Product Introduction

Development of Piston Pump PSVL-50 for 3 to 4-ton Mini Excavators

TAKEI Gen

1 Introduction

KYB's first mass-produced piston pump product for the Load Sensing (LS) system of mini excavators was the PSVL-54 for 5 to 6-ton excavators in 1996. In 2001, the company launched PSVL-42 for 3 to 4-ton excavators. In its history of more than 20 years, this product has remained almost as originally designed.

In recent years, more and more LS systems have been introduced into the mini excavator market. KYB has a range of LS system pumps for excavators of 3 tons or more, many of which have a long history as mentioned above. In anticipation of further growth in demand for LS systems in the future, we have developed the PSVL-50.

2 Overview of the Developed Product

2. 1 Product for LS System

KYB's LS system products consist of PSVL series pumps and KVSX series control valves. These products are available as a hydraulic system for excavators from the 3-ton to 8-ton series (Table 1). The newly developed PSVL-50 is designed for 3 to 4-ton excavators and is the successor of the current PSVL-42.

Table 1 LS system product lineup

3 ton	5 ton	7 ton	Piston pump	Control valve
			PSVL-42	KVSX-12
			PSVL-50	(KVSX-12or14)
			PSVL-64	KVSX-14
			PSVL-84	KVSX-18

2. 2 Current PSVL Series

The specifications of the current PSVL series are summarized in Table 2. The appearance is shown in Fig. 1. KYB's PSVL series features LS gain change control using a pilot pump and its discharge flow (LS control differential pressure changes according to input speed) as a standard function. As the engine speed is reduced, the maximum flow of the pump decreases accordingly. If the LS gain change control function is not available, the pump would reach the maximum operating speed in the middle of the input operation with the lever. With this function, the engine speed can be lowered along with the LS control flow, providing a wider range of cooperative operation of lever input and operating speed.

Please note that these specifications or standard features may be modified to meet customer requirements. Functions not listed in the specification table are subject to review for addition. KYB believes that its flexibility is one of its strengths.

Table 2 PSVL series specifications

Model		PSVL-42	PSVL-64	PSVL-84
Displacement (cm^3/rev)		Max 42.0	Max 64.0	Max 84.6
Maximum pressure (MPa)		24.5	28.0	32.0
Input speed (rpm)		2500	2400	2200
Pilot pump		Standard		
Displacement of pilot pump (cm^3/rev)		4.0 or 7.0		
Maximum pressure of pilot pump (MPa)		4.9		
Control system	LS control	Standard		
	LS gain change control	Standard		
	Horsepower control	Standard		
	Hydraulic pilot horsepower control shift	○	○	○
	Electromagnetic proportional horsepower control shift	○	○	○
	Pilot operated directional control valve	×	×	×
Installation	Spigot joint diameter (mm)	101.6	101.6	152.4
	Bolt pitch (mm)	180.0	200.0	228.6
	Bolt hole size (mm)	14.0	17.5	17.0
	Suction port (mm)	SAE 1 1/2 (port size ϕ38)	SAE 2 (port size ϕ45)	SAE 2 1/2 (port size ϕ63)
	Discharge port	G3/4	G3/4	G1

Fig. 1 Product appearance
(from left to right: PSVL-42, PSVL-64, PSVL-84)

2. 3 PSVL-50 Product Specifications

Table 3 shows the product specifications of the

current PSVL-42 and the newly developed PSVL-50. Fig. 2 shows the appearance of these products.

Table 3 Product specifications

Item		Current product	Developed product
Model		PSVL-42	PSVL-50
Displacement (cm^3/rev)		Max 42.0	Max 50.0
Maximum pressure (MPa)		24.5	28.0
Input speed (rpm)		2500	2500
Maximum input torque (horsepower control) (N・m)		165 (114)	223 (150)
Maximum flow rate (L/min)		106.0	125.0
Pilot pump		Standard	Standard
Control system	LS control	Standard	Standard
	LS gain change control	Standard	Standard
	Horsepower control	Standard	Standard
	Hydraulic pilot horsepower control shift	○	○
	Electromagnetic proportional horsepower control shift	○	○
	Pilot operated directional control valve	×	○
Overall length (mm) *Including GP, except options		265.5	259.2
Overall height (mm)		218.0	171.0
Overall width (mm)		210.0	170.0
Weight (kg)		30	23
Installation	Spigot joint diameter (mm)	101.6	101.6
	Bolt pitch (mm)	180.0	146.0
	Bolt hole size (mm)	14.0	14.0
	Suction port (mm)	SAE 1 1/2 (port size ϕ38)	SAE 1 1/2 (port size ϕ38)
	Discharge port	G3/4	G3/4

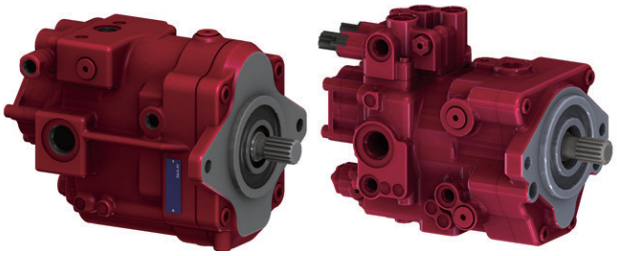

Fig. 2 Product appearance (Left: PSVL-42, Right: PSVL-50)
*The current product appears with standard features provided, while the developed product appears with full options provided. The same applies to the appearance in all figures on the following pages.

The basic product specifications include a maximum displacement of 50 cm^3/rev, which is the highest level in the 3 to 4-ton class market, a maximum pressure of 28 MPa, and a maximum input torque of 150 N・m during horsepower control. The developed product uses a mounting flange of standard SAE-B specifications, which is a non-standard feature in the current product.

2. 4 Features of the Developed Product

2. 4. 1 Weight Reduction

The developed product has been substantially modified in its internal configuration for downsizing and weight reduction. Mainly by modifying the pump displacement control mechanism, we have significantly reduced the overall height and reduced the weight of the pump body by about 23% from the current product as shown in Fig. 3, contributing to improved mountability on the actual machine and cost reduction.

2. 4. 2 Design for LS System

The developed product, designed to be used for an LS system, incorporates the valve essential for LS control into the pump body to reduce cost and weight (Fig. 4).

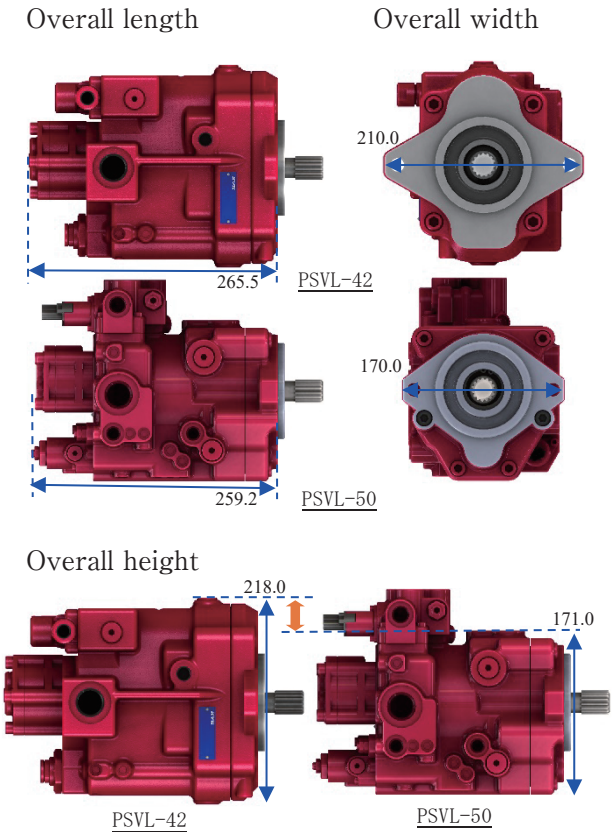

Fig. 3 Size comparison

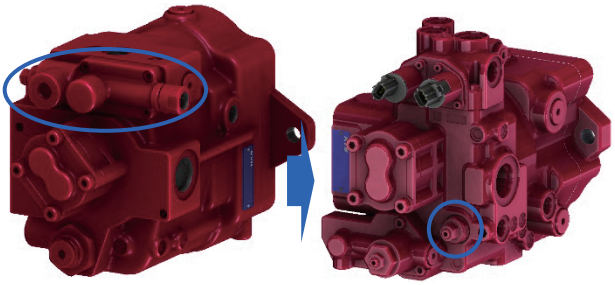

Fig. 4 LS valve appearance (Left: current product, Right: developed product)

2. 4. 3 Optional Functions

The developed product offers two optional functions.

One is the horsepower control shift. As shown in Fig. 5, the horsepower control characteristics can be shifted in parallel with electrical signals or external pilot pressures. This function can be freely

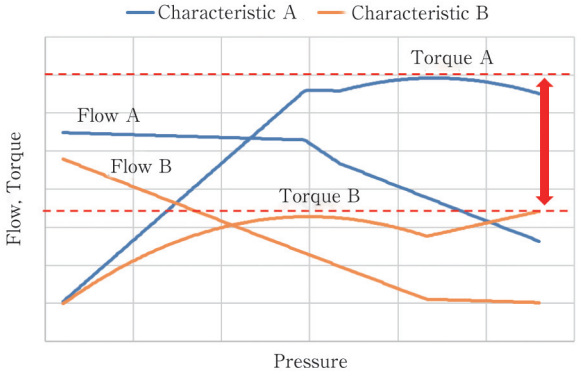

Fig. 5 Example of horsepower control shift characteristics

customized according to the customer's needs, allowing a variety of control.

In order to achieve both the various control characteristics of the horsepower control shift and productivity, we replaced the conventional internal horsepower control valve with an external type. This replacement made it possible to enable/disable the horsepower control shift only by attaching/detaching the valve. While the conventional product required a change on the body housing side, the developed product has a standardized body housing regardless of whether it has this option or not. The developed product saved space by designing the proportional solenoid used for the electromagnetic proportional horsepower control shift to face the pump body.

The other optional function is the pilot operated directional control valve. This is a valve used to switch the pilot pressure supply to lever operation, second gear drive, or other operation. As shown in the schematic diagram in Fig. 7, it includes a pilot relief valve and an accumulator check valve. This directional control valve is often installed in the machine body separate from the pump. With this option, excavator manufacturers can choose to concentrate components by integrating the valve into the machine layout or can reduce piping by mounting the valve on the pump.

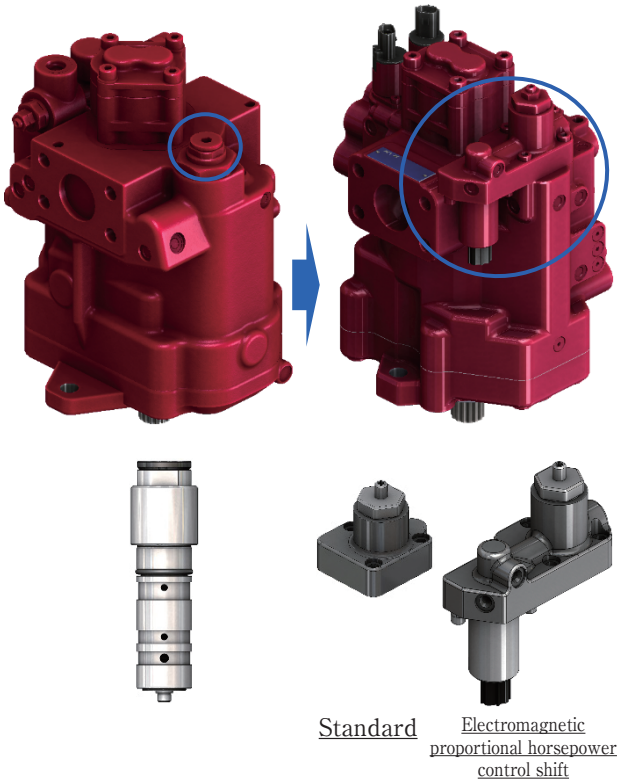

Fig. 6 Horsepower control valve (Left: conventional product, Right: developed product)

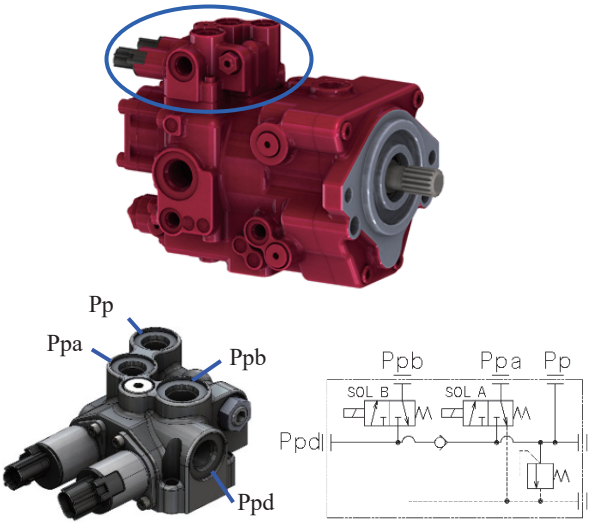

Fig. 7 Pilot operated directional control valve

3 Future Prospects

Based on the product model developed in this project, other classes of next-generation PSVL series are planned to be developed sequentially. The new product configurations are expected to significantly reduce the weight of the products compared to the conventional counterparts. Developing series products will contribute to social goals such as achieving carbon neutrality. To release the products earlier, we are committed to working harder on development.

4 In Closing

We are very pleased that, with the help of those around us, we were able to successfully launch the product, despite the challenges we faced during development due to the significant changes made to the current pump.

Finally, we would like to express our deep gratitude to everyone involved for their tremendous cooperation during the development.

Author

TAKEI Gen
Joined the company in 2013.
Pump and Motor Design Sect., Sagami Hydraulics Engineering Dept., Engineering Headquarters, Hydraulic Components Operations.
Engaged in design and development of hydraulic piston pump products.