ARC Technical Resources

AUSTRALIAN REFRIGERATION COUNCIL

Pressure testing stationary RAC systems

The main purpose of Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 is to reduce the emission of fluorocarbon refrigerants into the atmosphere as they destroy the Ozone Layer and/or increase Global Warming.

Therefore, it is vital to ensure operating refrigeration and air conditioning systems do not leak refrigerant by pressure testing the system before the system is commissioned or re-charged with refrigerant after service work. But how should the system be pressure tested and to what pressure?

This is determined by referring to the following Standards and Codes of Practice which are called up in the of Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995:

- **Australia and New Zealand Refrigerant handling code of practice 2007 –** Section 5 Installation Procedures.
- **Australian Standard AS/NZS 5149.2:2016 Refrigerating systems and heat pumps – Safety and environmental requirements, Part. 2: Design, construction, testing, marking and documentation** - Clauses 5.3.3.3.1 to 5.3.3.3.3.

What gas must the system be pressure tested with?

Clause 5.3.3.3.1 above states "Tests shall be performed with dry nitrogen or another non-flammable, non-reactive, dried gas. Oxygen, air, or mixtures containing them shall not be used." The following two readily available types of gases meet this requirement:

1) Oxygen Free Nitrogen (OFN)
   This must be dry, pure, high purity (HP) or ultra-high purity (UHP) nitrogen as the moisture level of industrial grade nitrogen is not low enough for effective use in refrigeration and air conditioning equipment.
2) Nitrogen/Hydrogen Mix
   Due to its exceedingly small molecular size and low viscosity hydrogen, it can improve detection by escaping easily through any leak in greater volume than other gases.

Once the system is pressurised with Oxygen Free Nitrogen or Nitrogen/Hydrogen Mix to the required level, all relevant piping and component joints must be checked for leaks using foam enhancer leak detection fluid.

If a leak is found, it must be repaired and then the system must be re-tested to ensure it is fixed and to check for other leaks. All leaks must be repaired before the system is evacuated and charged with refrigerant.

What pressure must the system be pressure tested to?

Australian Standard AS/NZS 5149.2:2016, Clause 5.2.2.1 Maximum Allowable Pressure (PS) states that:

> *Based on the refrigerating system, the designer shall determine the maximum allowable pressures in the different parts of the system taking into account a maximum ambient temperature as appropriate for the installation site.*

It provides two methods to determine the required test pressure for the different parts of the refrigerating system. The most commonly used is Method 2 below:

> *The minimum value of the maximum allowable pressure shall be-determined by the minimum specified temperatures given in Table 2 to determine the saturated refrigerant pressure. When the evaporators can be subject to high pressure, e.g. during hot gas defrosting or reverse cycle operation, the high-pressure side specified temperature shall be used.*

<table>
<tr><th colspan="6">Table 2 – Specified design temperatures</th></tr>
<tr><th colspan="2">Ambient conditions</th><th>≤ 32°C</th><th>≤ 38°C</th><th>≤ 43°C</th><th>≤ 55°C</th></tr>
<tr><td colspan="2">High-pressure side with air-cooled condenser</td><td>55°C</td><td>59°C</td><td>63°C</td><td>67°C</td></tr>
<tr><td colspan="2">High-pressure side with water cooled condenser and water heat pump</td><td colspan="4">Maximum leaving temperature + 8 K</td></tr>
<tr><td colspan="2">High-pressure side with evaporative condenser</td><td>43°C</td><td>43°C</td><td>43°C</td><td>55°C</td></tr>
<tr><td colspan="2">Low-pressure side with heat exchanger exposed to the outdoor ambient temperature</td><td>32°C</td><td>38°C</td><td>43°C</td><td>55°C</td></tr>
<tr><td colspan="2">Low-pressure side with heat exchanger exposed to the indoor ambient temperature</td><td>27°C</td><td>33°C</td><td>38°C</td><td>38°C</td></tr>
<tr><td>NOTE 1</td><td colspan="5">For the high-pressure side, the specified temperatures are considered the maximum that occur during operation. This temperature is higher than the temperature during compressor shutdown (standstill). For the low-pressure side and/or intermediate-pressure side, it is sufficient to base the calculation of pressure on the expected temperature during compressor standstill period. These temperatures are minimum temperatures and thus determine that the system is not designed for maximum allowable pressure lower than the saturated refrigerant pressure corresponding to these minimum temperatures.</td></tr>
<tr><td>NOTE 2</td><td colspan="5">The use of specified temperatures does not always result in saturated refrigerant pressure within the system, e.g. a limited-charge system or a system working at or above critical temperature.</td></tr>
<tr><td>NOTE 3</td><td colspan="5">For zeotropic blends, PS is the pressure at the bubble point.</td></tr>
<tr><td>NOTE 4</td><td colspan="5">The system can be subdivided into several parts (e.g. low- and high-pressure sides) for each of which there could be a different maximum allowable pressure.</td></tr>
<tr><td>NOTE 5</td><td colspan="5">The pressure at which the system (or part of the system) normally operates is lower than PS.</td></tr>
<tr><td>NOTE 6</td><td colspan="5">Excessive stress can result from gas pulsations.</td></tr>
<tr><td>NOTE 7</td><td colspan="5">For the determination of the ambient conditions, IEC 60721 can be used, as well as regional data.</td></tr>
</table>

In the table above, the Ambient Condition is the highest recorded temperature (°C Dry Bulb) for the system's location, available from http://www.bom.gov.au/climate/data/index.shtml

For example, Adelaide 47°C, Brisbane 42°C, Canberra 44°C Darwin 39°C Hobart 42°C, Melbourne 44°C, Perth 42°C, Sydney 43°C.

Examples

1) **Reverse cycle split air conditioning unit**

   The indoor and outdoor units are factory pressure tested, so the only components that need to be pressure tested are the field installed interconnecting pipework and their connections to the indoor and outdoor units. The required test pressure is that required for the high pressure side of the system as the indoor unit is the condenser on the heating cycle.

   Taking Sydney as the location: the Design Ambient Temperature for Sydney is 43°C, so per the table above, the required test pressure is equivalent to 63°C, which on R32 is 4,098 kPa.

2) **Medium temperature coolroom with air cooled condenser**

   The condensing unit and forced draft cooler are factory pressure tested, so the components that need to be pressure tested are the field installed interconnecting pipework and components, for example TX valve, dryer, pressure controls, etc.

   Taking Adelaide as the location: the required test pressure for the high pressure side of the system, based on the Design Ambient Temperature in summer for Adelaide of 47°C, per the table above, is equivalent to 67°C, which on R134a is 1,877 kPa.

   The required test pressure for the low pressure side of the system, based on the Design Ambient Temperature in summer for Adelaide of 47°C, is equivalent to 47°C, which on R134a is 1,120 kPa.

Summary

The installed connecting pipework and components of refrigeration and air conditioning systems must be pressure tested to an appropriate level based on the system's design conditions with dry, pure, high purity (HP) or ultra-high purity (UHP) Oxygen Free Nitrogen or Nitrogen/Hydrogen mix before the system is evacuated and charged with refrigerant.

If a leak is found, it must be repaired and then the system must be re-tested to ensure it is fixed and to check for other leaks. All leaks must be repaired before the system is evacuated and charged with refrigerant.

Pressure testing to just 1,000 kPa will not ensure the system will not leak refrigerant at high ambient conditions or normal operating conditions.