BEST PRACTICES: Pulling a DEEP VACUUM

A three-part series acquainting technicians with system evacuation best practices.

BY ANDREW ERBACH AND DAVE BOYD

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For a vapor compression refrigeration system to operate properly, the only fluids that should be inside the system are refrigerant and oil. This means that service technicians must be trained to apply best practices to ensure a proper vacuum is pulled on any system left open to atmosphere before charging. The purpose of this three-part series is to acquaint the technician with current best practice in system evacuation. In this article we discuss the basics of a clean, tight, dry system and the equipment used in a deep vacuum.

When servicing a refrigeration system, the technician is responsible for ensuring that all work results in a CLEAN, TIGHT, and DRY system. This is especially true of modern refrigerants that require the use of polyolester lubricant, which can be 10 times more hygroscopic than the mineral oils used with chlorinated refrigerants. Non-condensables, primarily air and moisture, can wreak havoc on a refrigeration system by mixing with the oil and creating acids and sludge.

Clean—Keeping the system clean requires only following standard service procedures: purge dry nitrogen when brazing, plan your work so that the system is opened for a minimal amount of time, and replace the liquid line filter dryer any time the system is opened to atmosphere.

Tight—Proper brazing practices will go a long way toward ensuring the system is tight; even seasoned technicians will have leaks from time to time. All brazing processes should be done while purging dry nitrogen through the tubing. After brazing, HVAC systems should be pressure tested before attempting to pull a vacuum. If your system can hold a nitrogen pressure charge slightly below the manufacturer's test pressure for 30 minutes, you are ready to pull a vacuum.

Dry—Here is where the rubber meets the road—remember not to permit air to enter the system after pressure testing. Bleed off the nitrogen to atmospheric pressure and immediately begin pulling a vacuum. The nitrogen will help prevent air and moisture from entering the system. Pull the system down to the required vacuum specified by the manufacturer, isolate the system and, if it holds for half an hour, charge with the appropriate refrigerant.

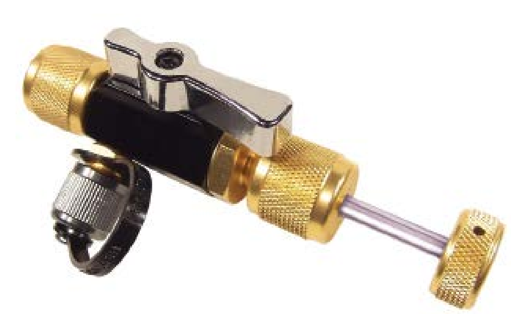
Properly evacuating and dehydrating a refrigerant system using a vacuum pump is one of those fundamental procedures which, if improperly done, costs both the customer and the contractor money and time. Since most manufacturers require that systems being repaired be pulled down to at least 500 microns, and in some cases 250 microns, using the right procedures and equipment to get the job done quickly is in everybody's interest. For a system to be dry and clean it must be tight, and that is where proper procedures come in.

Core Removal Tools

Core removal tools help keep the entire system clean, dry and tight while speeding up the recovery and evacuation processes. Using tools that have been manufactured for vacuum service is recommended. Some manufacturers actually test and rate their tools for a specific micron level. The lower the rating, the better. These tools permit us to remove the core and connect to the system with only the restriction caused by the inside diameter of the service port.

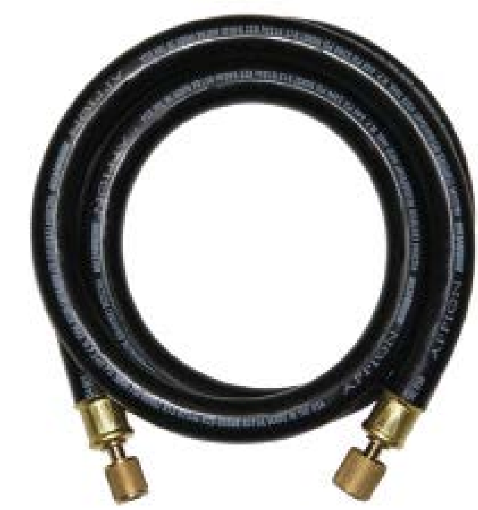
Hoses and manifold

If a technician uses a standard refrigeration manifold for both charging and evacuation, that technician is making a fundamental error. Only vacuum-rated manifolds and hoses should be used for evacuation and, if you are pulling vacuum through the gauge set, that should also be vacuum-rated. It is surprising to realize how many technicians actually believe that a manifold is necessary for pulling a deep vacuum; this simply is not true. Many technicians have been able to get to 500 microns using a pressure manifold with pressure hoses, but it takes longer than necessary to get the job done, and wasted time is wasted money.



A vacuum-rated valve core removal tool.

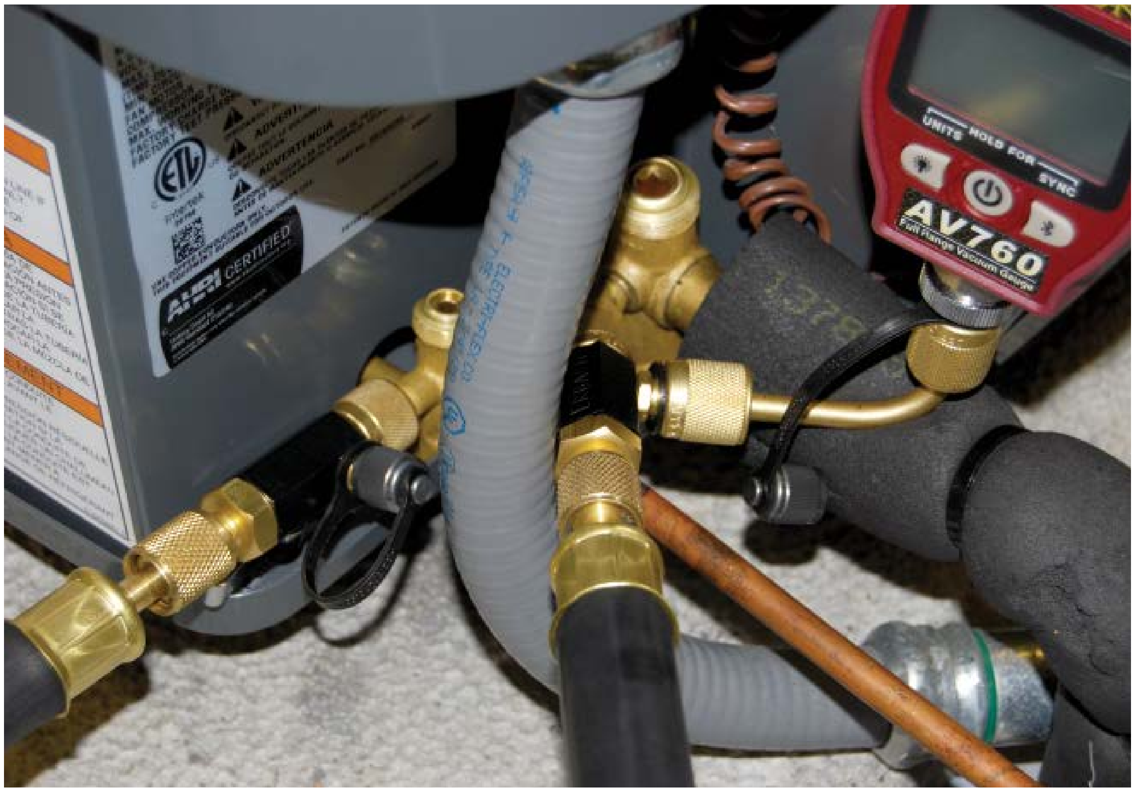
Some manufacturers test their products down to 20 microns and include vacuum ratings in their product literature; this information is especially helpful when purchasing service hoses. The better vacuum hoses will have their vacuum rating printed on the outside of the hose. Because there are differences in the way hoses are manufactured, vacuum-rated hoses should be used for evacuation only and pressure-rated hoses for charging only. Using large diameter short hoses speeds up the procedure exponentially.



A vacuum-rated hose.

We must look at every seal and connection as a possible vacuum leak, so reducing the number of connecting points helps minimize potential problems. Standard manifolds, hoses and fittings are designed to work properly when pressurized. The forces on them when in vacuum are trying to make them collapse, which is the exact opposite of the forces trying to expand them like a balloon when under pressure. If you choose to pull through a manifold, all parts of the evacuation system should be vacuum rated: hoses, core removal tools, micron gauges and manifolds. Ideally, the connections to the micron gauge should be located as close to the component being evacuated as possible. Connections should also be metallic—no pressure hoses running to the vacuum gauge. We want to measure the vacuum at the unit, not the vacuum at the hose or at the pump.

Non-condensables can enter through a leaky service hose, causing the pull down to take longer. Using metallic connections as close as possible to the service port is a great way to ensure that the leaks you are chasing are from the refrigeration circuit and not from the hoses. When working in a tight place, you can fabricate a small stem for your micron gauge out of soft copper with a couple of flair fittings, and locate it where it is easy to see without standing on your head. Once we are past the micron gauge, the use of vacuum-rated flexible hoses is acceptable.



›› **A digital micron gauge for pulling a deep vacuum.**

One great way to accomplish this is to use a core removal tool with your micron gauge attached directly to the side port and the evacuation hose connected to the straight port.

Micron gauges

Using the compound gauge on your manifold is not an acceptable way to measure vacuum; it simply lacks the accuracy needed to measure at the micron level. Using a compound gauge to measure vacuum is like trying to measure a distance of 1-in. using the odometer on your car. 500 microns is equal to .0196 in. of mercury; the graduations on a Bourdon tube compound gauge are simply unreadable to this level of precision.

Most micron gauges available today don't display the exact level of vacuum until you are at less than 9,999 microns. The better, and consequently more expensive, gauges start counting down at atmospheric pressure (760,000 microns). While either type of gauge will do the job, using one that starts at atmospheric gives you the ability to see when the vacuum process stalls, saving time by indicating an oil change is needed or that there may be a leak in the system. Many manufacturers also make the job easier by including both charting and Bluetooth features, allowing you to use a cell phone to track and document the entire evacuation for the service report. Documenting the entire process in this way will help avoid disputes with manufacturers over warranty claims. The fact is that if proper procedures are followed and documented, system failures and warranty issues are very rare.

Vacuum pumps

The most common type of vacuum pump in the refrigeration industry is a two-stage rotary vane pump. This pump is designed to remove non-condensables (air and moisture) from the system.

A properly operating and maintained vacuum pump should be able to pull down to at least 100 microns when blanked off. Why then does a pump take forever, or in many cases can never get down to 500 microns? The answer is simple—maintenance.

When was the oil changed last? How was the pump stored? And what type of oil was used? Most technicians know that at a minimum one should change the oil in a vacuum pump after every use, but only the good technicians do it. The oil should also be changed during the evacuation process as often as needed, changing more than once during a deep vacuum pull down is often necessary. The oil should be changed immediately after because when everything is still warm and most of the air and water that was just pulled out of that system is still in suspended in the oil. The oil water and debris go to the local oil recycling facility and the pump is filled with fresh oil getting it ready for the next job.

Remember that the vacuum pump dries the system out by pulling water out as a vapor; if you shut the pump down and don't change the oil while it is warm, the water and oil will separate—water on the bottom, oil on the top. Sure, if you change the oil before you use the pump the next time, the water and oil will come out the drain, but that water has spent time in the bottom of the sump on your pump building up a layer of debris and oxidation that will not run out the drainpipe. It doesn't take much water to make a mess of a good pump.

How is the pump stored? If it has been bouncing around in the back of the service van all summer, it probably looks like the losing car in a demolition derby. Dents in the sump can lead to gasket failure, and dirt in the pump will severely shorten its usable life.

What about the oil you are using? Sure, you are using a good quality vacuum pump oil, but if that oil container has been left open on the jobsite, capped up at the end of the day and been bounced around the van like a ping-pong ball in a drier, you probably don't want to use it in your vacuum pump. Find a plastic tub that fits your pump and a few quarts of oil, store the pump in it with the caps on loosely to keep dirt out of the equipment.

When we cannot get below 500 microns quickly, it's easy to blame the vacuum pump, the connections, the guy who sold us the gauges, the humidity outside, etc. The simple fact is that problems in achieving a deep vacuum on an otherwise tight system are directly related the procedures the technician uses and not to the equipment.

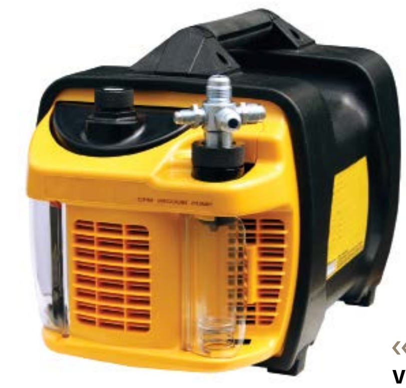
Oil

Vacuum pump oil, also called sealing oil serves three primary functions: it seals the pump, it lubricates the pump and it cools the pump. The first job of vacuum pump oil is to SEAL.

Changing the oil in the vacuum pump after every use is only the starting point. Monitoring oil condition and changing it as-needed is critical to performing a proper deep vacuum quickly and efficiently. In the past, most mineral oils that were used in compressors could only hold 25–30 ppm of moisture; modern systems using POE oil can hold up to 250 ppm. Moisture breaksdown POE oil into alcohol and acids; neither of these substances is known to be a good lubricant for refrigeration systems.

When servicing today's systems we must change the oil as soon as it becomes contaminated and no less frequently than every time the vacuum pump is used. Because the oil should be changed after the vacuum pump is used and while the oil is still hot, a look at the oil can indicate what is happening in the system. White cloudy oil indicates excessive moisture. Brown oil can indicate a burnout (which should be confirmed by an acid test) or a failure to properly clean the system. Oil with black or grey specks is usually the result of a previous technician who failed to purge nitrogen while brazing.

In the next installment of this three-part series we will perform three test vacuum pulls.



« **A two-stage vacuum pump.**

Andy Erbach is currently a full-time Professor at Elgin Community College, teaching courses in HVAC and Energy Management. His professional credentials include CMS, RCT and licenses as an electrical contractor, mechanical contractor and stationary engineer. He also holds a Master's degree in Adult Education from Northern Illinois University, as well as a Master's Certificate in Project Management from George Washington University.

Dave Boyd is the Vice President of Education and Sales for Appion Inc., a manufacturer of AC/R service tools. He also is the Chairman of the MSAC and provides answers for the monthly Educational Facilities nationwide. For more information and educational videos, visit www.appiontools.com.