Article

Danfoss OFC check and stop valve performance gain proven

By Miao Yan, Danfoss Product Manager for OFC, and Leping (Jessica) Zhang, Senior Manager at DCS Solution & Technology.

Tests conducted at the Danfoss Application Development Center in Haiyan, China demonstrated that the company's Oil-Free Check Valve (OFC) improves energy efficiency by 3% of a water-cooled chiller systems with Turbocor® compressors, offering potential savings on system design and running costs.

In 2021, Danfoss introduced the OFC check and stop valve, a game-changing discharge solution for oil-free systems. The OFC valve was designed to improve system efficiency by ensuring low pressure drops. But how much of an impact does the OFC valve have on system efficiency, when compared to other valve designs on the market? To find out, a cross function team of 15 experts tested – and demonstrated – how our Oil-Free Check Valve (OFC) solution can help boost system performance in water-cooled chillers by up to 3% compared with other check valve solutions. These tests back up the results previously generated only by simulations.

The test: dual plate check vs axial cone valves

The chiller tested had a cooling capacity of 50-430 kW. The discharge piping was an approximately 1m pipe expanding from approximately 60 to 100 mm. The team measured ΔP from the compressor discharge to the condenser pipe inlet.

The team tested two valve configurations: one with a direct mounted OFC and another with the 4" Dual Plate Check Valve. The ΔP measured with the OFC is -7.7 kPa while with the Dual Plate Check Valve is +7.1 kPa.

The results: OFC valve contributes to pressure recovery

Despite its lower Kv, the OFC axial valve achieved better pressure recovery due to its smooth, expanding geometry, which acts as a flow diffuser. The Bernoulli Principle states that in an expanding pipe section (diffuser), the fluid's velocity decreases and static pressure increases. The OFC's axial cone valve promotes this effect by guiding the flow through a smooth cone, converting kinetic energy into pressure[1].

In contrast, the dual plate valve caused turbulent separation and stagnation zones that increased irreversible pressure losses and reduced energy performance.

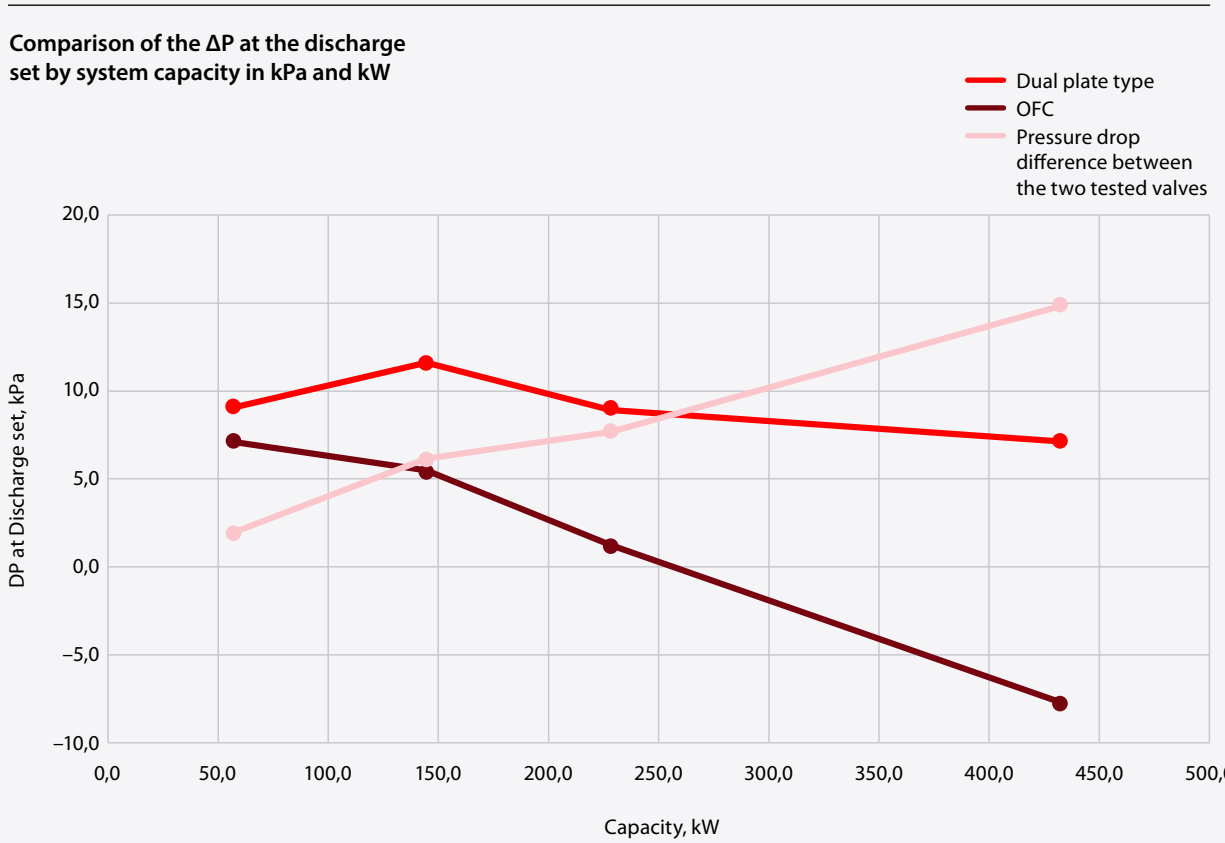


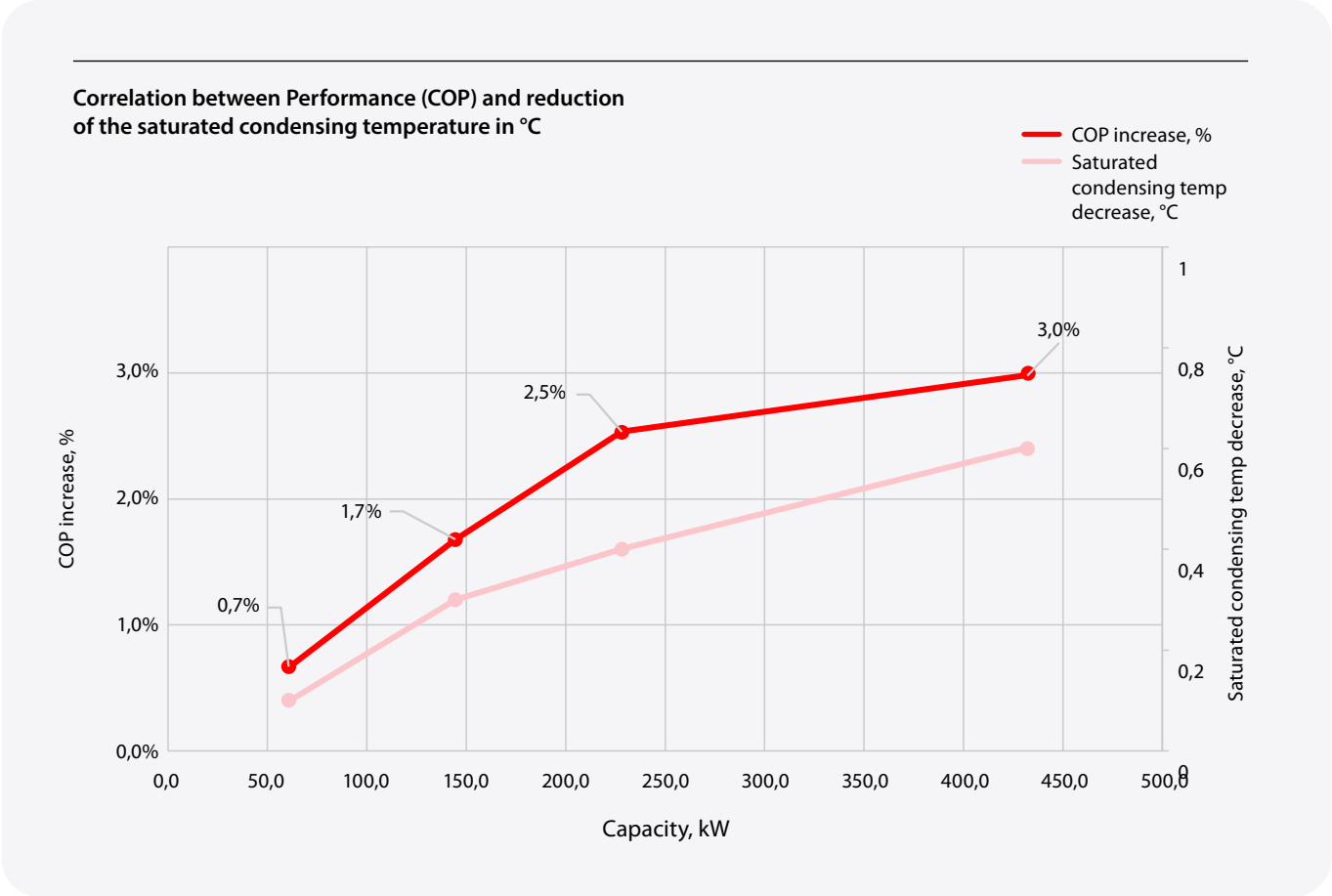
Figure 1: Due to the diffusion effect, the OFC valve helps the system recover pressure. This results in higher system efficiency, increasing with the system capacity.

[1] The pressure differential measurements were taken close to the valve outlet. Flow distortions can affect the absolute ΔP readings, hence standardized ISO/ASHRAE suggest set-ups where pressure taps are placed ≥5D downstream from the valve.

Impact on system performance and efficiency

The team used a Carnot-based COP estimation to determine what impact the OFC valve would have on overall system efficiency. In a full-load scenario, the estimated relative COP improvement would be ~3.35%. Assuming annual operating hours of 8,760, this would be energy savings of ≈11.6 MWh/year and an annual CO_2 reduction of ≈2.7 tons[2].

This also reduces the saturated condensing temperature and therefore a smaller condenser size can be used, reducing condenser cost for the same COP vs the system with a dual door check valve. Calculations give a reduction of the shell of the heat exchanger by 4.4% for an air-cooled system or by 17% for a water-cooled system.



↑ Figure 2: The lower pressure drop leads to a lower 0.6-degree Saturated Discharge Reduction (SDT), which corresponds to 3% COP increase as per test.

[2] In a 400 kW system and with the EU average of 0.233 kg/kWh.

Improved performance leads to capex and opex savings

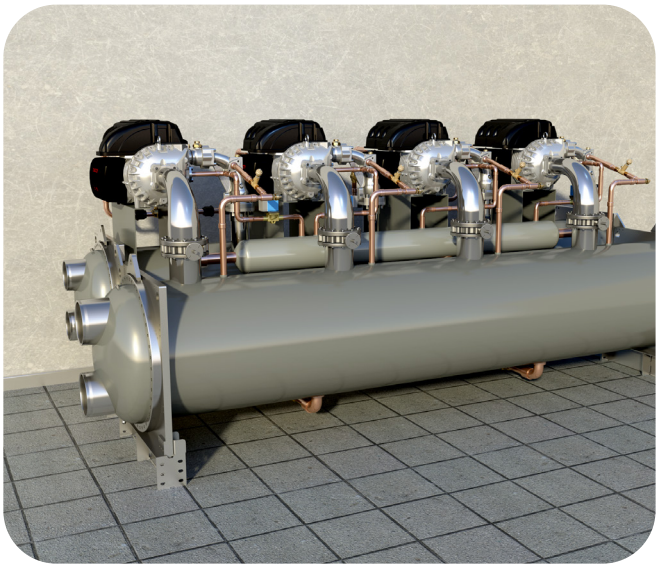
Although the OFC axial cone valve has a lower Kv when compared to its dual door counterpart, it performs better due to a smoother flow, pressure recovery and improved system efficiency of 3% COP[3]. And this improved system performance and efficiency translate into concrete savings for both system builders and end-users. "In terms of system design, the OFC creates less pressure loss, enabling the compressor to run at lower pressure ratio, which increases compressor performance and enables a wider cooling capacity range in a system," Miao Yan, Danfoss Product Manager for OFC explains. "This means system builders can select smaller condensers for the system, which has a direct impact on the initial system cost, or they can choose to keep the efficiency gains, which leads to lower operating expenses."

These benefits make the OFC valve an attractive option for HVAC/R system builders and end-users operating oil-free installations in areas such as data centers and commercial buildings.

Find out more about the OFC check valve and other Danfoss products here.

Download the OFC datasheet here

> "We recommend the OFC valve for retrofit and new centrifugal chiller installations, where installers and customers are interested in lower operating costs, improved energy efficiency and sustainability"
>
> Miao Yan
> Danfoss Product Manager for OFC



[3] In this test, Kv was measured under ideal conditions and does not reflect turbulent losses or diffuser effects in dynamic operation. Thus, real-world performance is determined by total pressure behavior, not just flow coefficient.