A NEW DIRECTION

Steer-by-wire in the era of
the software-defined vehicle

COOL IT

TLX Technologies' Chad VanRens discusses the vital role proportional flow control valves play in liquid cooling systems

TLX's discrete proportional valve system

As electrically powered systems across all sectors grow increasingly complex, the number of loads competing for a finite amount of power grows too. Engineers are under constant pressure to find solutions that are as energy efficient as possible within ever-tightening design constraints.

This pressure is underscored by the rapid proliferation of new data centres. In a data centre, even small improvements to energy efficiency at the component level can deliver much-needed power savings.

MAXIMISING EFFECTIVENESS

Electricity can account for as much as 30% of a data centre's operating costs. While most of that is used for powering servers, networking, and other IT-related functions, a significant portion is used for the cooling systems, often between 30% and 40%.

Consequently, engineers work hard to design data centres to maximise power usage effectiveness (PUE), which is the ratio of the facility's total power consumption compared to the amount of power consumed by computing operations. A key strategy for improving PUE is to improve the efficiency of the facility's thermal management system.

For decades, data centres relied heavily on air cooling to keep servers cool. But air cooling is insufficient for AI, high-performance computing (HPC), and hyperscale data centres. It is also an energy hog. Consequently, liquid cooling systems are seeing increased adoption. Liquid cooling systems are better at heat transfer than air cooling and support higher power rack densities. They also use far less electricity – as much as 20% less.

VALVES ARE VITAL

Proportional flow control valves are cardinal components in liquid cooling systems. A facility with a single liquid-cooled server may use one or two valves. A hyperscale data centre with extensive use of liquid cooling may use hundreds or even thousands of valves. Regardless of the scale of the system, the impact of the valves should not be underestimated.

An ideal proportional valve would not require constant power to maintain state, would be capable of a true leak-free off state, and would have a predictable and repeatable relationship between setting and flow (zero hysteresis). A valve with these characteristics not only reduces the amount of power consumed by the valve but also improves the energy efficiency of the cooling system.

Many traditional proportional valves lack this combination of attributes. They always exhibit some hysteresis induced by mechanical friction, backlash, and magnetics. This can cause fluid pumps to run harder or longer to maintain target conditions. Depending on the

design, they may also rely on constantly energised coils to maintain flow state. These characteristics reduce the system's energy efficiency.

ENTER THE DPV

TLX Technologies developed the discrete proportional valve system (DPV) to overcome these deficiencies. This valve system employs a combination of latching solenoid valves of differing flow coefficients, which use only a short pulse of current to actuate and no current to maintain state. These valves are housed in a single manifold, providing stepped-function flow control. The desired flow rate is achieved by opening and closing the valve members in specific combinations, and the flow rate is maintained without drawing current.

In a traditional proportional valve, the rate of flow increases or decreases in a linear fashion, but in the DPV, the flow rate changes in discrete steps and can be customised for four, eight, or 16 flow states with either a true zero-flow or low-flow initial state.

By design, the DPV exhibits zero

By design, the DPV exhibits zero hysteresis
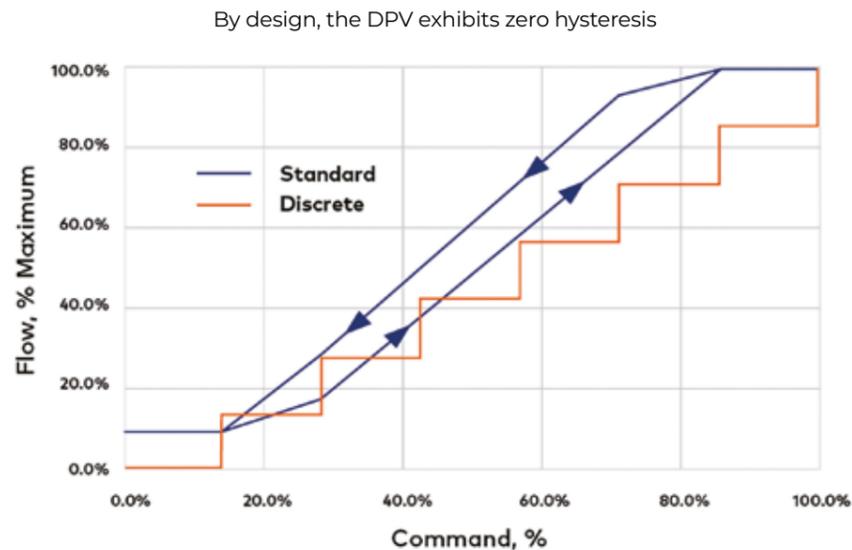
DPV system flow characteristics

State	Flow Rate GPM	Flow Rate L/min	Delta P psi	Delta P kPa
0	0.0	0.0	9.4	65
1	0.6	2.3	8	55
2	1.1	4.0	7.3	50
3	1.4	5.3	6.7	46
4	1.5	5.8	6.4	44
5	1.7	6.5	6.1	42
6	1.9	7.2	5.8	40
7	2.1	8.1	5.4	37

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hysteresis because the same valve members open and close in the same combination for any given flow state, resulting in the same repeatable flow coefficient regardless of whether the flow rate is increasing or decreasing.

A true zero-flow state is also native to the DPV. Other forms of proportional control can achieve near-zero flow, but to do so they require tight tolerances. This increases cost and sensitivity to debris and wear. The DPV's debris tolerance can be tailored to the needs

of the system, or the actuators can be isolated from the fluid flow, preventing ingress of debris to the actuators.

TLX's engineers work closely with design teams to map out the best iteration of the DPV for their system. They consider a range of parameters that include power limits, size limits, flow requirements, number of flow states, how the flow rates should change from state to state, and whether the system requires an initial zero- or low-flow state.

Data centre liquid cooling systems

are just one example of where the DPV can pay valuable dividends. With energy efficiency being an overriding design consideration for an increasing number of applications that use liquid cooling, the DPV has the potential to realise significant energy savings. •

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