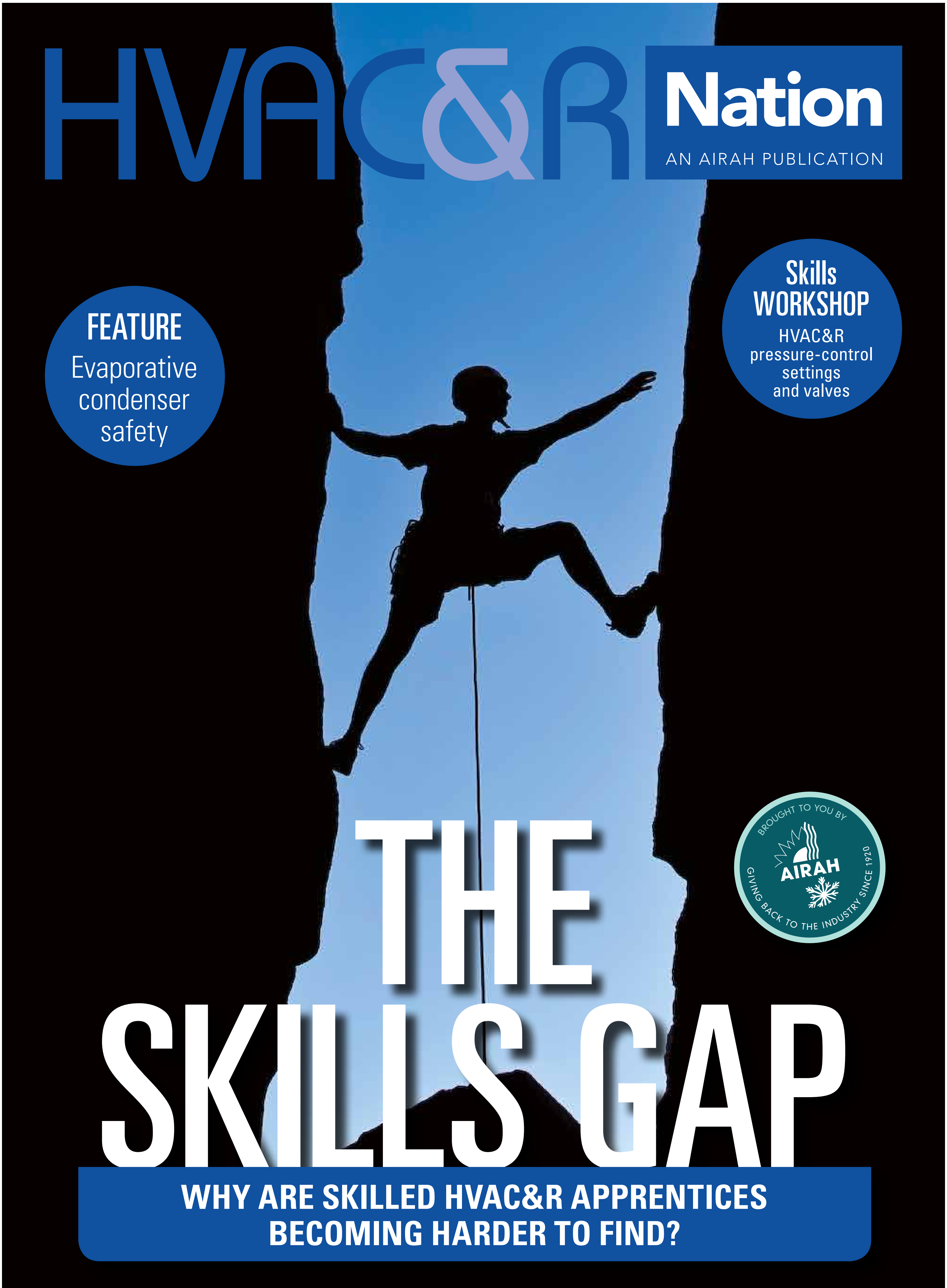
HVAC&R Nation

AN AIRAH PUBLICATION



FEATURE
Evaporative condenser safety

Skills WORKSHOP
HVAC&R pressure-control settings and valves

BROUGHT TO YOU BY AIRAH GIVING BACK TO THE INDUSTRY SINCE 1920

THE SKILLS GAP

WHY ARE SKILLED HVAC&R APPRENTICES BECOMING HARDER TO FIND?

PRINT POST APPROVAL NUMBER PP 727272/60606

October 2016 / ISSUE 096 / FREE

HVAC&R Skills Workshop

MODULE 96

PROUDLY SPONSORED BY DAIKIN

HVAC&R PRESSURE-CONTROL SETTINGS AND VALVES

Understanding pressure control and the technology involved is a challenge that faces both apprentices and experienced technicians alike. Pressure-control valves are found in virtually every hydraulic system, and they assist in a variety of functions, from keeping system pressures safely below a desired upper limit to maintaining a set pressure in part of a circuit. In this month's Skills Workshop, we will delve into low/high pressure-control settings, as well as the pros and cons of reversing and expansion valves.

PULLOUT

LOW/HIGH PRESSURE-CONTROL SETTING

Setting a pressure control requires you know the minimum and maximum design operating pressures of a system. Yet, this must be aligned to the correct refrigerant used.

In a coolroom for example, on a 6K evaporator design, room temp at 2˚C – the 6K evaporator TD will give you a -4˚C saturated evaporator temperature. This means the room needs to be operating -4˚C.

With head pressure, you will need to reference the condenser temperature difference chart. In short, should never exceed AS1677 on pressure testing, which states at a 43˚C ambient, you should not exceed 59˚C condensing temperature for air-cooled condensers at normal pressure testing.

Setting your head pressure to 59˚C maximum is key, but lower than this is also OK, especially if operating a freezer room.

The range of the control is the actual cut in pressure, the differential is the cut out, where range minus differential pressure equals cut-out pressure

This too confusing for many, so look at it this way. If you need to cut in below -4˚C SET, set your pressure control range to a pressure before -4˚C SET for the type of refrigerant.

Cut-out pressure has been so ignored over the years, especially with coolrooms. Many set the cut-out close to 0kpa gauge or atmospheric pressure – this is not right. Assuming this is a pump-down arrangement, if you have a gas leak or low capacity, the unit can operate at such a low pressure that any refrigerant in the coil left will likely dehydrate foods in the room, even at partial capacity due to the wide evaporator temperature difference from a loss of refrigerant. It's best not to exceed the minimum design saturated evaporator temperature. For example, at -4˚C SET, you cut it out at -10 ˚C SET.

Range pressure (cut in) differential pressure = cut out pressure. Therefore, the best way is to know how to set your cut-out pressure is to take your cut-out pressure from your design cut-in pressure. That leaves the required differential setting. Set the differential to that setting.

Most high-pressure cut-outs have internal differential reset pressures. But please, just do not set a high pressure at 2500kpa as standard etc. For instance, R134a hits 59˚C at 1600Kpa.

Always check your refrigerant pressure temperature charts.

As a guide . . .

- Coolrooms should operate to a design SET of -4˚C unless they have been re-engineered for higher humidity.
- freezer Rooms to -24˚C SET
- air conditioners to 4˚C to 0˚C SET.

Head pressures should not exceed 59˚C based on HFC/HCFC refrigerants.

REVERSING VALVES

Advantages

1. Reversing valves add heat of compression into the indoor unit, which increases the coefficient of performance.
2. In Australia's climate, they are the most effective for heating – for kW of energy in, to kW of refrigeration out. So puts out more heating energy than cooling.

Disadvantages

1. The pressure drop creates in the suction line and partially de-rates the unit's total cooling capacity. This is why cooling-only units always seem to have more cooling capacity than the equivalent heat-pump alternative. (However, inverter models can ramp up frequency and compensate depending on the manufacturers limitations.)
2. Defrosts are going to occur at 6˚C ambients or lower. Sub-zero climates may require electric heater boosting (not likely in Australia).
3. Higher condensing-temperature differences require capacity control. The unit accelerates performance over 19˚C air-on. Most splits terminate capacity at 65˚C condensing temperatures. Airflow is critical.

Ironically, a reversing valve is controlled by a reversing valve – the pilot electrical valve is a mini reversing valve.

In countries like Australia, we tend to energise the solenoid on heating. Whereas colder countries energise the solenoid for cooling. This is so we utilise the unit's majority needs without adding extra wattage for a magnetic coil. Makes sense.

What's the difference? Well, 180 degrees of installation. So be careful how you install them after repairs.

Never vapour charge a system with a reversing valve from evacuation. If you're unlucky, the partial gas-pressure changeover will create small gate change and align suction and discharge ports in the valve. This creates unloading and impossible addition of further gas charge. Always liquid charge to near weight.

Inverters will ramp up to minimum frequency speeds to allow positive higher pressure changeover of the gateway before changing modes.

ELECTRONIC VS THERMOSTATIC EXPANSION DEVICES

Well, the short answer is that the electronic stepper-type motorised valves win the efficiency dividends, with increased surface area of evaporator used by lower superheats and the ability to work with floating the head pressure much lower.

Yet, they demand a logical driver system only as good as the logic embedded into the CPU. They use the pressure enthalpy characteristics of the refrigerant as an operating guide, which seems flawless (0 to 0.5K superheat).

The thermostatic expansion valve can't react as quickly and requires a larger index of superheat to prevent hunting. It also requires a balanced port arrangement, and sufficient pressure drop to operate correctly. Yet, you can't ignore the fact that most feel more in control using these valves and being forced to set the ideal standard superheat conditions (4 to 6K superheat).

Air conditioning is already at the top of the efficiency chain, with much lower compression ratios and greater mass-flow of refrigerant for the volume used. All because they work at the highest saturated evaporation temperatures. And, mostly all split systems now employ the use of electronic stepper motors to squeeze the performance even more, combined with inverter technology that sees savings in energy input at part-load conditions. This is logical, since from 2004, air conditioning sales in Australia doubled and we need to find more efficiency dividends for power input.

Our refrigeration systems tend to only use electronic stepper control in larger systems with less volumetric efficiency. These work to float the head pressure and sometimes use liquid pumps to keep compression ratios much lower. Mostly, we are still using thermostatic expansion valves for nominal control, as most houses don't have a coolroom or freezer room. Most condensing units are not inverter driven, however, we need ideal temperature differences in cool rooms to keep the humidity correct for stored product.

Our domestic market, which in some cases could see more domestic-class fridges in a household than air conditioners, do not use stepper-type expansion. We are still using capillary tube systems with much higher superheats (25 to 30K superheat).

Still, the market has forced hydrocarbon refrigerants, linear compressors, and inverter drive in an effort to reduce power consumption and refrigerant weight. Design has changed to reduce air-change loads by using smaller access doors in refrigerators, rather than op ening the main door.

Do domestic fridges still work on much higher superheats, but use less power than before? It all comes down to costs at the end of the day. The costs are based on economies of scale and what regulatory influences we have on the designs. People want more for less, and that is also in line with the current sustainability needs we look for with energy consumption.

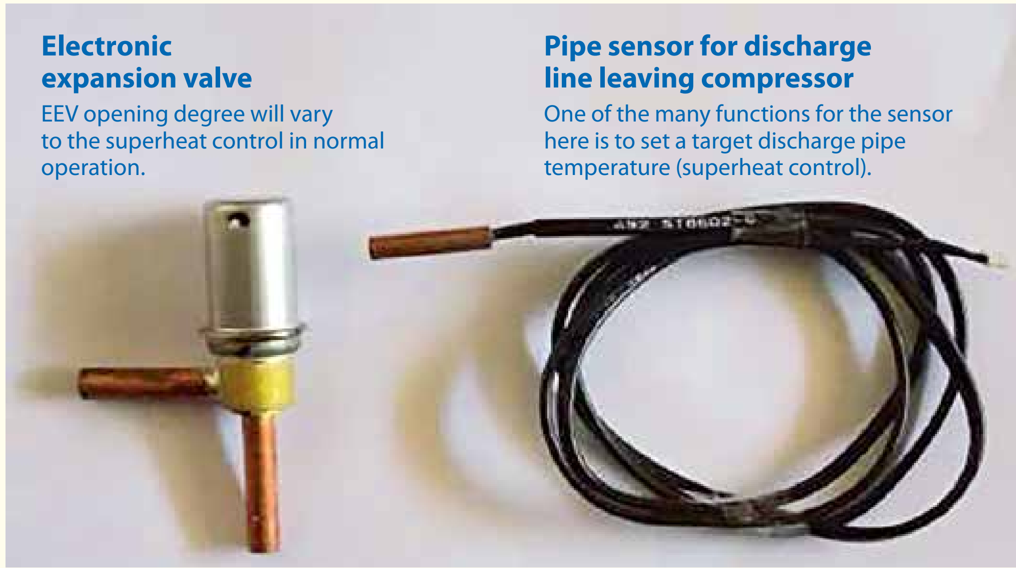


Figure: 1. Electronic stepper valves have very little moving parts and a simple construction. They can bi-flow easily and work with very little port-pressure as long they have subcooled liquid. These have been a major factor in efficiency increases to domestic and commercial air-conditioning systems. They allow better COP/EER, through effecting good flow capacity and lower superheats at varying ambient conditions.

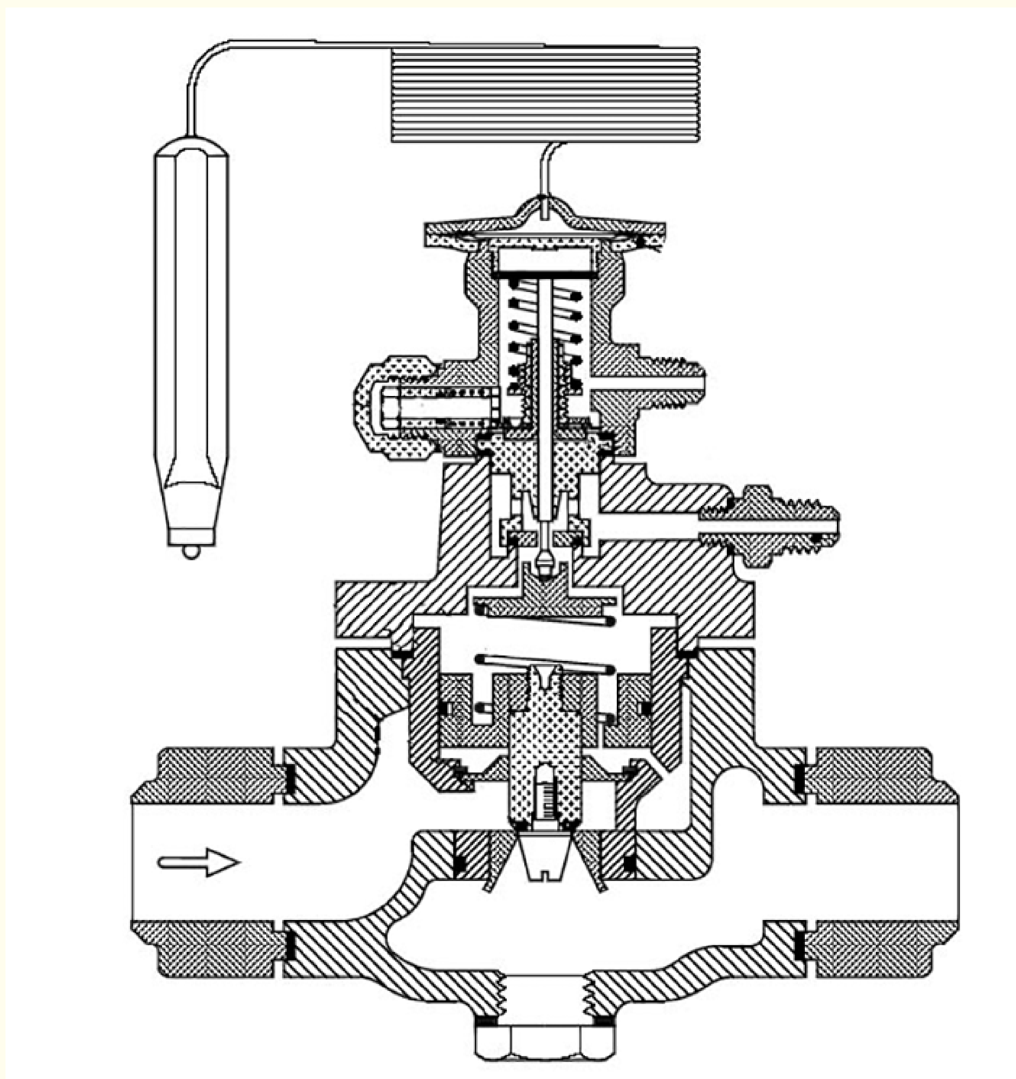


Figure: 2. Expansion valves are generally one of the industry's best-performing valves for both internal and external equalisation types. Stainless laser welding technology and stainless power elements/capillary/bulb have really extended valve life and performance.

Currently we have found new ways to reduce the costs of producing energy both fiscally and environmentally, but have we really found the ways to use less of it?

The expansion devices pictured below are different and produce very different efficiencies. They work so very differently but they have one thing in common – they work on superheat. Superheat has a direct impact on power consumption.

The air conditioning industry is really a "hands-off" approach so that manufacturers can embed effective control in their systems that constantly self-adjust. They are always trying to reach the ideal EER and COP. Nothing is serviceable, just repairable. Refrigeration allows us to set and tune the devices according to design evaporator K TDs.

Why? The air conditioning market is heavily regulated, with minimum energy performance conditions needed on classes of equipment. Maybe that explains the differences

PULLOUT

ELECTRONIC EXPANSION VALVES

Advantages

1. Very precise low-superheat control.
2. Can work with less subcooled-liquid pressure at the valve port.
3. Less mechanical restriction and can bi-flow, which is handy for heat-pump air conditioner applications.

Disadvantages

1. Requires a complex driver system to control the valves opening/closing degree.
2. Loses memory on degree position on a power loss, so it requires resetting on every power-up. This is not an issue, just a fact.
3. Needs a power source to operate. It is not self-maintaining like a thermostatic-expansion valve.

The driving magnetic motor is called a stepping motor. Actually, if you want to be precise, is it a four-phase linear pulse valve. It does not rotate (open and close) at speed, but by steps. These steps are pulsed and can set a full opening degree back to a full closing degree, in 1500 or even 2000 movements. This is how precise control can be maintained.

Effectively, the driving motor pulses a forward/reverse magnetic field to a permanent magnet rotor. The rotor acts on a needle valve, which creates the pressure drop and flow.

They typically in air conditioning, use a five or six-wire circuit with four winding taps for north-south polarity forward/reverse. They either use one or two common winding connections.

Split-system AC units employ the expansion devices in the outdoor unit and provide a saturated liquid line to the indoor system. While this has been done with capillary tubes

Figure: 3. Electronic expansion valve control panel for an air conditioning unit.

previously, the electronic expansion valve (EEV) can be more effective at part-load conditions, both indoor and outdoor, and maintain low superheat.

Controlling a successive pressure drop from the outdoor unit to the indoor unit by pre-expansion allows for smaller compressors to be used to pump liquid at volume and height/distance. This reduces both cost and power footprint.

In the case of multi-split AC units (where you have more than one indoor unit connected to a single outdoor unit), each EEV on the outdoor supplying an indoor unit can attempt to unify the return vapour gas temperature to the compressor, which will assist in capacity control, especially at varying indoor loads.

Most faults with EEV valves come from two typical problems – contaminated systems or particulate blockages.

EEV motorised head failure is rare given they are mostly 12Vdc. It usually is supply-based from the driver circuit PCB, inclusive of wiring faults and corrosion of terminations. Indirect failures are the result of logic malfunction or thermistor sensor damage/calibration.

The permanent magnet wont fail, you have to really hit a magnet hard to weaken it. However, corrosion does play a major factor to valve failure. The motorised heads rust out when placed in corrosive environments, especially where they are subject to bore water. With that being said, there has not been many problems with EEV units over the years.

As previously mentioned, in 2004, sales of air conditioning in Australia doubled. The need for energy efficiency grew and the emergence of electronic expansion valves in very small air conditioning splits became forefront to effective design. The good news is that the refrigeration trade has caught up, with evaporators now fitted with linear pulse valves. Now with not as attractive compression ratios and volumetric efficiency as its air-conditioning equivalent, a freezer in a low to medium commercial application now has an advantage to maximise its capacity with low-head and low-load conditions.

These are very exciting times for sustainability. ■

MORE INFORMATION

This month's Skills Workshop was put together by lecturer Dennis Kenworthy from South Metropolitan TAFE in Western Australia. Passionate about training, Kenworthy has been working in the HVAC&R industry since 1985 and is a key member of TAFE's refrigeration and air conditioning program.

Dennis Kenworthy

For more training tips and guides, visit Kenworthy's website **www.whatwoulddennisdo.com**

ACKNOWLEDGEMENT

In August and September, HVAC&R Nation ran excerpts from the NSW Office of Environment and Heritage's (OEH) Gas Management and Monitoring guide without proper acknowledgement.

The Skills Workshop sponsor for those months did not contribute to the development of the OEH Gas Management and Monitoring guide.

The full OEH Gas Management and Monitoring guide can be downloaded at www.environment.nsw.gov.au/business/gas-monitoring-guide.htm

Next month: Preventing refrigerant leaks