Pressure Testing for Strength and Leak Tightness

This guide explains why systems are pressure tested, and how to safely pressure test using nitrogen. It also shows how to calculate the test pressures in accordance with EN378[1].

Systems are pressure tested to ensure they are:

- **Safe** – for this test a pressure above the system's maximum allowable pressure (PS) is used;
- **Leak tight** – this test is at PS.

The section at the end on test pressures shows how to calculate the pressures that are used for both of these tests.

Pressure testing is hazardous and should be carried out carefully:

- The nitrogen used for pressure testing is an asphyxiant, so the area around the system should be well-ventilated;
- High pressures are used, so all non-essential personal should be evacuated from the area;
- Anyone carrying out the pressure testing should wear safety goggles.

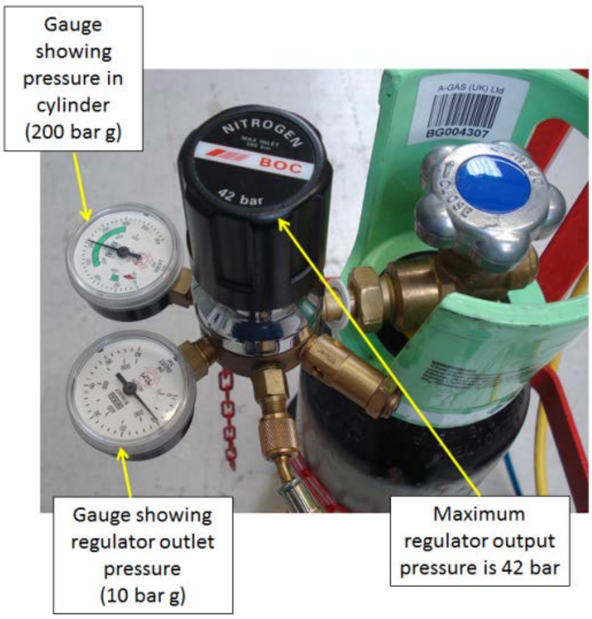
Nitrogen and regulation

Dry (oxygen free) nitrogen (OFN) is used to achieve the pressures required for the pressure tests because it is inert. You must **never** use oxygen for pressure testing - pure oxygen at high pressure reacts violently with oil and will explode.

Using the nitrogen regulator

1. Ensure the regulator is closed (wound fully anti clockwise);
2. Open the cylinder valve;
3. Slowly open the regulator to the pressure required.

Do not use a regulator with an output pressure much higher than you need.



[1] EN378-2:2008 Refrigerating systems and heat pumps – Safety and environmental requirements, Part 2 Design, construction, testing, marking and documentation.

You can also use nitrogen with a trace of either helium or hydrogen for the pressure testing (available from several suppliers). Both helium and hydrogen have small molecules and leak at a lower pressure than pure nitrogen. Leaks are detected using an electronic leak detector sensitive to either helium or hydrogen.

Pressure test equipment

The nitrogen cylinder should be connected to the system using a suitable pressure testing assembly with gauges and hoses suitable for the test pressure. The photo shows a suitable pressure testing gauge / regulator assembly.

If you are using a manifold ensure it is suitable for the pressure and does not have a sight glass.

You should use the gauge on the manifold to monitor the test pressure (the gauge on the regulator has a very small scale). Ensure the manifold valve is open before opening the nitrogen regulator.

What to test

You will not usually need to pressure test components and assemblies which have already been tested by the manufacturer. Most of the time you just be checking interconnecting pipe work.

If Rotolock valves are used to isolate components or assemblies be aware that they can pass nitrogen from the part of the system being pressurised into the isolated component.

Make sure there are no isolated sections of the system / part of the system you are testing, for example open solenoid valves using a permanent magnet.

The pressure tests

Increase the pressure to approximately 5 bar g and check for leaks using leak detection spray at this pressure initially – many leaks will be identified at this pressure so you will not waste nitrogen and time. It is also safer to find leaks at a lower pressure than the final test pressures.

Increase the pressure slowly to the strength test pressure and hold it for 15 minutes. Under the Pressure Equipment Regulation this strength test might need to be witnessed by a notified body.

Reduce the pressure to the tightness test pressure. To complete the tightness test you should either:

- Check each joint with leak detection spray;

  or

- Hold the test pressure for a period of at least 24 hours, checking that the pressure has not dropped during this time. Note that if the ambient temperature changes by 5^{O}C the nitrogen pressure will change by 0.7 bar. Therefore an increase in ambient could mask a drop in pressure due to a leak. You should record the ambient temperature as well as the pressure at the start and finish of the tightness test.

When the system has been correctly pressure tested you should vent the nitrogen to a well-ventilated area or outside.

Repairing leaks

If you find leaks during the pressure testing the nitrogen should be vented from the system before the leak is repaired. The joints should then be retested.

Testing the high side and low side

On most systems the high side is tested at a higher pressure than the low side (exceptions include reverse cycle heat pumps and systems with saturated gas defrost - see next section on test pressures for full details). Many low side components will not withstand the high side test pressure, so either:

- The high and low sides need to be separated or the pipe work tested in stages as installed;

  or

- The entire system should be tested at the low side test pressure.

Most assemblies and components will have been pressure tested by the manufacturer so you do not need to repeat this – they can be isolated during the pressure test. Pressure relief valves should also be isolated during the pressure test as they will discharge at the strength test pressure.

Test pressures

EN378, part 2 provides guidance on the pressures to be used for strength and tightness testing. To calculate these pressures you need to determine the maximum allowable pressure of the system (PS).

High side PS

PS depends on the maximum ambient temperature and the type of condenser. For the UK we usually use a 32^{O}C maximum ambient. PS for the high side is found using the condensing temperatures listed in the table over the page for this ambient. The equivalent pressures for common refrigerants are also listed. For zeotropic blends the pressure of the saturated liquid (also called the bubble point) is used.

Condenser type	Maximum condensing temp.	High side PS for R134a Bar g	High side PS for R404A Bar g	High side PS for R407C Bar g	High side PS for R410A Bar g
Air cooled	55°C	13.9	24.8	23.5	33.0
Water cooled	8°C above the max leaving water temp	Pressures dependent on water temperature			
Evaporative cooled	43°C	10.0	18.5	17.6	24.8

Low side PS

The maximum pressure on the low side of the system usually occurs at standstill so PS for the low side is dependent on the ambient temperature and whether any part of the low side of the system is outdoors:

Location	Maximum ambient temp.	Low side PS for R134a Bar g	Low side PS for R404A Bar g	Low side PS for R407C Bar g	High Low PS for R410A Bar g
All or part of low side outdoors	32°C	7.2	14.1	13.3	18.8
All of low side indoors	27°C	6.1	12.3	11.6	18.7

If the low side is subjected to high side pressures, for example in a reverse cycle heat pump or where saturated gas defrost is used, the PS is the same as for the high side.

In warmer climates higher maximum ambient temperatures are used, so the maximum condensing temperature and hence PS is higher.

Calculating the test pressures

The test pressures are as follows:

Minimum pressure strength test pressure = 1.1 x PS
Maximum pressure strength test pressure = 1.43 x PS
Tightness test pressure = 1.0 x PS.

For most pressure testing on site the minimum pressure strength test is used. The Health and Safety Executive guidance for on-site pneumatic pressure testing specifies the minimum pressure for safety reasons.

The maximum pressure strength test is only used for joints which fall into higher hazard category[2]. These are usually joints directly onto large vessels (i.e. not onto valves on those vessels), and joints in vessels such as welds on a liquid receiver. So the maximum pressure strength test would usually be used by a manufacturer, whereas on site the joints subject to pressure testing are pipe to pipe joints or pipe to valve joints.

Pre-charged split AC systems

If you are pressure testing the pipe work on a pre-charged split air conditioning system you risk contaminating the refrigerant charge with nitrogen if the outdoor unit valves leak. To avoid this, the test pressure should be no higher than the pressure equivalent to the saturation temperature of the outdoor unit. For example, with R410A in an ambient of 20^{O}C the test pressure should not be higher than 13.5 bar g.

Disclaimer

Every effort has been made to ensure the accuracy of the information in this document, but the content is subject to change and Cool Concerns Ltd cannot guarantee its accuracy or currency. No legal responsibility is accepted for any errors, omissions or misleading statements.

[2] Hazard categories are defined in EN378-2:2008 Annex B.