



AHR's 2017 Innovation Award-winning Daikin Pathfinder® AWV, with variable speed and variable volume ratio (VVR) compression technology.

SPOTLIGHT

Understanding Variable Volume Ratio (VVR) Compression Technology

Summary

Market-leading efficiency in both full and part load performance

Technology allows the compressor to change the internal compression ratio as water and air temperatures fluctuate

Best real-world performance available

Lowest operating cost chiller in the marketplace

Understanding Variable Volume Ratio (VVR) Compression Technology for Air-cooled Chillers

Background

In 2009, Daikin took the air cooled screw chiller market to the next level with the introduction of the Pathfinder AWS VFD screw chiller, offering the highest IPLV for any air cooled screw chiller in North America by using variable speed drive technology to control compressor speed and drastically improve part load performance.

With the recent launch of the new Pathfinder AWV air-cooled screw chiller, we have upped the ante yet again, with a fully configurable chiller product with market-leading efficiency in both full and part load performance.

A key component of the new Pathfinder AWV chiller is Variable Volume Ratio (VVR) technology, an industry-first for packaged air-cooled screw chillers. This technology allows the compressor to change the internal compression ratio as water and air temperatures fluctuate, to give the most optimal compression efficiency possible. Simply put, compared to previous screw technology, a VVR compressor will not only perform better at AHRI-standard conditions, it will perform better in real-world scenarios where air and water temperatures can fluctuate greatly.

To understand why VVR technology helps us, we must first understand how a traditional screw compressor works. A traditional screw compressor has a fixed compression ratio. Compression ratio is defined as the ratio of the outlet pressure to the inlet pressure. In other words, the higher the compression ratio, the more pressure the compressor is adding to the gas it compresses. High lift conditions, such as low leaving evaporator water temperature, or high ambient

temperature, require a compressor with a higher compression ratio design. In order to make a one-size-fits-all compressor, the traditional route was to build a compressor with a higher compression ratio so that it was capable of operating at those higher lift conditions.

The downside is that during low lift conditions (which occur the majority of the time in most applications) the compressor will 'over-compress' the gas to a pressure higher than what is really needed, which wastes energy.

Imagine inflating a basketball with a bicycle pump. Which requires more effort: A) Inflating the basketball to the desired pressure, or B) overinflating the basketball and then letting some of the air back out? Of course, the answer is B. With VVR compression technology, the compressor senses the amount of lift needed and adjusts the compression ratio on the fly to give the optimal efficiency at any operating condition. This means lower energy use, lower cost of ownership, and lower carbon footprint.

The Mechanics

Now that we understand why VVR technology is great, let's look at how we accomplish this. *Figure 1* is an image of a single rotor screw compressor. As the gas moves from the suction to the discharge, it is pressurized from low pressure (blue) to high pressure (red) within the flute of the screw.

A single rotor screw has a gate rotor on either side that acts as a rotating seal. As the tip of the gate rotor meshes with the screw, a section of gas is trapped inside the screw flute.

As the gate rotor continues to turn, the volume of that trapped gas is reduced, which increases the pressure, until the gas is finally released from the flute at the discharge end of the screw.

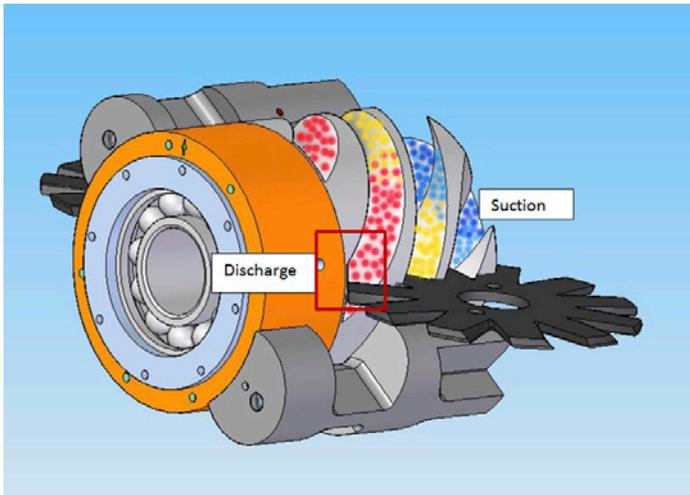


Figure 1: In the single rotor screw compressor, gas is trapped in the screw flutes by the gate rotor and is pressurized.

The pressure ratio is a function of the flute length from suction to discharge (the longer the flute length, the higher the compression ratio). While we can't change the physical length on the fly, we can change the effective length by changing the point along the flute at which the gas is allowed to discharge.

Consider the images below. In Figure 2, the VVR slide covers the full length of the flute, forcing the gas to compress along the full length of the flute, giving the highest compression ratio. In Figure 3, the slide moves to allow discharge at an earlier point, reducing the compression ratio.

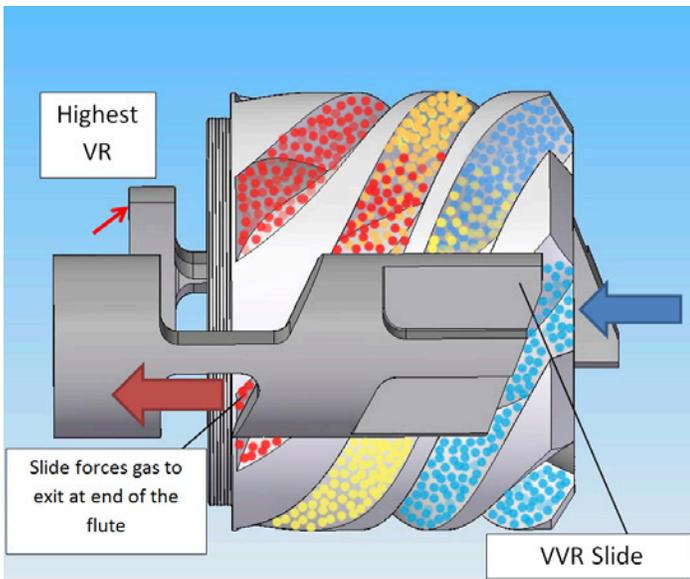


Figure 2: Single screw compressor with discharge VVR slide fully closed. This gives the highest compression ratio.

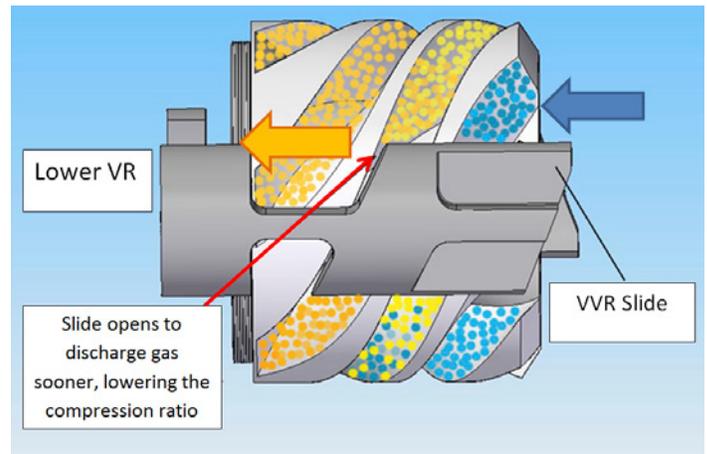


Figure 3: Single screw compressor with VVR slide open, allowing gas to exit sooner, which lowers pressure ratio

It's important to understand how VVR technology is different from traditional 'slide valve' capacity control that has been used on screw compressors for decades. Prior to the use of variable frequency drives (VFDs), capacity control slide valves were used to change the tonnage a compressor would produce. The slide valves of the past opened or closed on the suction side of the compressor, which changed the amount of refrigerant that was moved with each rotation of the screw, and thus changed the capacity. These slide valves did not change the compression ratio.

Unlike capacity control slide valves, VVR slides operate on the discharge side of the screw and do not change how much refrigerant is moved per stroke; they only change how much that refrigerant is compressed. VFDs are used in conjunction with VVR slides, with VFDs controlling the motor speed (and thus the compressor capacity) and VVR slides controlling the compression ratio.

Final Remarks

In summary, the new Daikin Pathfinder AWW air-cooled screw chiller with variable speed control and VVR compression technology revolutionizes the industry with unprecedented part load efficiency levels and the best real-world performance available. With the combination of VVR and VFD technology, Daikin is yet again paving the way to a more environmentally friendly and sustainable future, offering the lowest operating cost chillers in the marketplace.

To see Pathfinder's VVR technology at work, [click here](#) or the image below to view a short video, or visit: www.DaikinApplied.com/chiller-pathfinder.php

