Refrigeration piping selection – get it right

The selection and installation of refrigeration piping continues to be the source of concern and frustration to many members of the industry. Not only can it lead to inefficient system operation and performance. In some cases it can also lead to the voiding of manufacturer warranties, which in turn damages the reputation of the industry in the eyes of consumers, as Sean McGowan discovered.

As refrigeration system design becomes increasingly complex in a bid to achieve the greatest energy efficiency, some technicians on the ground are favouring cost ahead of system design to the detriment of the end user.

According to Roger Stringer, national technical manager at Actrol, a less than perfect system installation will always result in less than perfect operation and performance.

Stringer says the drive towards energy efficiency has seen a rapid introduction of innovations in design including capacity control, variable refrigerant volume, floating head pressures and others which all make piping design and installation more complicated.

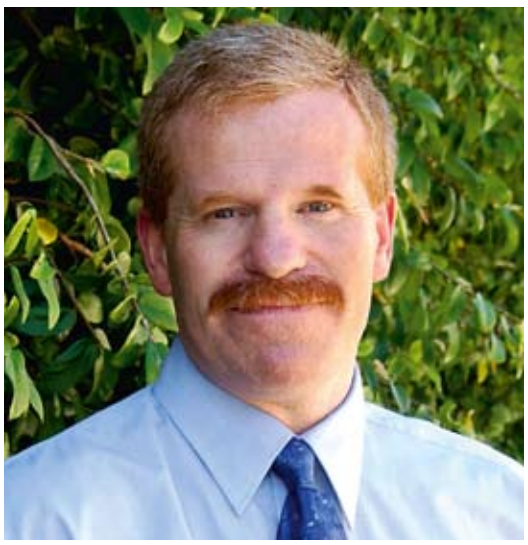
"The effect is the goal posts keep moving for the technicians out there trying to ensure a reliable and cost effective solution," he says.

Nevertheless, he warns that a cost effective installation is rarely the cheapest, with cheaper installations almost always resulting in greater energy consumption. As such, incorrect selection of refrigeration piping, flow control and accessories is something the industry needs to avoid.

"We live in a new, environmentally aware market with consumers wanting to do the right thing. If a system uses more energy to maintain the design conditions as a result of poor selection, this will directly impact on the environment, the consumer and the reputation of the industry."

Three common errors of incorrect piping selection

Incorrect pipe selection generally falls into three categories:



Roger Stringer

Undersizing

According to Graham Boyle, head of programs for Swan TAFE's metals, technology and safety divisions, refrigerant piping is often undersized through ignorance, convenience or through trying to make a cost saving because smaller pipes cost less.

Undersized piping results in high internal refrigerant velocities and good oil return but high line per metre pressure drops and resultant loss in system capacity; as well as compressor overheating due to compressor cooling losses and compressor failures.

"Undersizing can come about also by using too many bends and fittings in the pipe run. As with any fluid flow, friction creates resistance to flow (so) the longer the pipe run and the more bends and fittings included creates friction penalties and a pressure drop in the run," explains Boyle.

"A pressure drop will then create capacity reduction at the compressor in the case of the suction line and capacity reduction at the expansion device and evaporator in the case of the liquid line. Bad pipe design can cause liquid 'hang up' in the condenser which can reduce capacity and cause erratic operation of the expansion device."

Oversizing

Oversized refrigeration piping commonly results in low refrigerant velocities, poor oil return but also low line per metre pressure drops, thus no resultant system capacity losses are experienced. But it's false economics.

"It is poor economics as oversizing can result in compressor oil losses and compressor failures due to a lack of lubricant," warns Ian Paul, head teacher of refrigeration at NSW TAFE.

Incorrect wall thickness and grading

As popular refrigerants such as R410A and R744(CO_2) operate at much higher system pressures, it is essential to ensure the pipe wall thickness and therefore the maximum safe working pressure of the pipe system and all line components used are correctly rated.

Incorrect wall thickness can result in pipe work failures and splitting pipes, leading to refrigerant leaks.

According to Paul, refrigeration and air conditioning systems must use refrigeration tube that meets AS/NZS1571 (the RAC standard) and not AS/NZS1432, the standard used by plumbers. Furthermore, the BCA requires pipe insulation in many building types to comply with AS1530.3-1999 which relates to the behaviour of the insulation in a fire situation.

"The industry is becoming more regulated and many technicians are not aware of the requirement to comply with not only the relevant Australian Standards but also the Building Code of Australia (BCA)," adds Stringer.

Do's and don'ts of pipe selection

Pipe selection and design is based largely on pressure drop and velocity requirements, and is therefore different for liquid, suction, wet suction return and discharge lines.

"Since many of the operational problems encountered in the field can be traced back to improper design and/or installation of the refrigerant piping and accessories, the importance of correct design and installation procedures cannot be over-emphasised," says Paul.

In general, he says refrigerant piping should be designed and installed so as to:

1. Ensure an adequate supply of refrigerant to all evaporators.
2. Ensure positive and continuous return of oil to the compressor crankcase.
3. Avoid excessive refrigerant pressure losses which unnecessarily reduce the capacity and efficiency of the system.
4. Prevent liquid refrigerant from entering the compressor during either the running or off cycles, or during compressor start-up.
5. Avoid the trapping of oil in the evaporator or suction line which may subsequently return to the compressor in the form of a large 'slug' with possible damage to the compressor.

"Careful attention must be given to the proper sizing of suction, wet return suction, liquid and discharge lines if the full rated capacity of the refrigeration equipment is to be achieved."

Excessive pressure drops can lead to reduced system capacity, while insufficient vapour velocity causes compressor lubrication problems.

"When a self-contained condensing unit is used on a particular installation the discharge line does not present a problem, as this is already sized and piped into the unit. The suction and liquid line, however, must always be sized correctly, as excessive pressure drop in either of these lines will impose a severe penalty on the operating capacity of the refrigeration compressor."

Paul says refrigerant piping has to maintain refrigerant flow with minimum pressure drop, and sufficient velocity to return oil to the compressor. To ensure the efficient operation of the plant, the piping system should also contain where necessary fittings, traps and correct pitch on horizontal runs.

Horses for courses – considering the refrigerant

Every refrigerant and every system has specific design requirements which must be considered if reliability and system performance is to be achieved. Therefore the basic principles of pipe design and installation must be considered every time as every installation will be different.

Will the velocity be sufficiently high to return the oil to the compressor?

Will the pressure drop be within acceptable limits to ensure a more efficient system?

Are the pipe work and system components rated for the operating pressures of the system, and of the refrigerant?

"So long as these basic design principles are adhered to, all commonly used refrigerants pose no particular problems," says Stringer. "However, CO_2 systems require many additional safe guards to ensure a safe, reliable and efficient system, and it is advisable to consult with manufacturers and suppliers of equipment before installation of any CO_2 pipe work."

According to Boyle, different refrigerants also entrain the oil differently, and therefore require different velocities. They also have different specific volumes and these factors are built into the pipe sizing charts.

"Other factors include proper bracketing to allow for expansion and contraction of the pipe, as well as vibration reduction to prevent pipe cracking and refrigerant leaks," he says.

Avoid being complacent

Boyle warns that while many piping systems may be badly designed, the refrigeration system will continue to operate. This is where complacency needs to be addressed.

"The key point is that they are operating inefficiently, which means they are using more energy than they should, but they get away with the inefficiency because they are generally oversized or often required to operate at full capacity, when they shouldn't be," he says.

Industry bodies, as well as manufacturers and suppliers, are working hard to ensure those in the field charged with the responsibility of installing systems correctly, have the knowledge and support to do so.

But it also requires technicians to seek advice and keep abreast of the latest regulations and refrigeration design techniques.

"Change is constantly upon us and ongoing training will always be required to improve customer outcomes," says Stringer. ▲