Introduction of Product

Introduction of HM250-2

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The articulated dump truck HM250-2 was placed on the market in October 2008. This model is a 25-ton class model that has not been included in Komatsu's product series. The model was developed to expand the series and to focus mainly on environmental friendliness and safety based on the HM300-2, which is already placed in the market, meeting the EPA Tier3 emission regulation, EU Tier3 emission regulation and EU Tier2 noise regulation. This introduction of product describes the aforementioned model.

Key Words: *Articulated dump truck, EPA Tier3 emissions regulations, EU Tier3 emissions regulations, EU Tier2 noise regulations, 25-ton class*

1. Introduction

Launched in early 2006 to meet emission and noise regulations, HM300-2 won high evaluation in the market thanks to its high productivity, economical efficiency and excellent travel performance. Attaining these features, the 25-ton class articulated dump truck HM250-2 was newly developed by optimizing strength members and components through a reduction of the payload (**Photo 1**).

Photo 1 HM250-2 (From product bulletin)

2. Aims of Development

1) Expansion of product series

Komatsu first sold an articulated dump truck in 2001, but did not have a 25-ton class model. In response to strong market demand, a 25-ton specification was developed using HM300-2 as the base.

2) Environment and safety

(1) A clean emission level that conforms to EPA and EU Tier3 emissions regulations was achieved by installing an ecot3 engine.

(2) Noise to the operator and surrounding environment was reduced to meet EU Tier2 noise regulations.

(3) Safety was enhanced to meet EN474 (EU safety standard for construction and civil engineering machines) and OSHA (Occupational Safety and Health Administration, USA).

3) Economical efficiency and productivity

(1) As a design concept, low fuel consumption and high economical efficiency were set to reduce power loss and to achieve speed change control of the transmission similar to those of HM300-2.

(2) Wet-type multiple disc brakes were used for the first

time for a 25-ton class articulated dump truck to ensure high reliability.

(3) The uphill traveling speed was increased by achieving the largest engine output for this class for high productivity.

3. Model Series

HM250-2 was included in the model series in addition to HM400-2, HM350-2 and HM300-2 as shown in **Table 1**.

4. Characteristics of Product

4.1 25-ton specification

Using the same major components as those used in HM300-2, the following items were implemented to realize a 25-ton specification.

· Rational engine output
· Rational retarder capacity
· Change in body capacity
· One-stage hoist cylinder
· Optimum strength of structures

(1) Reexamining the length and height, a body capacity, which was of the largest class for 25 tons, was implemented. Additionally, the loading height was lowered to make loading work easier. The same plate thicknesses and materials as those for HM300-2 were used for the various components to retain excellent durability and wear resistance. (The bottom plate uses wear resistant steel of hardness HB400).

Table 2 Comparison of body dimensions

	Unit	HM250-2	HM300-2
Body capacity (SAE 2:1)	m^3	14.7	16.6
Body loading length	mm	4975	5240
Body loading height	mm	2670	2790
Body interior width	mm	2685	←

(2) In conjunction with the reduction in loading mass, the performance, cost and mass were reviewed comprehensively. As a result, a one-stage cylinder was used for the first time for a Komatsu articulated dump truck, improving the lowering speed compared with a 2-stage cylinder. (Improved 3s over HM300-2) A double dust seal structure was employed for the rod sliding parts to enhance the resistance to dust (See **Fig. 1**).

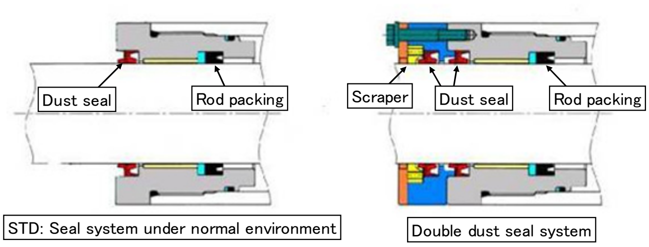

Fig. 1 Structure of double dust seal system

Table 1 Main specifications

		Unit	HM250-2	HM300-2	HM350-2	HM400-2
Body capacity	Maximum loading mass	t	24	27.3	32.3	36.5
	SAE (2:1) capacity	m^3	14.7	16.6	19.8	22.3
Mass	Curb mass	kg	23600	24040	31060	32460
	Fully-loaded mass	kg	47680	51340	63360	68960
Engine	Model	-	SAA6D125E-5	←	SAA6D140E-5	←
	Displacement	ltr	11	←	15.2	←
	Gross output/Rated speed	kW(ps)/rpm	232(315)/2000	254(345)/2000	304(413)/2000	338(459)/2000
	Max. torque/Engine speed	Nm(kgm)/rpm	1706(174)/1400	←	1991(203)/1400	2089(213)/1400
Transmission	Model	-	Komatsu multi-axle type	←	←	←
	Inter-axle differential lock	-	Wet type multiple disc brake	←	←	←
	Left and right differential locks	-	L..S.D	←	Wet type multiple disc brake	←
	Maximum speed of vehicle	km/h	57.6	59	57	58.5
Brake	Service	-	Wet-type multiple disc brake	←	←	←
	Parking	-	Dry type calipers	←	←	←
	Retarder	-	Wet type multiple disc brake	←	←	←
	Retarder absorption horsepower	kW(ps)	296(402)	370(503)	444(604)	389(529)
Regulation compliance	Gas emissions	-	Tier3	←	←	←
	EU dynamic ambient noise	dB(A)	108	←	109	110

(3) Optimum strengths of structures

Parallel with a reduction in the loading capacity, the plate thicknesses and compositions of the materials of the structures were reexamined for their weight lightening.

· Front and rear frames
· Rear trailing arm (center and rear axles)
· Equalizer bar
· Rear suspension cylinder

Lightening weight of HM250-2 by 440kg compared with HM300-2.

4.2 Environment and safety

1) Clean exhaust gas

Installed with the Komatsu SAA6D125E-5, which implements Komatsu's state-of-the-art technology [ecot3], HM250-2 conforms to EPA Tier3 emissions regulations and EU Tier3 emissions regulations.

Examples of exhaust gas measures employed in HM250-2 are as follows.

A high-pressure electronically controlled common rail system of the multi-stage injection type was installed in the fuel injection system to feed fuel at high pressure to achieve the optimum injection amount and control of multi-stage injection, to achieve more perfect combustion of fuel and to reduce the amount of particulate matter.

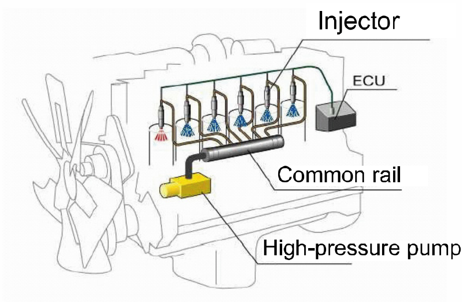

Fig. 2 Injection system

NOx emissions were reduced by employing cooled EGR in the exhaust system and by feeding exhaust gas cooled by a water-cooled cooler to the air supply side to lower the combustion temperature. The optimum EGR rate was achieved by controlling the pressure balance between the air supply side and exhaust side at this time. A bypass circuit was provided between the air supply side and exhaust side and a bypass valve was opened to feed exhaust gas to the air supply side by using air intake pressure, to prevent an EGR shutdown in case pressure of the exhaust side was lower than that of the air intake side depending on the engine operation state.

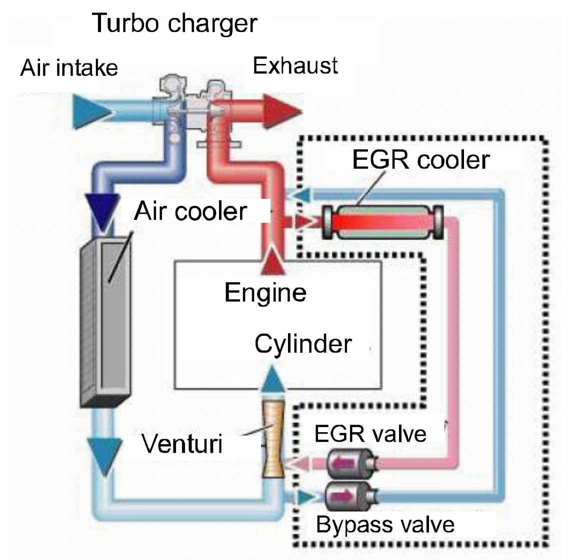

Fig. 3 EGR configuration

2) Reduction of ambient noise

A noise absorption braid was installed with HM300-2 to prevent noise of the radiator fan and engine body, which were the main sources of ambient noise, from leaking through the opening in front of the radiator, to meet EU Tier2 noise regulations (**Fig. 4**).

At the same time, a sound-absorbing material was placed on the inner walls of the engine hood to reduce transmission sounds from the engine hood.

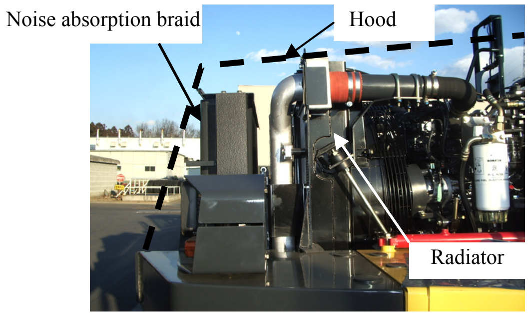

Fig. 4 Radiator air intake opening

HM250-2 conforms to EU noise regulations without installing a noise absorption braid and sound-absorbing material inside the hood by:

- Engine output change (345PS → 315PS)
- Change in engine high idling revolution speed (2200rpm → 2100rpm)
- Change in engine control during low speed travel (travel in F1 gear)

Eliminating the need for a noise absorption braid freed up space so the total length was reduced. (Front overhang shortened by 210mm compared with HM300-2. **Fig. 5**)

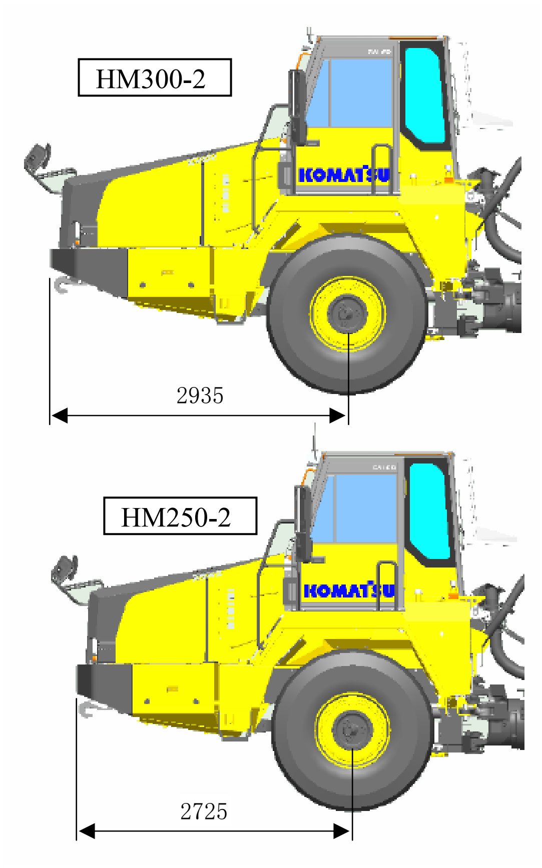

Fig. 5

3) Environmental friendliness

· Aluminum radiator

An aluminum radiator was installed to prevent environmental pollution by lead.

· Prevention of oil oozing from axles

The following modifications were made to reduce oozing of cooling oil through the floating seals of the axles to the absolute minimum.

(1) Low cooling oil pressure

A brake cooling valve (BCV - refer to “Modification of brake cooling circuit” in 4.3) was installed in the brake cooling circuit, to lower the pressure applied to the floating seals by directly draining some oil from the BCV into the tank when the brakes were not applied.

(2) Improved lubricity of seal surfaces

The lubricity of the floating seal surfaces was enhanced by changing the material of the floating seals from cast iron seals to sprayed seals.

Oil oozing was reduced significantly by (1) and (2).

(3) An oil recovery tank was installed on each wheel to pool oil in the tanks in case oil leaked. Oil in the tanks is recovered during periodic maintenance using a hand pump installed on the vehicle.

Fig. 6 Oil recovery tank (From product bulletin)

4.3 Safety

As in HM300-2, HM250-2 conforms to EN474. Since HM250-2, all Komatsu articulated dump trucks models have incorporated the following features:

(1) Engine-hood double lock mechanism

A double lock mechanism was added to prevent obscuring operator visibility by opening of the engine hood during vehicle travel due to a damaged catch that anchors the engine hood. A lock rod disables further hood motion and prevents the hood opening fully when the hood opens even slightly (**Fig. 7**).

(2) Battery disconnecting switch

A switch was installed between the negative terminal and the body ground to prevent discharge even if the battery cable was not disconnected during long down time. (The switch is installed on all Komatsu construction machinery destined for EU countries beginning October 2008.)

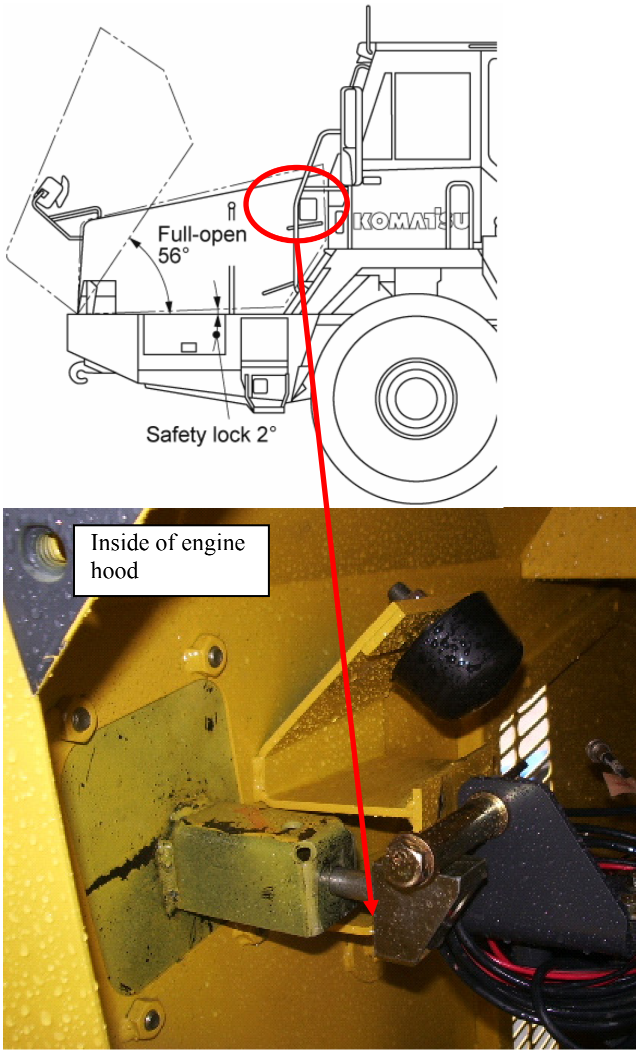

Fig. 7 Engine-hood double lock mechanism

4.4 Economical efficiency

Horsepower loss was reduced and fuel consumption was improved to upgrade the economical efficiency.

1) The operation ratio at a low engine load is relatively high in road and construction works where articulated dump trucks are used. Taking note of this low-load part, fuel consumption was reduced by changing the gear-shift logic of the transmission in the partial region.

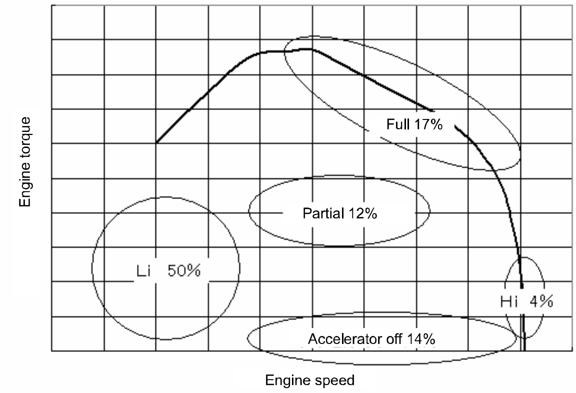

Fig. 8 Engine operation ratio (One example of usage)

Articulated dump trucks automatically change their transmission gears through a controller. The engine speed during a gear change was changed in accordance with the engine load to reduce the fuel consumption of the engine.

The engine speed for shifting up was increased to secure high driving force during uphill traveling, acceleration or fully loaded travel when the engine load was high.

The engine speed for shifting up was set low during traveling on a flat road or flat place when the engine load was low. As a result, the following reductions in loss horsepower were achieved.

· Reduction in racing loss horsepower of the transmission
· Reduction in fan driving horsepower
· Reduction in engine friction loss horsepower
· Reduction in pressure loss of hydraulic circuit

2) Wet-type multiple disc brakes for the first time in the 25-ton class

As in HM300-2, the brake system is comprised of dual axle brakes in the front and center. Both axles have wet type multiple disc brakes for maintenance-free operation. The maintenance cost is reduced due to the long disc life compared with conventional disc brakes (**Fig. 9**).

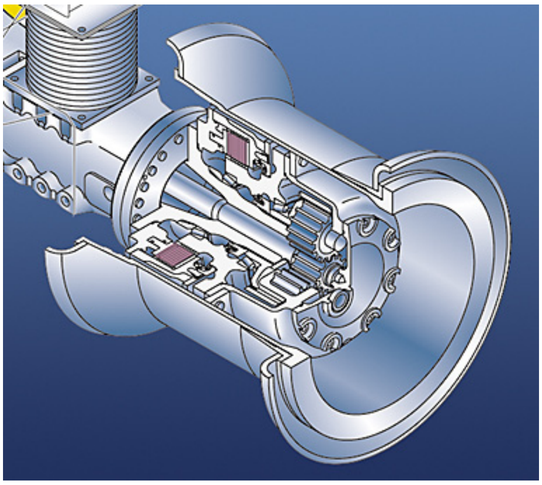

Fig. 9 Wet-type multiple disc retarder brake (From product bulletin)

3) Reduced power loss of brake cooling circuit

As in HM300-2, the retarder brakes installed with axles for descending a slope at high speed are cooled forcibly by circulating oil. A brake cooling valve (BCV) was installed with this cooling circuit, to reduce the flow rate in the retarder brakes while the brakes were not activated, to reduce:

· Pressure loss of the cooling circuit
· Axle racing loss horsepower

4.5 Productivity

1) Equipped with the same maximum engine torque as that of a higher model, HM300-2, the work rate during uphill traveling and at a muddy site or other place, where running resistance is high, is increased.

The vehicle speed during descending a slope is increased by retarder absorption horsepower unrivaled by competing machines, to achieve travel performance that can be demonstrated on any road.

2) KOMTRAX II is installed to obtain operational and fuel consumption information.

5. Conclusion

This development project allowed a very short lead time to quickly respond to market needs. The development was completed in time by innovations such as installing a single-stage double acting hoist cylinder for the first time for Komatsu's dump trucks, to achieve both low cost and high performance.

Introduction to the writers

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[A few words from the writers]

During the course of this development, we experienced great failures when tackling new challenges such as in the use of a single-stage cylinder. These problems were solved and the development work was accomplished on time. Teamwork was essential to this development, which could not have been achieved without the cooperation of not only the design department, but also the manufacturing, testing and other departments.