

ZAXIS-5 Hydraulic Excavator Series Compliant with New Emissions Law

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OVERVIEW: Exhaust emission laws are becoming stricter, with new laws being introduced progressively in Japan, Europe, and North America, starting in 2011. Designed to reduce the load on the environment, these laws also apply to the engines used in construction machinery. To comply with these requirements, Hitachi Construction Machinery Co., Ltd. is proceeding with a full revamp of its range of hydraulic excavator models to incorporate the numerous requests gleaned from surveys of user needs in Japan and elsewhere. The new models will be called the ZAXIS-5 Series. In addition to compliance with the new emissions laws, the ZAXIS-5 Series aims to provide even better fuel consumption, a safer and more comfortable operator's cab, and more advanced information technology functions. Models have already been released in Europe and North America.*

INTRODUCTION

RECENT years have seen progress on measures aimed at reducing the load on the environment in various ways, and construction machinery also faces stricter exhaust emission laws around the world. In response, Hitachi Construction Machinery Co., Ltd. has developed the ZAXIS-5 Series of hydraulic excavators that are compliant with the new emissions laws and has released them on the European and North American markets.

In addition to having an engine that complies with the new emissions laws, Hitachi Construction Machinery has built a system for the ZAXIS-5 Series that achieves both better fuel consumption and improved digging performance. Along with the durability of the front attachment and crawler unit, lifecycle costs have been reduced through easier maintenance, including the addition of the fault diagnosis equipment to the cab monitor. The operator's environment has also been considered with a more spacious and comfortable cab, and the excavator is full of new technology that operators will find easy to use, including multi-function switches to provide centralized controls in easy reach. Further enhancements have been made to the information technology functions that earned a strong reputation in previous models, including a rear-view camera that displays on a wide monitor and an upgrade to the Global e-Service function that operates as a mobile communications device.

This article describes the energy efficiency technologies on the ZAXIS-5 Series, its clean engine technology, safe and comfortable cab, and advanced information technology (see Fig. 1).

CLEAN ENGINE TECHNOLOGY AND PURSUIT OF ENERGY-EFFICIENT PERFORMANCE

New Hydraulic System

The ZAXIS-5 Series uses the three-pump/three-valve hydraulic system in place of two-pump/two-valve systems used in the past. The objectives of the system are to further reduce fuel consumption and



Fig. 1—ZAXIS-5 Series.

The photograph shows a ZAXIS 250LC-5 hydraulic excavator.

* ZAXIS is a trademark of Hitachi Construction Machinery Co., Ltd.

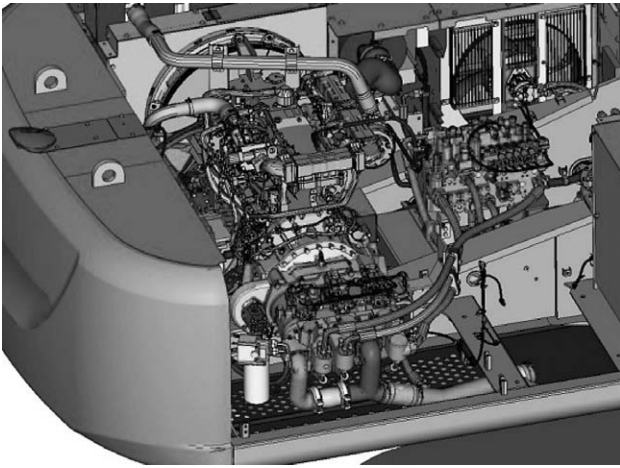


Fig. 2—Hydraulics.

The hydraulics makes the excavator easier to operate and provides a significant reduction in fuel consumption.

improve operation by making the excavator easier to drive (see Fig. 2).

In particular, to reduce fuel consumption, the system uses precise electronic control to achieve more appropriate pump output as well as paying close attention to reducing pressure losses in the hydraulic circuits, which is achieved through both software and hardware (see Fig. 3).

Specifically, the system combines different techniques, including reducing power losses during simultaneous operations by selecting optimal power settings for each pump, reducing pump power by adjusting the efficiency of each actuator, reducing throttling losses for energy regeneration by increasing the pump discharge volume, and reducing pressure losses by adding additional circuits and switching valves. These result in a significant improvement in fuel consumption.

The result when using the new ECO operating mode is an 18% saving in fuel consumption (on the ZAXIS 250LC-5, compared to a previous model).

Clean Engine Technology for Hydraulic Excavators

The new emission laws require particulate matter (PM) to be reduced to one-tenth the level required by the previous law, and nitrogen oxides (NO_x) to one-half. In addition to the common rail fuel injection system from the previous engine, newly developed technologies adopted on the new engine include a muffler filter to reduce PM, a variable geometry system (VGS) turbo (variable turbo) to reduce NO_x, and a larger capacity exhaust gas recirculation (EGR) cooler (see Fig. 4).

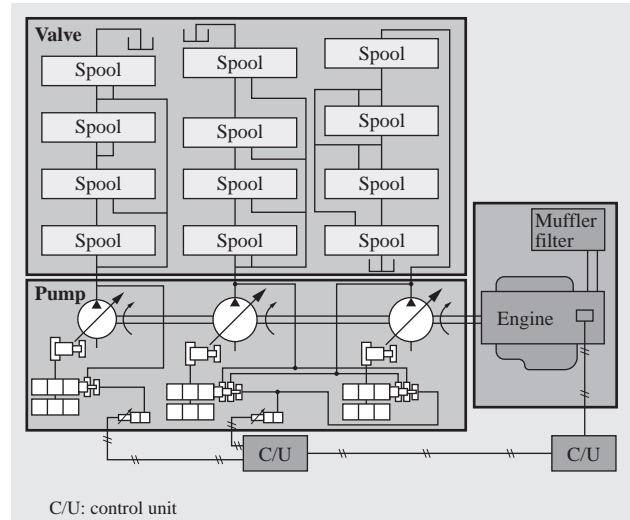


Fig. 3—Three-pump/three-valve Hydraulic System Configuration. Pressure losses in the hydraulic circuit were significantly reduced by maintaining a more appropriate level of pump output.



Fig. 4—Engine for ZAXIS 250-5 Class.

The engine complies with the new emissions laws in Europe, North America, and Japan.

The catalyst used in the muffler filter becomes active when the engine is heavily loaded and the temperature of the exhaust gas is high. However, because hydraulic excavators are used for a wide range of tasks, including digging, leveling, lifting, and loading, and are fitted with various different attachments, such as breakers or fork grapples, there are times when most of their operation takes place under light loads with low exhaust gas temperature. During development, Hitachi Construction Machinery tested different engine running patterns associated with the various different types of hydraulic excavator operation to fine-tune the engine control to suit its use in hydraulic excavators, including working on the fuel

injection timing and EGR valve open/close control to optimize the level of PM removal by the muffler filter, the savings on fuel consumption, and the level of exhaust gas.

CAB

Pursuit of Safety and Improved Comfort

The safety and comfort of the cab are important elements in improving the working environment for the operator and preventing accidental damage at the worksite.

For safety, the hydraulic excavators comply with roll-over protective structures (ROPS) requirements to maintain a minimum safe area that prevents the operator from being crushed even if the machine were to fall over and rotate through 360°. The performance requirements that ROPS must satisfy and the associated test methods have been stipulated in International Organization for Standardization (ISO) standards. The cab design also uses irregular-profile pipe for the pillars to optimize the ROPS, and maximizes the area of glass to improve the field of view and allow the operator to check the safety of the region around the excavator.

A rear-view monitor is also included as a standard feature, with the monitor conveniently located where the operator can see it without turning his or her head. Frequently used switches such as those that control the wipers and lights are located close to the operator, with the layout designed to prevent misoperation (see Fig. 5).

For operator comfort, in addition to a seat designed to allow extended use without tiring, the automatic air conditioning system (a standard feature) has been optimized so as to surround the operator with vents



Fig. 5—ZAXIS-5 Series Cab Interior. The spacious and comfortable cab improves monitor visibility and the right-hand-side field of view.

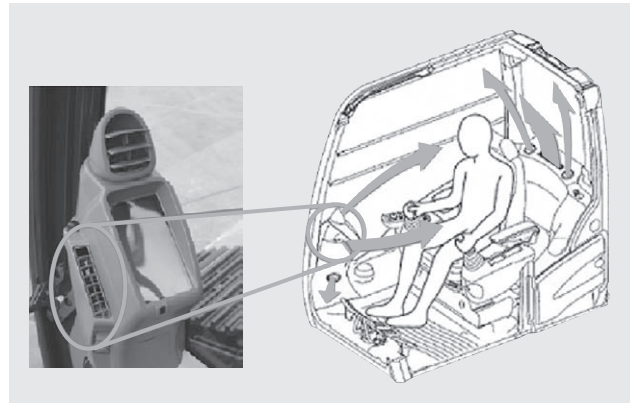


Fig. 6—Location of Air Conditioning Vents on ZAXIS-5 Series. The air conditioning vents surround the operator.

(see Fig. 6). Improvements to the air tightness of the cab have also improved thermal insulation and reduced interior noise levels.

Multi-function Monitor Operator Controls

Multi-function monitors that use full-dot color liquid-crystal displays have been used since earlier models where they were well regarded. On the new models, these have been upgraded to provide additional functions and easier monitor operation.

In addition to basic functions such as the water temperature gauge, fuel gauge, and machine information display, features such as the radio and air conditioning have been consolidated into the monitor along with existing functions that used the multi-function monitors, such as those for maintenance and hydraulics adjustment (see Fig. 7). These functions are available in 32 different languages.



Fig. 7—Multi-function Monitor and Controls. The photographs show the main screen of the multi-function monitor (left) and the multi-function switch and air conditioning and radio switches (right).

The multi-function monitor is also used for machine adjustment. Previous models also used a monitor for fault diagnostics and other simple servicing tasks. To these, the new models have added a selection of sensor and engine data monitoring functions as well as machine adjustment and other setup functions, these being the bare minimum of functions required for servicing. While servicing of previous models required a special external device, these devices are not available in some countries or regions and therefore these functions are used as a workaround for this problem. In addition to providing additional functions of value to both the customer and service staff, the new models have been localized to suit different markets.

Feedback on previous models indicated that their large number of switches made them confusing to operate. To simplify the operation of the new excavator models, Hitachi Construction Machinery responded by undertaking considerable testing of their ease-of-operation. Based on this, the controls on the multi-function monitor were limited to “turn” or “press” only, and multi-function switches were developed specifically for use in construction machinery. While dedicated switches were still provided for the air conditioning and radio because of their frequency of use, the switches were consolidated into a single location and restricted to the same turn and press operations as other functions to ensure that the multi-function monitor would be easy to use.

ENHANCEMENTS TO INFORMATION TECHNOLOGY

On the previous models, it was difficult to determine what condition the machine was in when a fault occurred in the marketplace. Even after service staff had carried out an inspection, identifying the cause of the fault sometimes took a long time, if it could be identified at all. Because of the enhancements to the engines used in the new models required for compliance with exhaust emission laws, Hitachi Construction Machinery built the following three systems to minimize downtime and make faults easier to diagnose.

Recording of Machine Information when Fault Occurs

Hitachi Construction Machinery has simplified problem analysis and fault finding by recording sensor readings, digital signals, and other data from around the time a fault occurs. All of this recorded machine

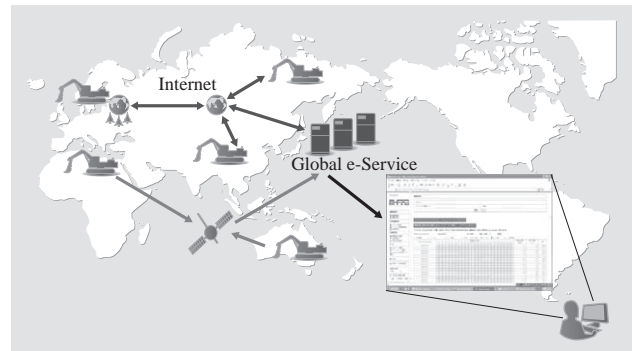


Fig. 8—Overview of Remote Monitoring System. Operating data from machines located throughout the world can be viewed from the office.

data can be retrieved remotely by issuing commands from the office.

Building of Remote Monitoring Function

The ZAXIS-5 Series collects data from the various sensors fitted to the machine and uses a built-in communications device to send this data to the Global e-Service monitoring server. The aim is to reduce downtime by building a system capable of monitoring machines in use around the world from the office (see Fig. 8).

Enhancements to Fault Diagnostics System

The growing use of electronics and more complex control in construction machinery is increasing the number of data points for monitoring of the machine’s sensors. In the past, a special-purpose fault diagnostics system was used during maintenance to select from approximately 100 different data points. For the new models, functions have been added to the device

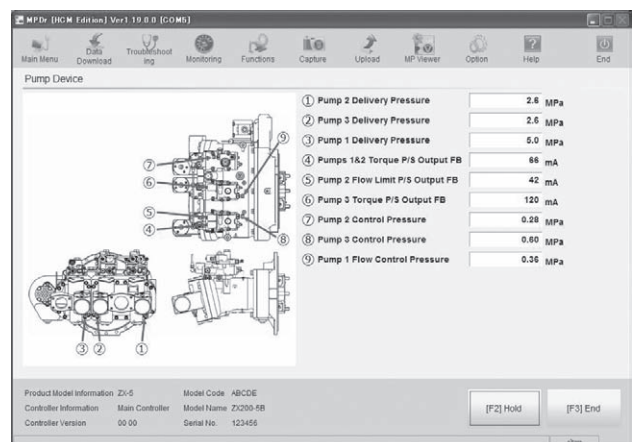


Fig. 9—Example Screen on Fault Diagnostics System. The example screen from the fault diagnostics system shows the main pump pressure.

to make it easier for staff to perform servicing, simplifying the task of checking the machine's condition by displaying a diagram of the relevant control system as they go (see Fig. 9).

CONCLUSIONS

This article has described the energy efficiency technologies on the ZAXIS-5 Series, its clean engine technology, safe and comfortable cab, and advanced information technology.

The ZAXIS-5 Series is being adopted by users in all parts of the world where its performance is earning a strong reputation.

In the future, Hitachi Construction Machinery Co., Ltd. intends to continue working on developments aimed at increasing customer satisfaction, strengthening the "made by Hitachi" brand, and supplying products that will be in demand from a larger number of users.

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