

Technical paper

Danfoss efficiency tests deliver on promise to **A/C manufacturers**

Around the world, air conditioning OEMs are scrambling to meet new energy efficiency standards like EU Ecodesign. Danfoss has responded by offering enhanced simulation and testing capabilities – and using them to prove a 7.3% system-wide improvement from new, drop-in compressors.

By Matthieu Stoll – Global Marketing Manager – Danfoss Air Conditioning Compressors

As the world's governments seek to slow climate change by limiting CO₂ emissions, air conditioning manufacturers are responding to tough new energy efficiency standards.

This is particularly true in Europe, where the Ecodesign directive is posing significant challenges. Data from industry association Eurovent showed in 2015 that 80% of current air conditioning chillers would fail to meet new Minimum Energy Performance Standards (MEPS).

Similar regulations are being introduced on other continents, and as a result air conditioning brands worldwide are redesigning product ranges in an effort to reduce energy consumption, and ensure they comply with the regulations.

Danfoss has taken action to help its OEM customers, in two ways. First, delivering on a promise that new, drop-in compressor technology could give a system-wide efficiency boost. And second, offering engineers the ability to simulate, test and refine the seasonal energy consumption of their revised system designs.

IDV scroll compressor technology: a proven 7.3% system-wide gain

Compressors with Intermediate Discharge Valve (IDV) technology promise an immediate step-change in seasonal efficiency, with minimal redesign cost. Now, new tests have delivered on that potential, confirming a significant, system-wide benefit of 6 – 12% depending on the system type.

In test conditions, this change alone improved a rooftop unit's Seasonal Energy Efficiency Ratio (SEER) by 7.3% from 3.43 to 3.68: enough to exceed the challenging Tier 2 Ecodesign target.

Importantly for OEMs, this change is effectively a like-for-like replacement within an existing design. The new scroll compressors are backward compatible with the existing Danfoss S and H ranges – minimizing redesign costs.

Danfoss has already deployed IDV technology to its full range of DSH scroll compressors (ten sizes from 7.5TR to 40TR and soon a new 50TR size) and part of the VZH series (variable speed compressors from 28cc to 65cc).



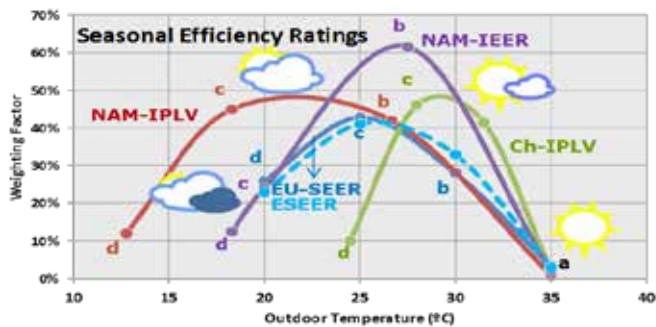
Intermediate Discharge Valves: proven to improve part-load efficiency.

Danfoss IDV technology: a perfect fit for SEER and IPLV

The impact of IDV on a system's seasonal efficiency is especially pronounced because it directly improves the efficiency under part-load conditions – by allowing the compressor to avoid over-compression losses and thus extra work by the motor.

Rather than measuring energy consumption at a system's full capacity, seasonal energy measures like SEER and Integrated Part Load Value (IPLV) give a representative picture of its efficiency over a whole year.

Energy efficiency is measured at 100%, 75%, 50% and 25% load ratios. And because air conditioning systems almost always operate under part load, this is reflected in the relative weightings used to calculate the final score: the exact figures vary by region but full load efficiency is always a small fraction of the total.



Chinese, European and US seasonal / part-load efficiency rating points for chiller systems

Part-load efficiency promises proven in lab tests

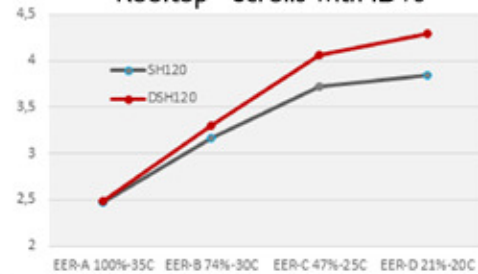
The growing effect of IDV compressor technology as load decreases was demonstrated in one of a growing number of Danfoss test facilities around the world.

A single-circuit rooftop unit was equipped with a tandem of 12T SH120 compressors, and tested according to EN14825. Its efficiency was compared against the same unit with equivalent IDV-equipped DSH120 compressors, across four load points:

- EER-A is the full load point. This was traditionally used to rate units, but only accounts for 3% of the new, weighted SEER score.
- EER-B represents 74% load. It is the result of an interpolation between a high and low points (two and one compressors running, respectively).
- EER-C and EER-D – 47% and 21% load – represent a single compressor running, and applying cycling losses to make up for the extra capacity.

The higher the number, the better the energy efficiency rating at that load point:

Live system test results The impact of IDVs increases as part load falls Rooftop - Scrolls with IDVs



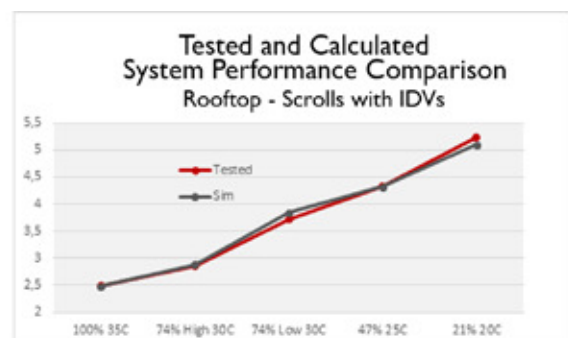
At full load, the Intermediate Discharge Valve is not active, so the results are virtually identical (a difference of 0.4%). But as the load decreases, the effect of the valve becomes obvious – creating a 4.4%, 9.1% and finally 12.0% differential in the EER scores.

With the four figures combined and the weightings applied to give a SEER figure, the use of IDV gives a 7.3% improvement. Critically, this enables the system's score to comply with the Ecodesign Tier 2 target for a unit of this kind.

Optimising efficiency through simulation

As well as proving the projected efficiency of IDV technology at a system level, the tests validated a simulation model developed by Danfoss to project the efficiency impact of system design changes.

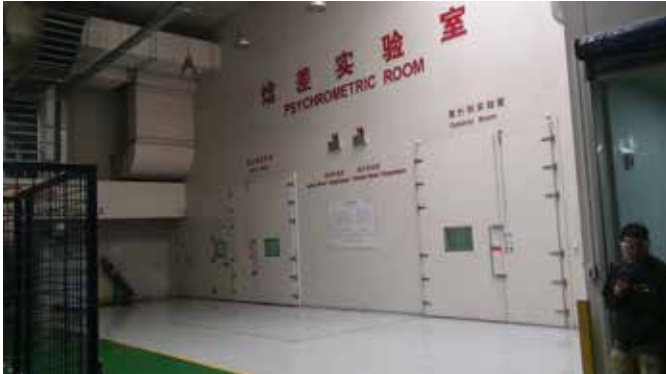
Danfoss will use the tool to help A/C manufacturers to accurately predict the potential effect of individual component and configuration choices; not only in the compressor, but throughout the system.



As well as enabling Danfoss and OEMs to collaborate on fine-tuning efficiency, the simulator can project the performance of a design in a different region, under alternate climate conditions, or against other load profiles and efficiency standards. For example, this same RTU design scaled to 60 Hz would yield 14.02 IEER, above the DOE 2023 target.

Here, the simulator accurately predicted the observed EER impact of the new IDV compressors to within 1%, at each load point tested.

Opportunities for partnership



Danfoss will open its test capabilities to partner OEMs.

All the tests were completed at the Danfoss Compressor factory in China, a double psychrometric room equipped with water loop has the capacity to test chillers up to 100TR, and rooftop units up to 35TR. Three new test rooms at the company's Application Development Centre in Tallahassee, Florida, are expanding this capability still further – to 150TR, and 50TR.

Danfoss is making these facilities available to support select partner OEMs, and help drive and validate further innovation in seasonal energy efficiency, as the industry continues its progress towards a low-carbon, compliant future.

Danfoss is committed to helping air conditioning manufacturers, as they overcome the energy efficiency challenge. To find out how they can help contact Danfoss or visit airconditioning.danfoss.com

Unit description:

20TR Rooftop unit using R410A, with a DSH120 tandem in a single circuit and variable speed fan.

