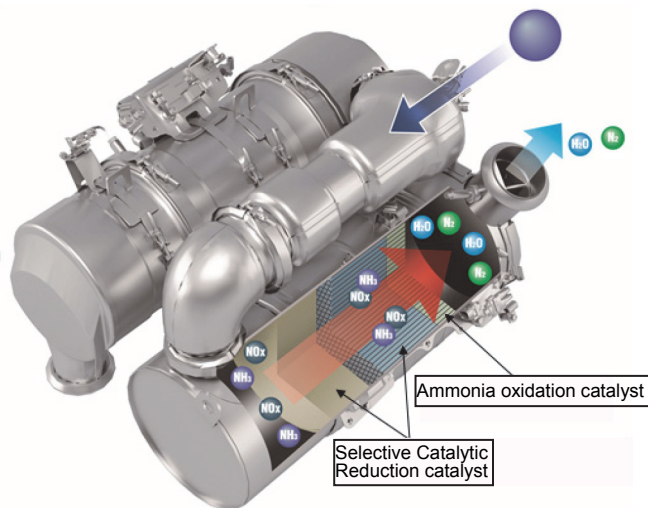


Fig. 29 Internal structure of assembly

In an operating condition of construction machinery, load frequency is high compared to commercial vehicles and passenger cars and exhaust gas temperature tends to be high; therefore, various chemical reactions with an aftertreatment device are more likely to be promoted. Komatsu Diesel Particulate Filter, urea mixing piping and Selective Catalytic Reduction assembly developed this time prevent a temperature decrease inside with heat insulating structure, effectively utilizes high exhaust gas temperature and can suppress a decrease in function to the minimum with respect to operation under light load or a decrease in exhaust gas temperature due to operation in the low temperature environment. As is seen from the above, these are optimally designed for installation in construction machinery and high quality is assured because they are manufactured in-house.

3) Variable turbo system for construction machinery

“Komatsu Variable Geometry Turbo Charger System” uses the hydraulically-driven variable nozzle located in the turbocharger, our unique technology. (Fig. 30) This nozzle is controlled according to the engine load to optimize the air flow and pressure, realizing high efficiency combustion and allowing for low emission, low fuel consumption and good responsiveness.

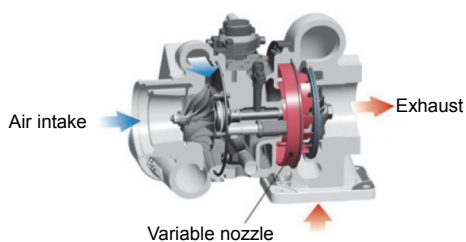


Fig. 30 Structure of Komatsu Variable Geometry Turbo

4) Electronically-controlled cooled Exhaust Gas Recirculation system for construction machinery

This is a system which reduces NOx by recirculating a part of exhaust gas and reusing it for combustion. (Fig. 31)

To pass the 2014 Off Road Law, it is important to sufficiently decrease the temperature of exhaust gas to be recirculated. For this purpose, a newly designed, high cooling efficiency Exhaust Gas Recirculation cooler is installed. To the Exhaust Gas Recirculation valve which controls recirculated exhaust gas flow rate, our unique hydraulic drive system which has both sufficient reliability and durability even in the severe environment and usage of construction machinery has been applied. This has realized a highly durable valve which can control gas flow rate with high accuracy in spite of its compact size.

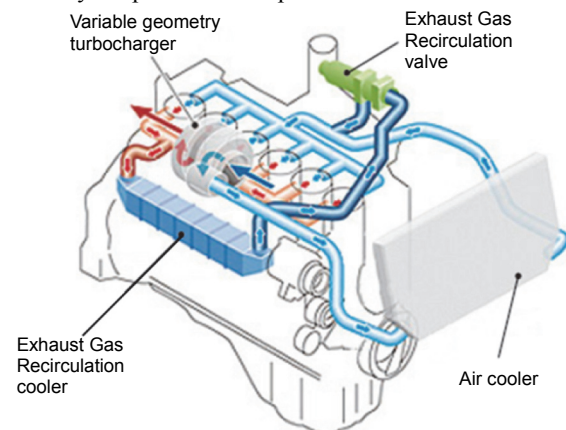


Fig. 31 Electronically-controlled cooled Exhaust Gas Recirculation system

5) Komatsu Closed Crankcase Ventilation System

To pass the 2014 Off Road Law, it is necessary to take in, reduce and burn blowby gas, which was released to the atmosphere in the past. As blowby gas contains oil content, it must be removed before reduction. Otherwise, performance of other equipment can be impaired. Therefore, “Komatsu Closed Crankcase Ventilation System” with a built-in high performance filter which can remove the oil content efficiently is installed. This system is equipped with a pressure sensor which detects filter clogging and is placed in the engine compartment for easy filter maintenance. (Fig. 32)

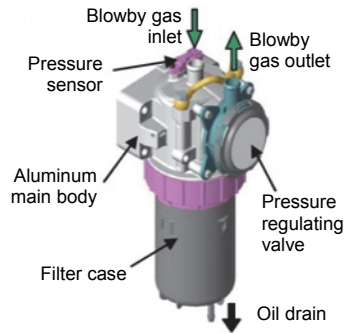


Fig. 32 Komatsu Closed Crankcase Ventilation

3.5 Others

1) Auto idle stop

When there is no movement or no operation of work equipment and an idle state continues, the engine is automatically stopped to suppress unnecessary emission of exhaust gas in consideration of the environment. The time until idle stop activation is set, at the time of factory shipment, matching the time stipulated in the regulation for areas having the regulation. For areas having no regulation, machines are shipped in a state in which the time can be set.

2) Support system ensuring safety and reliability

Considering it important to provide support so that customers can use this high performance machine for a long time with security, Komatsu adopted a new machine warranty program “KOMATSU CARE” for all machines meeting the 2011 Off Road Law which began to be sold in the fiscal year 2012 for the first time in Japan, and this program is also applied to D85-18. The program consists of a free program and a charged program. The free program adds “Extended warranty of powerline” (warranty up to three years or 5,000 hours) and “free maintenance” (engine oil and engine oil filter are replaced for every 500 hours for free up to four times, and Komatsu Diesel Particulate Filter is cleaned once for free when 4,500 hours is reached). This maintains machine’s original performance and environmental performance and contributes to the reduction in the total life cycle cost.

4. Conclusion

“D85EX/PX-18” have undergone a full model change after an interval of 10 years and are new models which have incorporated many selling points such as consideration to the natural environment, safety, operation environment and ICT. We are confident that these models will be rated very highly in various markets. We expect that in the near future these models will obtain a designation of “Excellent machine” from customers all over the world.

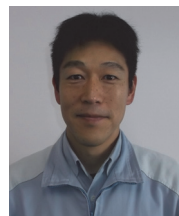
Introduction of the writers



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[A few words from writers]

We have developed, for the first time at Awazu, D85 which is a full model change after an interval of 10 years, in line with adoption of new technologies to meet the new exhaust gas regulations. During the development, importance was placed on strict quality check, production costs and awareness of delivery time. Although we encountered many challenges, we strived to achieve the goal with the concerted efforts of Design, Quality Assurance and Production Departments, and our efforts are now going to bear fruit. We believe this product will be well accepted in the market and we would like to express our sincere thanks to all parties concerned for their cooperation.