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Effective Evacuation

This guide covers the evacuation of systems to remove contamination prior to charging with refrigerant.

Evacuation removes:

- Non condensable gases such as air or nitrogen, which would increase the head pressure in a system, reducing its cooling capacity, efficiency and reliability, and leading to premature tripping on a high pressure switch;
- Moisture, which can block expansion valves and lead to acid formation with consequent compressor damage.

Equipment

A two stage vacuum pump is required for all but the smallest (domestic type) systems. The greater the flow rate (usually expressed in CFM, cubic feet per minute or litres / min) the more effective and faster the evacuation process will be. For most commercial systems you should use a pump with a flow rate of at least 5 CFM. The table below gives an indication of the vacuum pump flow rate required for a range of system sizes.

System cooling capacity, kW	Vacuum pump minimum CFM
Up to 35	1.2
35 to 100	4
100 to 175	6
175 to 250	10
250 to 350	18
More than 350	24

The vacuum pump should be in good condition and capable of achieving a vacuum of 50 microns – you can check this by connecting a vacuum gauge directly to the pump and running the pump.

The vacuum pump oil should be at the correct level and in good condition – it needs to be changed if the pump has been used to evacuate badly contaminated systems or at regular intervals. When the oil needs changing it is best to do this when the pump is warm, i.e. following evacuation so oil is changed ready for the next use. Make sure you use the correct type of oil for the pump.

Note - Vacuum pumps are usually delivered without oil and must be charged with oil prior to use.

You will also need to measure the vacuum achieved on the system. You should use the correct vacuum gauge – the low pressure (compound) gauge on a manifold gauge set does not provide an accurate indication of vacuum. The photo, right, shows a suitable gauge with a range of units (including Torr, microns, mbar, Pascal, mm Hg).

Connection to the system

The vacuum pump should be connected into the system with as little restriction as possible. This is best achieved using ¼" or 3/8"copper tube connected directly from the vacuum pump onto the system. If you do use a manifold gauge set ensure you minimise pressure drops by fully opening the valves during evacuation and make sure all points of connection are as unrestricted as possible. Some manifold sets include a 3/8" common hose – this is better than a ¼" line as it offers less restriction.

If you are evacuating the whole system connect the pump to both the high and low pressure sides. Connect the vacuum gauge to the system as far as possible from the pump connections to ensure you are accurately measuring the vacuum in the system and not just the vacuum achieved by the pump.

The evacuation procedure

Ensure there is no pressure in the system before opening the system to the vacuum pump – pressurising the vacuum pump will damage it. If there is refrigerant in the system it should be recovered prior to evacuation. Start the vacuum pump with the system isolated, then slowly open the system to the pump. If you are evacuating the whole system ensure there are no isolated sections of the system:

- Ensure the access service valves are off the back seat;
- Ensure solenoid valves are open by replacing the coil with a permanent magnet or by energising the coils.

When the required vacuum has been achieved the system should be isolated before the vacuum pump is stopped.

Single deep evacuation

A single evacuation process is appropriate for small systems. The system is evacuated to the level required without breaking the vacuum with dry nitrogen.

Triple evacuation

For larger systems a quicker and more effective method is to use a triple evacuation procedure:

1. Evacuate the system to 1500 microns;
2. Break the vacuum with oxygen free (dry) nitrogen to a pressure of 0.15 bar g;
3. Repeat steps 1 and 2;
4. Evacuate the system to the required level (see section on vacuum levels below).

The dry nitrogen absorbs moisture and gas remaining in the system and increases the effectiveness of the evacuation process.

Gas ballast

Most vacuum pumps have a gas ballast which introduces air into the pump, preventing condensation of moisture into the pump oil and helping to exhaust the moisture from the pump. This extends the life of the pump and improves its efficiency.

You should start the vacuum pump and open the gas ballast valve. When a vacuum of approximately 2000 microns has been achieved you should close the gas ballast valve to allow the pump to pull the system down to the required vacuum.

Vacuum levels

To eliminate as much moisture and non-condensable gases as is practical from the system the vacuum level should be as low (deep) as possible. You should aim to achieve better than (lower than):

- 500 microns on new systems;
- 1000 microns on existing systems.

The section at the end of this document provides other units of vacuum measurement.

Failure to achieve or hold a vacuum

When you have achieved the required vacuum you should check that the vacuum does not rise when the system is isolated from the pump. The pressure should not rise by more than 2% of the vacuum achieved. For example, for a new system you have evacuated to 500 microns, the vacuum should rise to more than 510 microns.

If you don't **achieve** the required vacuum this is either because there is a leak (see below) or because there is still moisture in the system or because there is a problem with the vacuum pump:

- It is not in good condition;
- The vacuum pump oil needs changing;
- There is insufficient oil in the pump;
- The gas ballast valve is open;
- It does not have sufficient flow rate for the system.

If you don't **hold** the required vacuum this is likely to be for one of the following reasons:

- There is a leak. In this case the pressure will rise continuously when the pump is isolated:
    - The leak could be at one of the connections between the vacuum pump and the system. You can check this by applying oil to the suspected leak – the vacuum will briefly improve while the oil is sealing the leak. Do not use any other substance to check this;

- The leak could be on the system. Leaks should have been identified during the strength and leak tightness test procedure;

- There is still moisture in the system - you just need to extend the evacuation period.

- There is still refrigerant dissolved in the compressor oil or. In this case the pressure will rise and plateau when the pump is isolated.

Vacuum units

Microns	Torr	Pascal (Pa)	mbar	in Hg
5000	5	666.5	6.65	29.72 0.1969
2000	2	266.6	2.67	29.84 0.0787
1000	1	133.3	1.33	29.88 0.0394
500	0.5	66.6	0.67	29.90 0.0197
200	0.2	26.7	0.27	29.91 0.00787

Note – 200 microns is a better (deeper) vacuum than 5000 microns.

A perfect vacuum is 0 microns (29.92 in Hg) and will never be achieved! So strictly speaking we only ever achieve a partial vacuum in a refrigeration system.

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