

Hysteresis

Refer to Development of the KVSX-12C-PSL control valve for small hydraulic excavators (page 24).

FUKUSHIMA Ryo, Valve Design Sect., Nagano Hydraulic Engineering Dept., Hydraulic Components Operations

1 What is Hysteresis?

Hysteresis is a delayed response to an applied force rather than an immediate one.

In the context of control valves, hysteresis refers to the phenomenon whereby the spool moves along different trajectories during pressurization and depressurization in response to hydraulic or electric signals input from the machine lever.

Fig. 1 shows a simplified waveform of the pilot spool pressure response characteristics. With the horizontal axis showing pilot pressure and the vertical axis showing spool stroke, the graph plots the operations of pressurization and depressurization operations. The farther apart these two curves are, the greater the hysteresis. In the graph, $\Delta PH1$ indicates the maximum hysteresis of the spool with no oil flow and $\Delta PH2$ indicates the maximum hysteresis of the spool with oil flow. ΔPF indicates the maximum flow force.

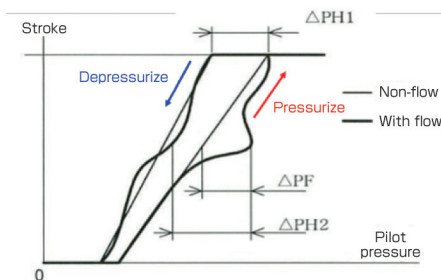


Fig. 1 Pilot spool pressure response characteristics diagram

$\Delta PH1$: Non-flow hysteresis

Affected by the workmanship of sliding components.

$\Delta PH2$: Flow hysteresis

Includes the effects of flow force in addition to $\Delta PH1$.

ΔPF : Flow force

The difference between flow and non-flow. It is a force attributable to the pressure distribution on the spool surface.

Large hysteresis can cause problems with the actual machine. The operating speed and pressure of the actuator may vary during pressurization or depressurization operations with the lever.

Possible causes of large hysteresis include small clearance of the spool, increased sliding resistance due to the spool bore or spool being out of alignment, and spool snagging caused by burrs.

KYB has established internal specifications to control hysteresis during operation of the main spool. We set the appropriate clearances and geometric tolerances. We also machine grooves on the outer circumference of the spool (Fig. 2) to ensure uniform pressure application over the entire circumference. This reduces hysteresis by suppressing physical sliding resistance.

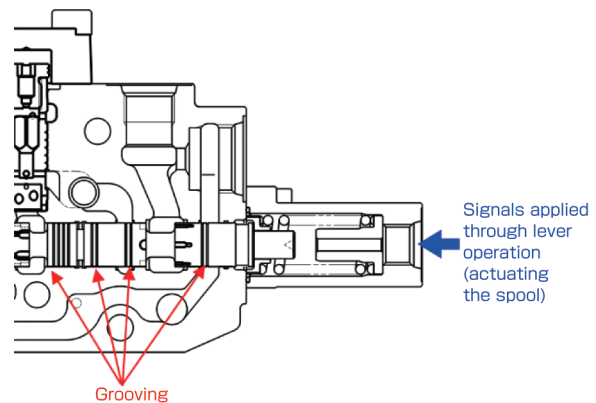


Fig. 2 Grooving