Introduction of Products

Introduction of Komatsu genuine hydraulic oil KOMHYDRO HE

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Komatsu developed genuine hydraulic oil KOMHYDRO HE to reduce internal leakage of the hydraulic system and increase the system efficiency by increasing the viscosity in the operating temperature range and put it in the market in September 2009. The development concept and outline of this KOMHYDRO HE are introduced in this paper.

1. Introduction

Global warming is a serious environmental problem which we have confronted and is getting serious. Construction machinery also emits CO_2 which is considered to be one of the causes of the global warming. The CO_2 emission from construction machinery is estimated at about 0.35% of the total CO_2 emission in the entire world.

As a measure to reduce the CO_2 emission, or the fuel consumption, Komatsu put the hybrid hydraulic excavator in the market (**Fig. 1**).

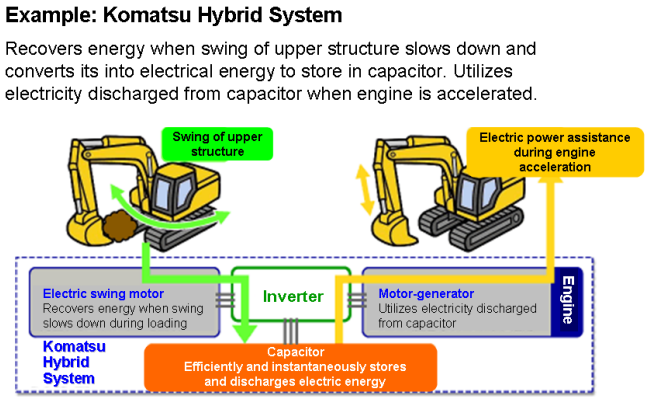


Fig. 1 Hybrid construction machinery

In addition, Komatsu is working on increasing the efficiency of the hydraulic system as an important subject since power is transmitted hydraulically in the construction machinery.

As a mean to increase the efficiency of the hydraulic system, oil companies have been developing energy saving hydraulic oil containing friction modifier or having high viscosity index (**Table 1**). Komatsu developed hydraulic oil of high viscosity index which features less leakage inside the hydraulic components to reduce fuel consumption of hydraulic excavators and put it in the market. This report introduces this new oil.

Table 1 Energy saving hydraulic oil available in the market

High-efficiency hydraulic oil for fuel economy are sold in the Japanese market. Most of them contain various additives to reduce friction coefficient and to improve VI (Viscosity Index).

Supplier	Brand name	Outline
Japan Energy	Hydrux SES	With friction modifier, VI =167
Cosmo Oil	Cosmo Hydro HV	With friction modifier, VI =132
Nippon Oil	Super Highland SE	With friction modifier, VI =129
Showa Shell	Tellus Oil SX-Z	Synthetic oil with FM, VI =136
Idemitsu	Daphne Super Hydro ST	VI =150

2. System and efficiency of construction machine

Among the construction machinery, hydraulic excavators emit CO_2 most and their emission accounts for about 60 % of the total (**Fig. 2**).

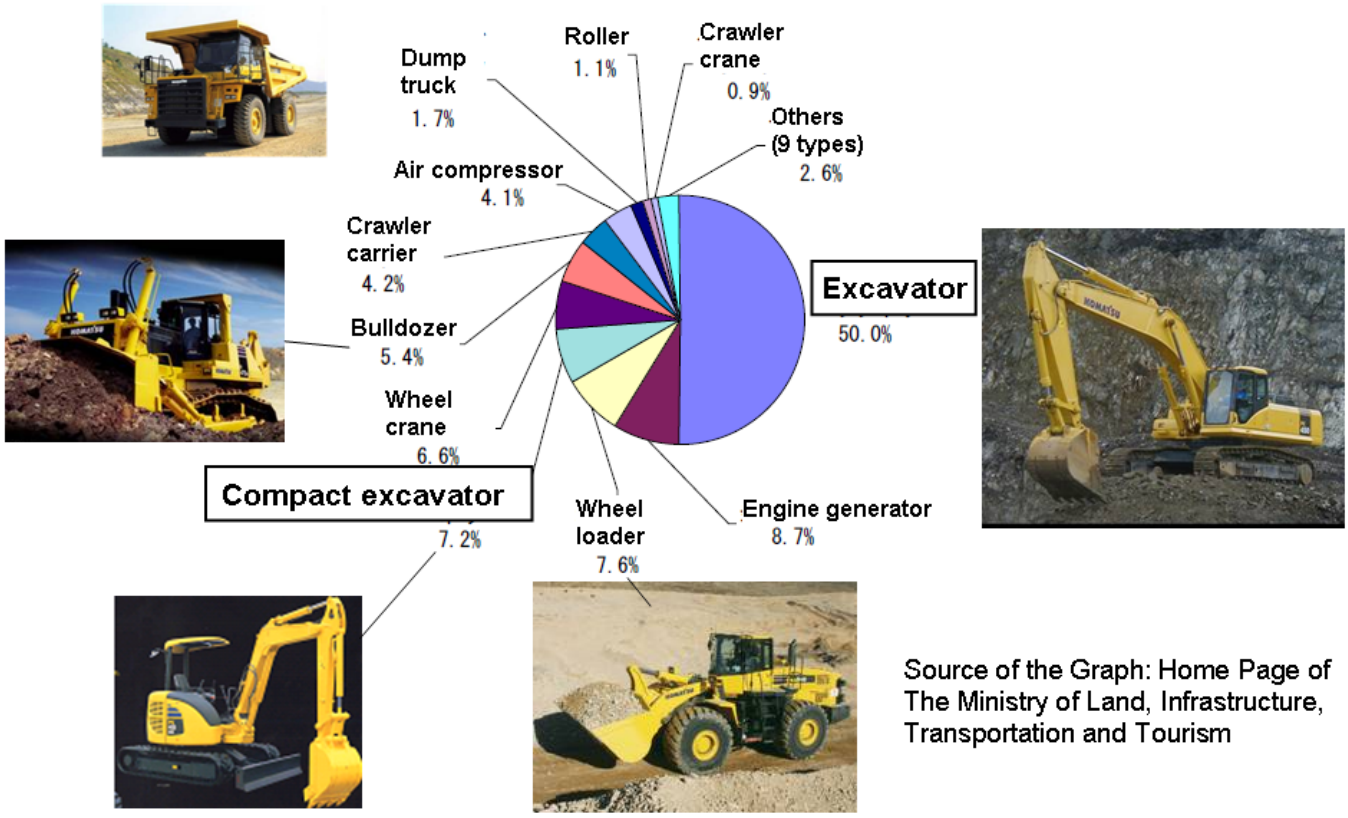


Fig. 2 Percentage of total CO_2 emission by type of construction machinery

The hydraulic system of a hydraulic excavator and the energy loss caused in the system are explained below.

In the hydraulic excavator, the diesel engine drives the hydraulic pump. The hydraulic oil delivered from the hydraulic pump is sent through the control valve to the actuators such as the travel motor, work equipment cylinders, etc. to perform work such as digging, travel, and swing (**Fig. 3**).

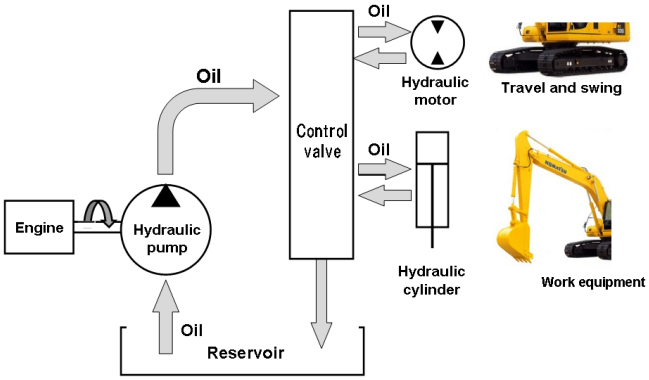


Fig. 3 Outline of hydraulic system of hydraulic excavator

Energy loss in the hydraulic excavator occurs mainly in the engine and hydraulic system. The energy loss in the hydraulic system includes (1) loss due to sliding friction in the hydraulic pump and hydraulic motor, (2) pressure loss in the piping, and (3) loss due to oil leakage inside the hydraulic pump, hydraulic motor, and control valve (**Fig. 4**).

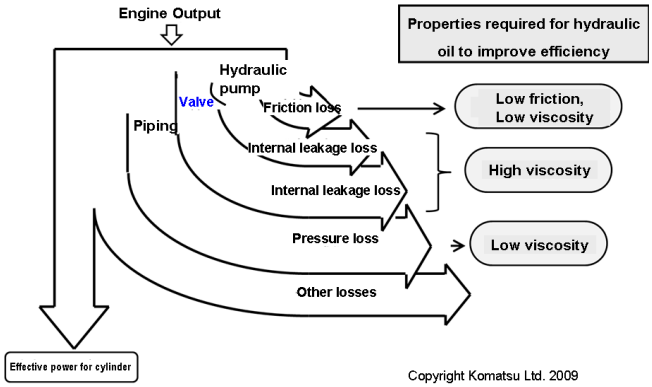


Fig. 4 Energy loss caused in hydraulic system and measures to increase efficiency

3. Energy saving hydraulic oil for construction machinery

To increase the efficiency of the hydraulic system of the construction machinery, the hydraulic oil must have the following characteristics; (1) Low friction coefficient and low viscosity to reduce the sliding friction loss caused in the hydraulic pump and hydraulic motor, (2) Low viscosity to

reduce the pressure loss caused in the piping, and (3) High viscosity to reduce oil leakage inside the hydraulic pump, hydraulic motor, and control valve.

Meanwhile, since the construction machinery is used in many regions from cold to tropical regions, it must have the ability to operate in a wide temperature range. In addition, it must meet required characteristics of mechanisms necessary for a vehicle including frictional characteristics of the wet-type brake, which are not required for a stationary hydraulic system.

Table 2 Features of hydraulic oil for construction machinery

	Industrial Machine	Construction Machine
Hydraulic Pump & Motor	Vane Pump, Gear Pump, Piston Pump/Motor	Piston Pump/Motor Gear Pump
Pressure, MPa	13 - 32	32 - 42
Oil Temperature, C	60	80 - 100
Cold startability	Not Necessary	Necessary (< -20 C)
Oil Reservoir	Open/Closed	Pressurized or Closed
Airation	Small	Yes
Tank Capacity	Large	Small
Parking Brake	No	Yes
Allowable Limit of H2O, %	> 1.0	< 0.2
Water Drain	Yes (Drain Cock)	No
Mix of dust	> NAS 7 Grade	Some cases; < NAS 9
Mix of engine oil	None	Yes

⇨ Higher pressure

⇨ Wider operating temperature

⇨ Need to consider friction coefficient of brake materials

⇨ Poor maintenance conditions

Accordingly, the above measures for increasing the efficiency cannot be employed simply for the following reasons. (1) Low friction coefficient lowers the brake performance, (2) Low viscosity increases internal leakage during operation at high temperatures and accordingly decreases the efficiency, and (3) High viscosity lowers the fluidity during operation at low temperatures and accordingly decreases the operability.

To solve these problems, many measures have been taken, and Komatsu has developed hydraulic oil having high viscosity index which decreases oil leakage inside the hydraulic components (**Fig. 5**). The following is the explanation of this new oil.

This hydraulic oil has a high viscosity index of 200. (**Fig. 6**)

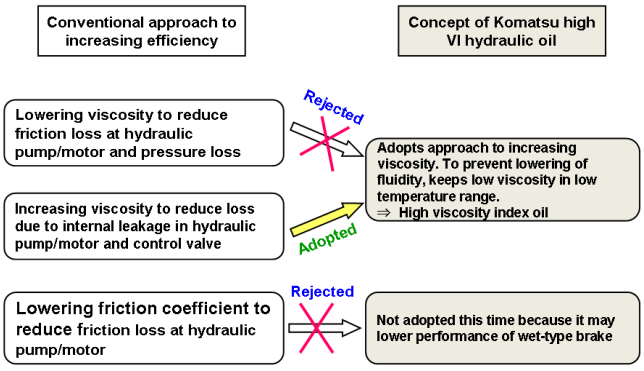


Fig. 5 Concept of Komatsu high viscosity index oil

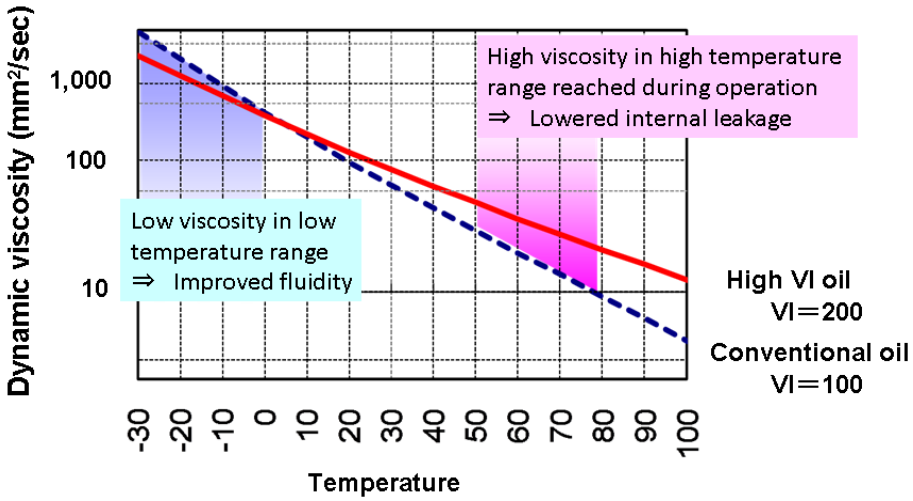
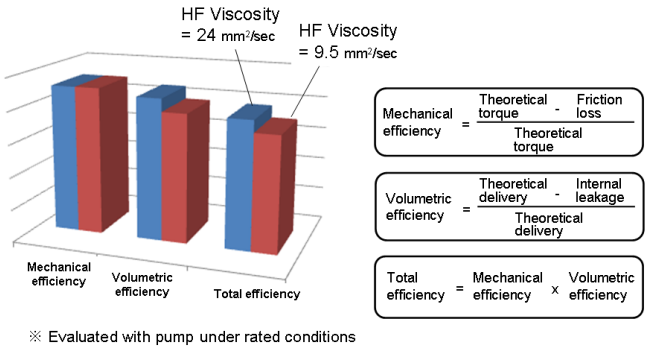


Fig. 6 Viscosity characteristics of Komatsu high viscosity index oil

The hydraulic oil temperature of the construction machinery is about 50 to 80 °C during normal operations. The new oil has a dynamic viscosity higher than that of the common hydraulic oil in this temperature range (about twice at 100 °C). Accordingly, the oil leakage inside the hydraulic component is less than the common hydraulic oil in the range of oil temperature during operation.

In this temperature range, the sliding frictional resistance in the hydraulic pump and hydraulic motor and the pressure loss caused in the piping increase, but their impact is little for the efficiency increase by the internal leakage reduction. As a result, the hydraulic system efficiency is increased (**Fig. 7** to **10**).



Higher viscosity provides higher efficiency (under rated conditions)

Fig. 7 Effects of viscosity of hydraulic oil on pump efficiency

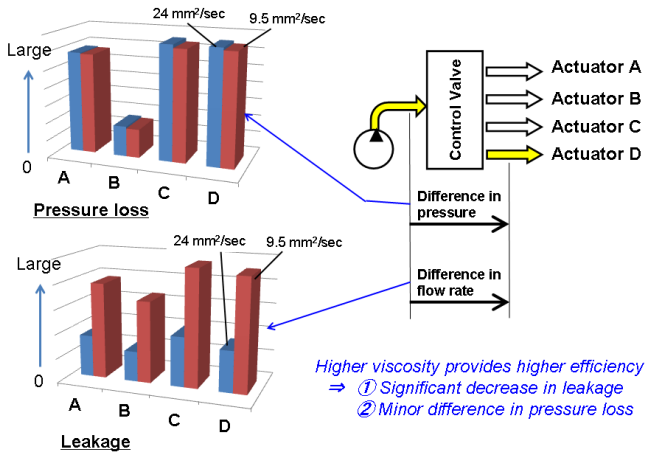


Fig. 8 Effects of viscosity of hydraulic oil on leakage and pressure loss

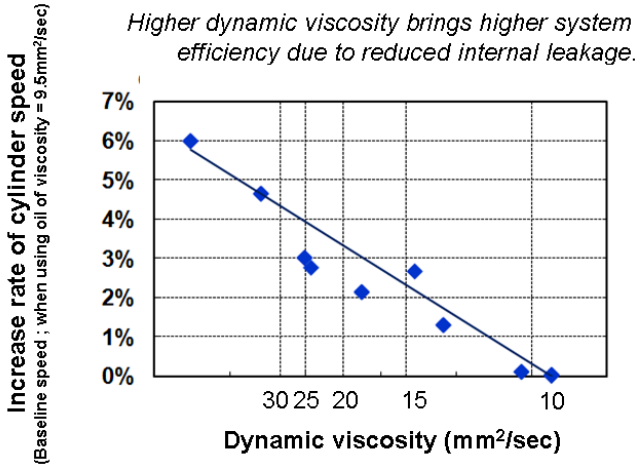
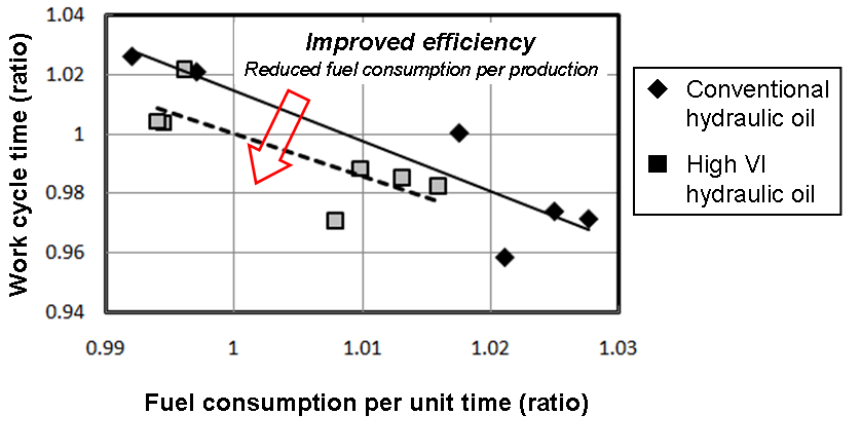


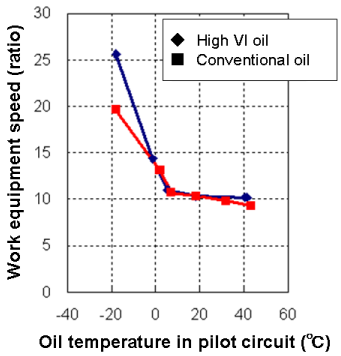
Fig. 9 Relationship between dynamic viscosity of hydraulic oil and working efficiency (hydraulic cylinder speed)



Test results of loading onto truck by Komatsu medium-sized excavator

Fig. 10 Effect of high viscosity index oil

On the other hand, the new oil has a dynamic viscosity lower than that of the common hydraulic oil in the range of low oil temperatures for operation in a cold region. When a construction machine is operated in a cold region, its workability may be lower than usual because of the low fluidity of the hydraulic oil in the hydraulic system. However, since this hydraulic oil of high viscosity index has good fluidity at low temperatures, high operability is obtained (**Fig. 11**). This feature can shorten the necessary warm-up operation time of the construction machinery in cold regions, that is, it can increase the efficiency.



Test conducted in Hokkaido, Japan

Relationship between hydraulic oil temperature in pilot circuit and work equipment speed

Fig. 11 Low-temperature characteristics of high viscosity index oil

Judging from the above, this hydraulic oil of high viscosity index can attain high efficiency of the hydraulic system in the wide operating temperature range specific to the construction machinery. For the effect on friction characteristics, it has the same performance as the common hydraulic oil and does not lower the brake performance.

Komatsu has put this hydraulic oil of high viscosity index "KOMHYDRO HE" in the market (**Fig. 12**).

Komatsu launched KOMHYDRO HE in September, 2009 to improve efficiency of hydraulic excavators. KOMHYDRO HE is used in Komatsu hybrid hydraulic excavator.

Fig. 12 KOMHYDRO HE

4. Conclusion

As the technology to increase the viscosity index of the lubricating oil including hydraulic oil progresses, use of single grade oil which needs seasonal change of its type has been replaced with multi grade oil which can be used through the year.

KOMHYDRO HE is unique hydraulic oil developed by advancing and utilizing the viscosity increasing technology, which is usable through the year, saves the fuel, and increases the efficiency of the construction machinery.

Fuel saving and high efficiency will be further required as the environmental problem becomes a larger concern, thus we must develop lubricating oils that meet the request.

Introduction of the writers

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[A few words from writers]

If the machine is compared to the man, the lubricating oil is an “important part” which can be the blood, muscle, and even the nervous system. Accordingly, development of high-performance lubricating oil can contribute to improvement of the competitive edge of the construction machinery and we are proud of this development showing that it is possible.

We were able to complete this development with the full backing of the departments of Tractor Design, Component Design, Testing, Production Division, Quality Assurance Department, Procurement Division, and Product Support Division. We also received great assistance and directions from the lubricating oil supplier. We thank all of the persons who gave us cooperation in this development.