Introduction of Products

Introduction of HM300/400-3

Shinichi Kanazawa

Kouji Tanaka

The articulated dump truck model HM300/400-3 has been launched on the market as Komatsu's first dump truck to meet the EPA-EU Tier4 emission regulation. Based on HM300/400-2, which enjoys a high market reputation, the new dump truck features improved fuel efficiency, an advanced design, eco-friendliness and high economic efficiency achieved by drastically reviewing the original design.

Key Words: *Articulated Dump Truck, EPA Tier4 Interim Emission Regulation, EU Tier3B Emission Regulation, 30-Ton Class, 40-Ton Class*

1. Introduction

The HM300-2/400-2 series, which were first launched onto the market in 2006 to meet the EPA and EU Tier3 emission regulation, have won high market acclaim for their high productivity and excellent travel performance. Based on these ranges, new products meeting the new Tier4 Interim regulation and featuring environmental friendliness and economical fuel consumption were developed, incorporating fuel improvement measures and state-of-the-art design.

2. Development Objectives

1) Environmental friendliness and economic efficiency
   (1) The new products feature an engine, which meets EPA and EU Tier4Interim emission regulation enforced in 2011, emitting clean exhaust gases, and a post-processing device.
   (2) Low fuel consumption through fewer machine losses using a variable hydraulic pump and engine output control.

2) Productivity
   (1) Higher dump body capacity.
   (2) Higher ability to travel through or escape from soft ground incorporating a traction control system (Komatsu Traction Control System - KTCS) unique to Komatsu.
   (3) Improved front overhang and minimum ground clearance.

3) Safety and comfortability
   (1) Higher safety to meet the most recent regulation including EN474 (safety regulation for earth-moving machinery for the EU).
   (2) A newly-designed cabin to optimize the operator's seat layout, high-visibility meter panel and other features for a safe and comfortable operating environment.

4) Information technology
An ECO guidance system that displays advice messages for energy saving operation on the monitor panel is installed. A fuel consumption reporting function is also added to the KOMTRAX machine management system to support economical operation.

3. Machine Model Series

The two models HM300-3 and HM400-3 are model-changed under the same concept.

Fig. 1 HM400-3

Table 1 Main specification

			New Model		New Model	
		Unit	HM300-3	HM300-2	HM400-3	HM400-2
Dump body capacity	Maximum load weight	t	28	27.3	40	36.5
	SAE (2:1) capacity	m^3	17.1	16.6	24	22.3
Weight	Unloaded weight	kg	24910	24040	33660	32460
	Loaded weight	kg	52990	51340	73740	68960
Engine	Type	-	SAA6D125E-6	SAA6D125E-5	SAA6D140E-6	SAA6D140E-5
	Displacement	ltr	11.4	←	15.24	←
	Gross output/ Rated speed	kW (ps) /rpm	248 (337) /2000	254 (345) /2000	353 (480) /2000	338 (459) /2000
	Max. torque/ Engine speed	Nm (kgm) /rpm	1680 (171) /1400	1706 (174) /1400	2263 (232) /1400	2089 (213) /1400
Transmission	Type	-	Komatsu multi-shaft type	←	←	←
	Inter-axle differential lock-up	-	Wet type multiple discs	←	←	←
	Right-left differential lock-up	-	KTCS	LSD	KTCS	Wet type multiple discs
	Maximum travel speed	hm/h	58.6	59	55.9	58.5
Brake	Service	-	Wet type multiple discs	←	←	←
	Parking	-	Dry type calipers	←	←	←
	Retarder	-	Wet type multiple discs	←	←	←
	Retarder capacity	kW (ps)	392 (533)	370 (503)	510 (693)	389 (529)
Regulation Conformance	Exhaust gas emission	-	Tier 4 Interim	Tier 3	Tier 4 Interim	Tier 3
	EU dynamic ambient noise	db (A)	108	←	110	←

4. Product Features

4-1 Ecology and Economical Efficiency

1) Cleaner exhaust gas

Conformance to the EPA and EU Tier4 Interim emission regulation is ensured by modifying the engine body itself in addition to the post-processing device of exhaust gases (Komatsu Diesel Particulate Filter (KDPF)).

(1) Installation of the KDPF

Emissions of particulate matter (PM, black smoke) have been reduced by capturing and burning soot in exhaust gases by a post-processing device for exhaust gases comprising the Komatsu Diesel Oxidation Catalyst (KDOC) and Komatsu Catalyzed Soot Filter (KCSF). A 12-inch diameter KDPF is installed in the HM300-3 while a 14-inch diameter KDPF is installed in the HM400-3.

(2) Modification of the engine body

The common rail fuel injection system and EGR (Exhaust Gas Recirculation) system that were used in conformance to the EPA and EU Tier3 emission regulation were modified to conform to EPA-EU Tier4 Interim emission regulation.

(3) Installation of the KCCV

Blowby gas is returned to the intake side and reburnt to prevent the release of blowby gases into the atmosphere. The mechanism for this process separates oil from blowby gas via the KCCV filter and returns the blowby gas to the intake piping this time to prevent any adverse impacts on the intake side parts.

(4) Use of KVGT

The transient response performance in the region of low speed and load was secured through variable flow control by a sliding vane system.

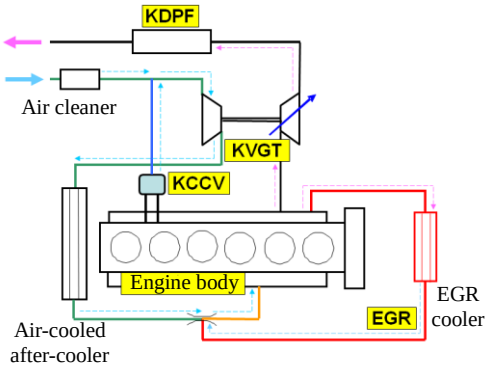

Fig. 2 Engine intake and exhaust circuit

2) Reduction in fuel consumption

(1) Reduction of losses in the steering and work equipment hydraulic circuits

A variable piston pump is newly installed in the HM300/400-3, as opposed to conventional machines, which install a gear pump. The piston pump discharges only the required amount of flow, thus reducing oil pressure losses.

(2) Reduction of losses in hydraulic transmission circuits and torque converter

Conventional machines share a pump for the transmission and torque converter. Accordingly, the total oil quantity is supplied to the torque converter after traversing a high-pressure circuit for clutch holding.

The HM300/400-3 have independent pumps for the transmission and torque converter and a flow changeover valve.

This allows bypassing of the oil for clutch holding via the flow changeover valve at a high engine speed, restraining the excessive oil supply.

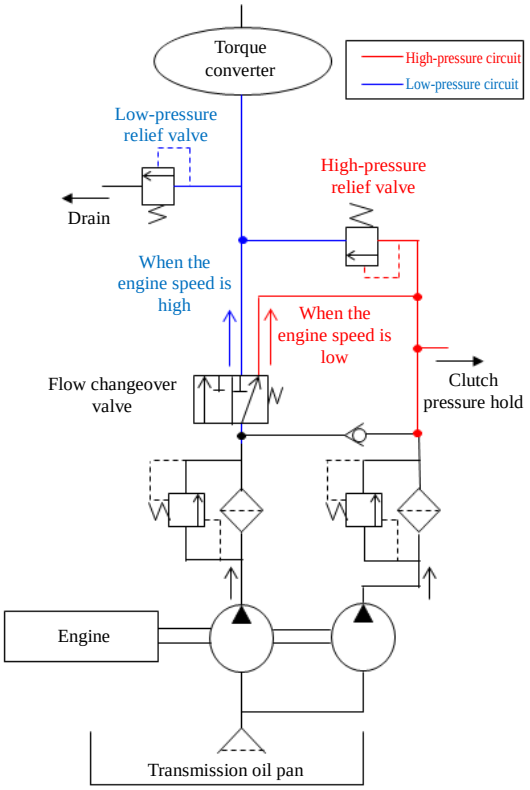

Fig. 3 Two transmission pump circuits

(3) Reduction of transmission axle losses

Stirring losses inside the transmission have been reduced. Losses are reduced by increasing the height of the buffer plate separating axle 4 of the transmission and oil, making the axle less immersed in oil to reduce losses.

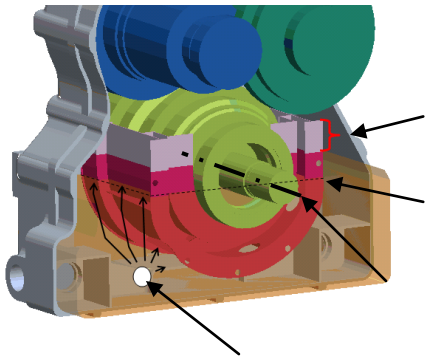

Fig. 4 Internal structure of the transmission

Oil resistance was reduced in axle rotation losses by increasing the disc spacing of the embedded wet type multiple disc brake.

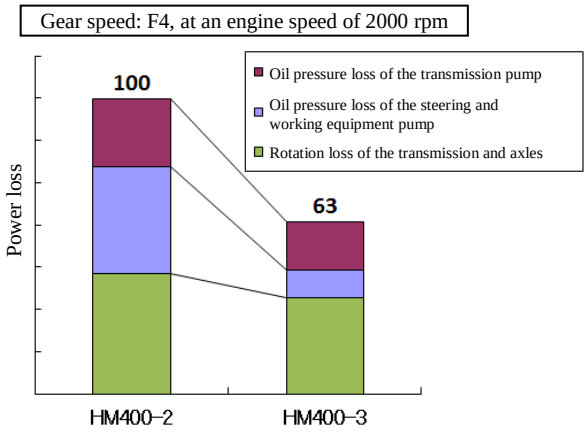

Fig. 5 Result of power loss improvement

(4) Control of fan speed and engine dynamic torque

In HM300/400-3, the cooling fan operation is changed from the previous direct belt-drive to hydraulic drive to allow control of the fan speed by heat generated by the engine and environmental temperature in order to reduce rotation losses due to unnecessary fan drive.

The gross engine output is controlled in accordance with the fan driving force to keep the net output constant and achieve dynamic engine torque control. When the condition allows for low fan speed, gross output is proportionately lowered for that portion and both low fuel consumption and high travel performance are achieved simultaneously.

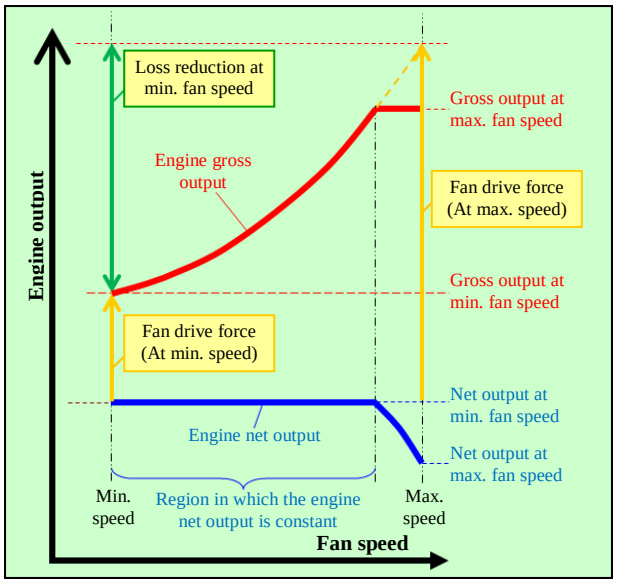

Fig. 6 Image of the 40-ton class engine dynamic torque control

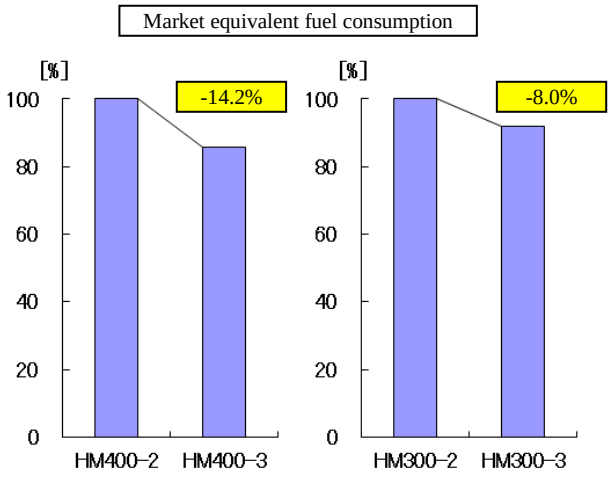

Fig. 7 Result of the fuel consumption improvement

4-2 Productivity

1) Dump body capacity increase

The dump body capacity was increased from 27.3 tons with the HM300-2 to 28.0 tons with the HM300-3, and from 36.5 with the HM400-2 to 40.0 tons with the HM400-3.

2) Use of the Komatsu Traction Control System (KTCS)

The KTCS is installed as part of the standard specification to achieve both the ability to travel through or escape from soft ground and ensure turnability.

The KTCS is a system that automatically and simultaneously imposes differential brake control limits independently for each of the four wheels and inter-axle differential gears (front and rear differential gears contained in the transmission) and comprises tire rotation sensors, articulation angle sensors and acceleration sensors.

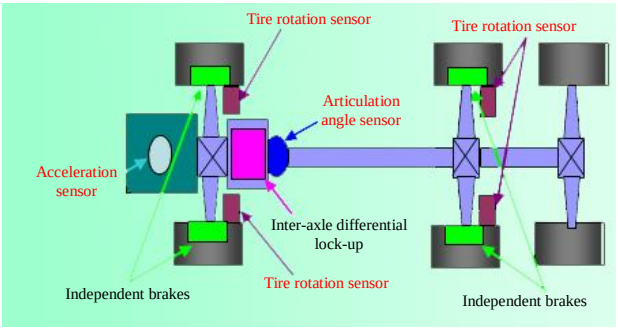

Fig. 8 Composition of the KTCS

The brakes and inter-axle differential lock-up are controlled by calculating the tire slip rate from the machine speed and estimated tire rpm based on data received from the acceleration sensor, targeting a slip rate that would maximize the traction force. The KTCS has turnability and the ability to travel through or escape from soft ground that are superior to those of the conventional differential lock-up and limited slip differential gear (LSD).

As all controls are performed automatically, the operator need not have any skilled operation technique.

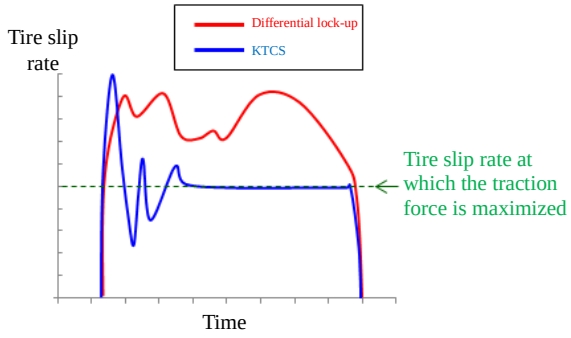

Fig. 9 Image of the tier slip rate controlled by KTCS

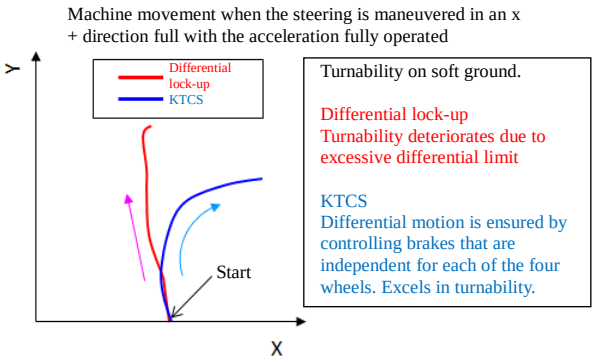

Fig. 10 Image of turnability achieved by KTCS

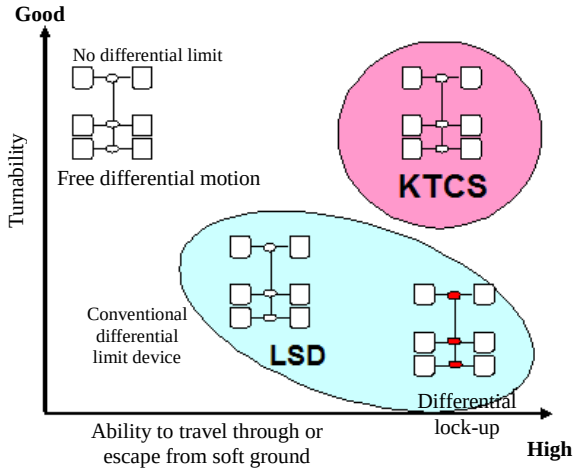

Fig. 11 Features of the KTCS

3) Improvement of front overhang and minimum ground clearance

The front overhang was reduced by changing the layout of the cooling equipment and using a plastic hood. The drive shaft of the hitch portion was also moved up to increase the minimum ground clearance and enhance the ability to travel through rugged roads required for articulated dump trucks.

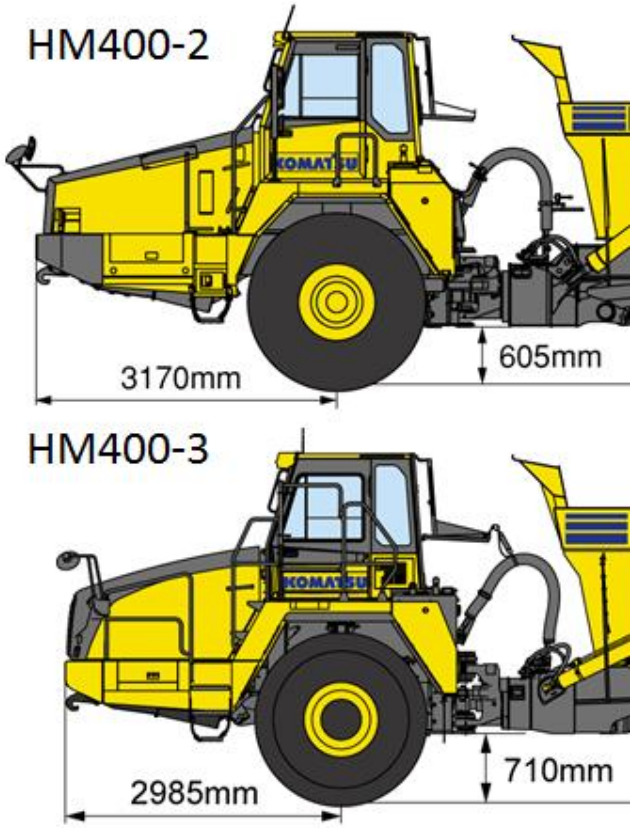

Fig. 12 Improvement of front overhang and minimum ground clearance (Source: Komatsu catalog)

4-3 Safety and Comfortability

1) Safety

(1) Enhanced safety when getting on and off from the operator's seat and during maintenance and repairs

The products are based on the international safety standard ISO 2867 and conform to the latest version of EU regulation EN474. Protection fences and toe guards have been added to the left and right platforms, as well as a protection fence to the battery box to prevent falling during maintenance. Slip-proof sheets on passages are of the pin spike type to prevent any deterioration of the anti-slip function due to age-related deterioration and deposits of mud.

(2) A newly-designed common cab has been installed on the HM300/400-3. The operator's seat was located on the left inside the cab, but is now placed centrally for visibility with good balance between the left and right.

The newly developed color LCD multi-monitor displays meters and gauges clearly and visibly for easy reading.

Fig. 13 Field of view from cab (Source: Komatsu catalog)

(3) Color rearview monitor

A rearview camera and color LCD monitor are part of the standard specification. Interlocking with the reverse position of the shift lever, a rear image is displayed on the monitor in the cab to check blind spot hidden by the machine body during reverse travel.

(4) Optimization of the switch, lever and display layout

The dashboard surrounds the operator's seat. The shift levers, dump control levers and switch panel (to operate the air conditioner and monitors) are placed to be easily accessible by the operator.

Fig. 14 Layout around the operator's seat

2) Comfortability

The operator's seat now has a heater and air suspension. The combination with hydro-pneumatic suspension ensures pleasant comfortability.

Thorough acoustic design, including sound absorbing material 30mm thick installed under the cab floor, has achieved effective noise reduction. The noise level achieved near the ears of the operator is 73dB (A) with the HM300-3 and 72dB (A) with the HM400-3 in the ISO 6396 standard, to mitigate operator fatigue in a quiet cab environment.

4-4 Information Technology

An ECO guidance function has been newly added for energy saving operations. For example, if idle continues more than five minutes, a message will be displayed urging the operator to stop engine operation or fuel consumption is notified to the operator in real-time through an ECO gauge, to support energy saving operation.

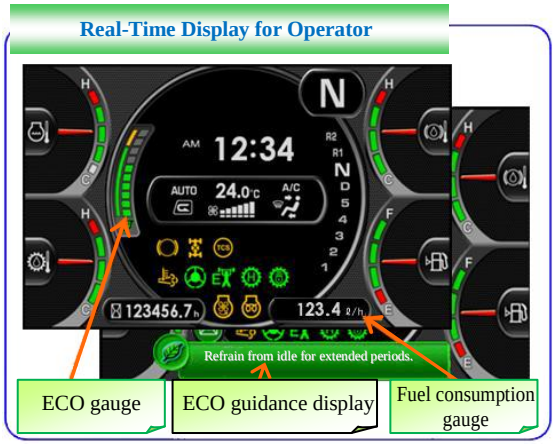

Fig. 15 Multi-monitor

Fig. 16 Example of ECO guidance messages

Additionally, the latest version of the machine management system KOMTRAX is installed as part of the standard specification. In addition to machine location information and failure information supplied in the conventional version, the new version includes a fuel consumption reporting function, information related to KDPF and load capacity information (optional).

5. Conclusion

Aiming to make these products Dantotsu (only one) products, the newly developed products incorporate various technologies that are the first to be used with Komatsu dump trucks. This presented many challenges and it is indeed a great feeling to succeed in mass production of the products while seeking the cooperation of the related departments.

While expressing its appreciation for the cooperation of all those involved in this development task, the design department will continue positive support to ensure the HM300/400-3 will win high market acclaim.

Introduction of the writers

Shinichi Kanazawa

Entered Komatsu in 1990.
Currently assigned to the Construction Equipment Technical Center 2, Corporate Development Division.

Kouji Tanaka

Entered Komatsu in 2006.
Currently assigned to the Construction Equipment Technical Center 2, Corporate Development Division.

[A few words from the writers]

Aiming to make these products Dantotsu (only one) products, the newly developed products incorporate various technologies that are the first to be used with Komatsu dump trucks. This presented many challenges and it is indeed a great feeling to succeed in mass production of the products while seeking the cooperation of the related departments.

While expressing its appreciation for the cooperation of all those involved in this development task, the design department will continue positive support to ensure the HM300/400-3 will win high market acclaim.