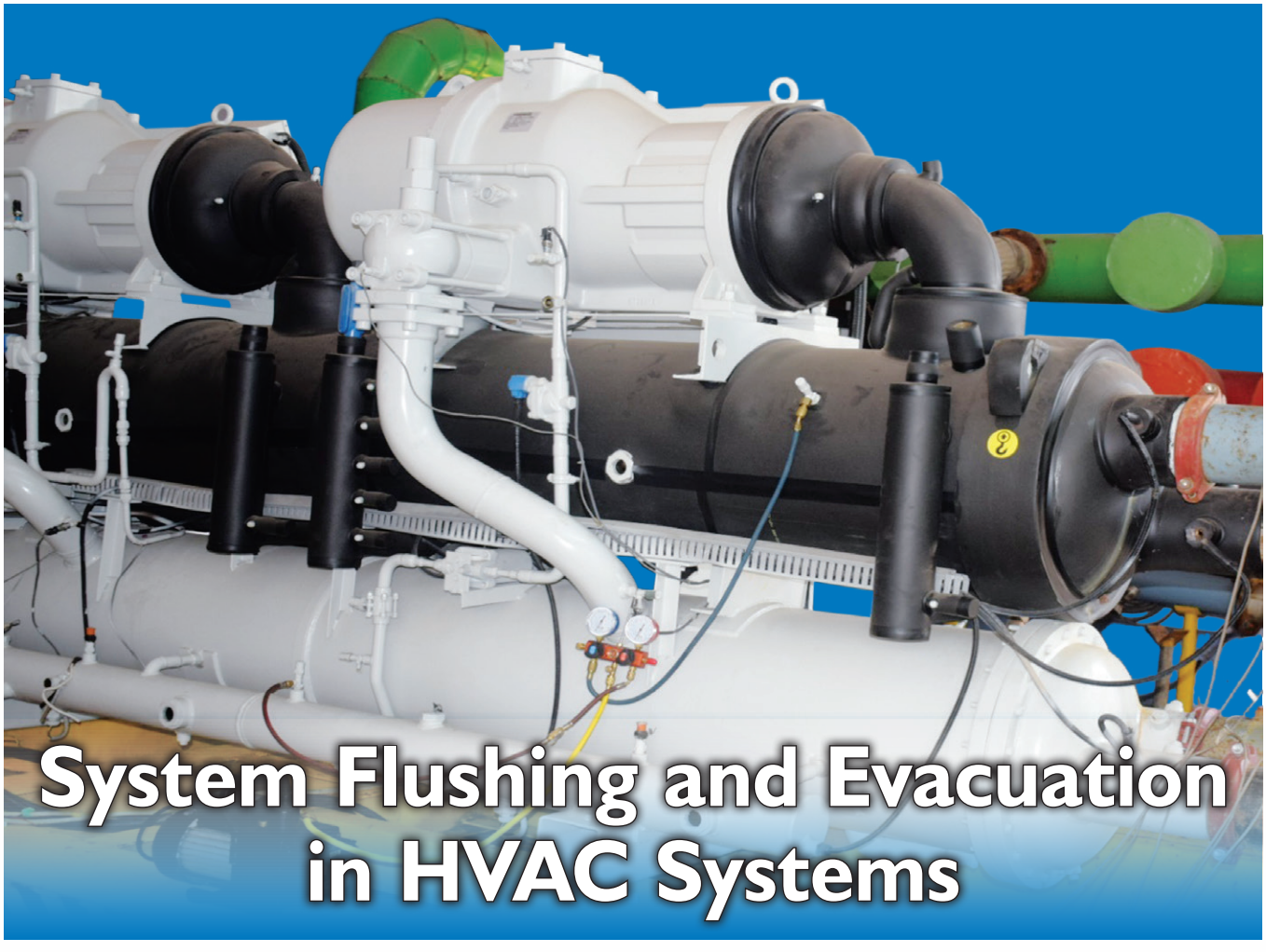
Vacuum pump connected to suction and liquid lines



System Flushing and Evacuation in HVAC Systems

By Sanjeev Rastogi NEBB USA Accredited TAB Professional, Blue Star Limited, Thane

Introduction

Before commissioning a system that is carbonated due to winding burnout or bad oil, it is mandatory that all impurities be removed from the system at the time of commissioning. Brazing particles, dirt, flux, metal chips, bits of steel, etc. have often been found in systems and they frequently end compressor life. Many of these contaminants are so small that they will pass through a fine mesh screen. In addition, the metal fragments may rotate because of gas velocity and cut or break the usual compressor suction screen.

Pulling a vacuum in a system prior to gas charging is also important to make the system operate properly and efficiently, and to ensure a long service life.

About the Author

Sanjeev Rastogi is a graduate in mechanical engineering with MS in Industrial Production and Management from BITS Pilani, and has 25 years of experience in HVAC industry. Presently, he is working at Blue Star, heading the Service Specialists Group. He is an accredited professional from NEBB, USA for Testing, Adjusting and Balancing services, and a certified IAQ prefessional.

System Clean up After Compressor Burnout

In case of motor burnout in a compressor, the resulting high temperature arc causes a portion of the refrigerant-oil mixture to break down into carbon sludge. The increase in oil acidity level is also detrimental to the system. It has long been recognized that contamination resulting from a burnout can result in repeat failure if the contaminants are allowed to reach and remain in the crankcase of the replacement compressor. Such situations can be avoided by following proper clean up procedures after a burnout.

Cleaning the lines of such systems requires a proper flushing solution. Earlier, before CFC refrigerants were banned, service technicians used R-11 or R141B to flush the lines. The current Environmental Protection Agency (EPA) regulations prohibit this practice. The search is on for a flushing agent that is both effective in dissolving contaminants and mineral oil, and is also eco-friendly.

To ensure complete removal of contaminants during flushing, they must vaporize. Therefore, any un-pressurized liquid flushing

continued on page 82

continued from page 80

solution from a can is totally unsuitable, since it just replaces the oil and other non-evaporating fluids in the system with another non-evaporating liquid impurity. Considering the complexity of HFC refrigerants and synthetic oils, this is not advisable. Instead, only such flushing compounds that vaporize should be used, which means they would be packaged in a pressurized disposable cylinder or pressurized aerosol can.

Flushing Procedure

Irrespective of the cleaning agent used, a proper activity setup requires:

1. A method of getting the flushing agent into the lines;
2. Creating resistance with a restriction at the end of the line so that the flushing agent flows slowly and remains in contact with the contaminants for a longer duration;
3. A receptacle such as a bucket at the other end of the piping;
4. An access valve that fits the flushing agent container.

Before using a flushing agent, nitrogen purging is recommended to blow out any loose particles. Lesser the particles in the lines, more the dissolving action of the flushing agent on the remaining contaminants. Purging also blows out as much residual oil as possible.

Getting the flushing agent into the lines requires some kind of fitting. A time-efficient method would be to wedge a conical rubber fitting into the open line and hold it in position during flushing. Crimping the exterior end of the lines will create resistance.

Flushing must always be carried out from the indoor side to the outdoor, which is commonly located outside. This will make clean up easier, and will limit vapors. Despite using a safe, non-toxic flushing agent, breathing any vapors is best avoided. The used flushing agent must be collected and disposed as per EPA norms.

Figure 1: Nitrogen flushing before using cleaning agent to remove loose particles from system

Flushing agents are excellent for removing oil from lines, but at the same time they should never be blown through a compressor to avoid removal of oil from the compressor and its seizure. Likewise, a filter-drier must never be flushed because the large amount of particles will reduce its filtering capacity. Thermostatic expansion valve (TXV) apertures and capillary tubes will clog as well. These are not major concerns because, in a conversion or a system clean up procedure, the compressor and filter-drier are typically cut out of the system. However it is recommended to replace all the filter-driers once the flushing procedure is completed.

Post-cleanup Check

It is recommended for both burnouts and retrofits that, after the cleaning procedure is completed, the system be rechecked after approximately two weeks to ensure that its condition and operation are completely satisfactory. This includes checking oil acidity.

If acid is present, two types of acid removers can be used:

1. A neutralizing product that introduces an alkaline base to neutralize the acid.
2. An acid flush that removes acid and moisture by absorbing it and flushing it to the filter-drier.

The latter method is recommended because it leaves no residue, unlike the neutralizing process. Residue is a contaminant that can eventually damage the system.

System Evacuation

Moisture hinders proper functioning of the compressor and the refrigeration system. Air and moisture increase condensing pressure and reduce service life. Excessively high discharge pressure and temperature can also destroy the lubricating properties of oil. Air and moisture increase the risk of acid formation, giving rise to copper plating and motor insulation damage. These phenomena can cause mechanical and electrical compressor failure. To eliminate these risks, evacuation (or vacuumising) is recommended prior to gas charging.

Evacuation Procedure

It is essential to connect the vacuum pump to both the liquid and suction valve in order to avoid dead-ending parts of the system, which would hinder staisfactory evacuation.

The refrigeration circuit is pulled down to a vacuum of 500 microns of Hg (0.67 mbar). It is essential to use an electronic vacuum gauge, since its senstivity and accuracy is high compared to a compound gauge.

When a vacuum level of 500 microns is reached, isolate the circuit from the pump. Wait for 30 minutes. If the pressure increases rapidly, the circuit is not leak-tight. Locate and repair the leaks. Start again from the beginning. If the pressure increases slowly, the circuit contains moisture. Break the vacuum with dry nitrogen gas and repeat the above steps.

A vacuum of 500 microns should be reached and maintained lower than 700 microns for a minimum of one hour. It will guarantee that the circuit is both tight and fully dehydrated. This pressure should be measured at the refrigeration system, not at the vacuum pump gauge.

continued on page 84

continued from page 82

At the time of commissioning, system moisture content may be up to 100 ppm. During operation, the filter-drier must reduce this to a level between 20 and 50 ppm.

Points to Remember

- During the initial system evacuation, lowering the pressure below 500 microns carries the risk of freezing the moisture present in the system. (Liquid moisture trapped in small pockets will turn into ice and not evaporate). The low vacuum achieved can be misinterpreted as a moisture-free system whereas, in fact, ice is still present. Such a risk is high when using a relatively large vacuum pump or a small volume circuit.
- A single vacuum pump down evacuation to 250 microns (0.33 mbar) will not guarantee a sufficiently low moisture level.
- A low ambient temperature around the equipment – below 10°C – impedes moisture removal. Take counter measures and energize the compressor's crankcase heater.
- Fit the vacuum gauge as far away as possible from the vacuum pump. This will ensure more accurate measurement of vacuum in the system.

Warning

Do not use a megohmeter or apply power to the compressor while it is under vacuum. It may cause motor winding damage. Never run the compressor under vacuum, as it may cause compressor motor burnout.

Figure 2: Technician fixing manifold to chiller

Improving the Evacuation process

Methods usually adopted to improve the evacuation and dehydration process are:

a. Heating the system. This is recommended only for small systems. The size of the oven decides the size of the system it can handle. Sometimes cooling coils and condensers are flame heated to drive away the moisture quickly.

b. Triple evacuation. After vacuumising fully, charge the system with the refrigerant to 2 psig, and re-vacuumise. Repeat this. The refrigerant carries out the moisture quickly.

c. Use a cold trap – an intercooler placed between the vacuum pump and the system. The intercooler provides a cold surface in the air stream from the system and the moisture in the air gets condensed on the cold surface. The air going beyond the cold trap, thus, has less moisture.

Guidelines for Vacuum Pump Selection

- Always select the right capacity vacuum pump according to the system in which it has to be used.
- A two stage rotary vacuum pump with 200-300 lpm is generally used. A good vacuum pump can draw the required vacuum within a reasonable time.
- Most rotary vane vacuum pumps employ oil for the creation of vacuum. The oil level of most vacuum pumps is stated on the sight glass. If not stated, the level (meniscus) should be observed just past the halfway mark of the oil sight glass with the pump in operation. Oil levels, typically, are maintained by filling through the exhaust port of the pump. No harm will occur by filling through the intake port. The preferred oil fill entry port is the exhaust port, which makes it easier for the user to accomplish quick filling and adjustment of the oil level. Correct oil level can affect high vacuum pressures if the oil level falls below the actuation level of the exhaust flutter valve typically found on the top of the exhaust stator on the vacuum pump (inside the pump casing).
- Before connecting the pump to the system, connect a good vacuum gauge at the pump intake port without the system attached in any manner. This is the only way to baseline the pump. In problem areas and while troubleshooting vacuum systems, this is the first step in the process. Determine the 'blank-off' or the ultimate vacuum pressure, which is mentioned in the technical details of the vacuum pump.

Conclusion

A complete evacuation ensures that there is no moisture or non-condensables that can harm the system and affect its smooth working.

Once the evacuation activity is completed, if working on a new installation, isolate the pump and vacuum gauge, slightly open the liquid line service letting a small amount of refrigerant into the system bringing the system slowly into a positive pressure. Once the liquid line is completely open, open the suction service valve, purge the manifold hoses and install gauges to finish commissioning the system.

If working on an existing installation, or while recommissioning, break the vacuum with the required system refrigerant and commission the system.