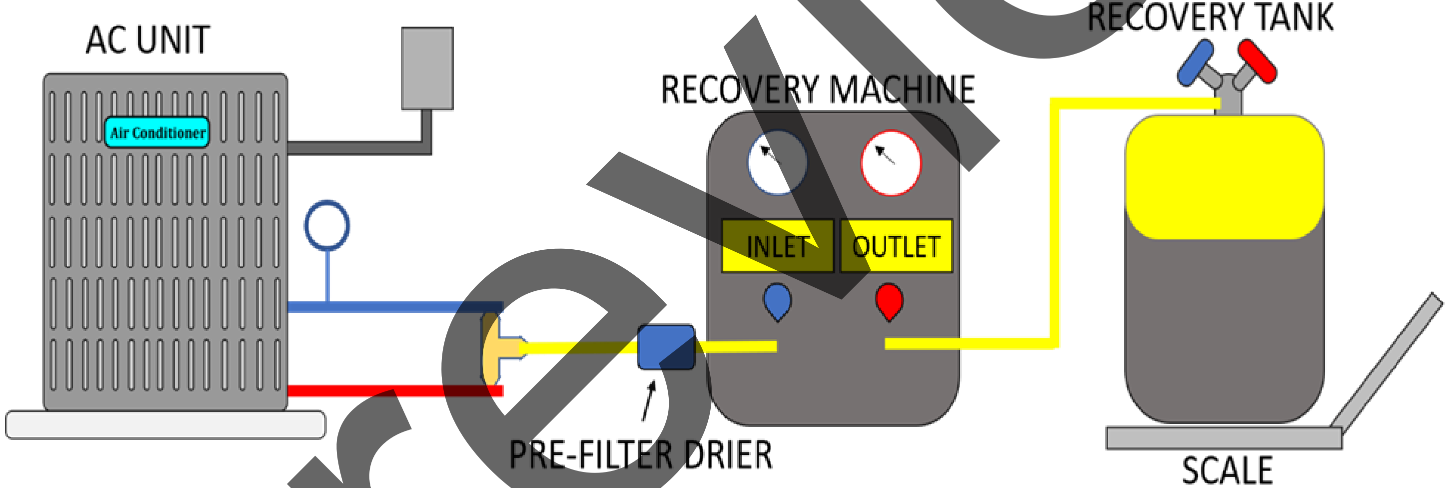
System Recovery and Evacuation



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Printed in the United States of America

ISBN Print Edition: 1-930044-64-X
ISBN Ebook Edition: 1-930044-52-6

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esco institute

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Learning Outcomes:

After completing this section, the learner should be able to:

- understand the refrigerant recovery process.
- discuss EPA refrigerant recovery requirements.
- explain the differences between recycling and reclaiming refrigerant.
- describe the tools and equipment necessary for refrigerant recovery.
- discuss the proper used of DOT-approved recovery tanks.
- understand evacuation theory.
- understand the measurement of a vacuum.
- describe the tools and equipment necessary for system evacuation.
- explain the use of a micron gauge.
- understand the triple evacuation process.
- understand the functions of filter driers.
- discuss the differences between suction and liquid line filter driers.

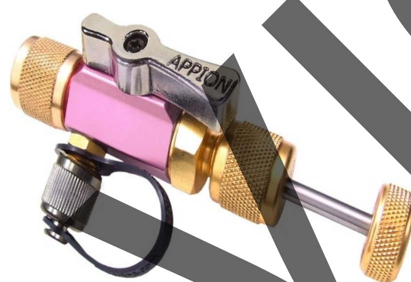
Recovery Equipment

The tools necessary for recovery may depend on the size of the system and the amount of refrigerant being recovered. The most common recovery set up consists of:

- **Recovery machine** –pumps the refrigerant from the system to the recovery tank.
- **DOT-approved recovery tank** – used to store the recovered refrigerant, colored gray and yellow; also referred to as refillable cylinders.
- **Core removal tool(s)** – used to remove the Schrader valve cores, allowing for greater flow.
- **1/4-inch or 3/8-inch refrigerant hoses** (manifold optional) – used to transfer the refrigerant.
- **Pre-filter drier** – filters particulate from the refrigerant before it enters the machine.
- **Refrigerant scale** – used to monitor how much refrigerant has been pumped into the tank.

Recovery machine

Refrigerant hoses



Core removal tool

Recovery tanks

Recovery Procedures

The two most common reasons to recover a system's charge are to open the system for repair or for disposal of the equipment. Equipment connections, start up, and shutdown procedures can vary from one machine to another and from one system to another. Some recovery machines can handle liquid refrigerant while others can only be fed vapor. Read the manufacturer's literature for the equipment being used to ensure proper use.

Liquid refrigerant recovery is faster than vapor recovery, but some oil will likely be removed from the system along with the refrigerant. Once all of the liquid refrigerant has been removed from the system, any remaining vapor must also be recovered from the system. To minimize the loss of oil from the system, it is recommended that, although a slower process, refrigerant is recovered from the system in the vapor state.

When working with refrigerant, safety is a primary concern. Proper personal protective equipment (PPE) should always be worn and industry best practices should be followed. The recovery tank should not be filled beyond 80% of its capacity, allowing room for refrigerant expansion. Different refrigerant types should not be mixed in the same recovery tank.

Prior to beginning the recovery process, the maximum allowable tank weight should be determined. Located on the collar of the tank are the water capacity (WC) and the tare weight (TW) of the tank. The maximum allowable weight can be calculated by using the following formula:

$$(\text{Water Capacity (WC)} \times 0.8\ (80\%)) + \text{Tare Weight (TW)}$$

It may be necessary to restart the recovery machine if the system pressure rises to an unacceptable level. A rise in pressure can result when refrigerant trapped in the system oil begins to vaporize. For most residential and light commercial heat pump and air conditioning systems containing less than 200 pounds of either R-22 or R-410A, the required recovery level is 0 psig. (R-22 and R-410A are both classified as high-pressure refrigerants by the EPA.)

Upon completion of recovery, the recovery unit's purge cycle should run, if applicable. The recovery tank and equipment valves should be closed, and the equipment disconnected and properly stored.

Recovery Tips: Dos and Don'ts

- Read the manual for the recovery machine being used to ensure proper use.
- Always purge air from the refrigerant hoses to prevent refrigerant contamination and excessive pressure in the recovery tank.
- Remove the valve core pins from the system for faster refrigerant transfer.
- New recovery tanks should be evacuated before use.
- If 3/8-inch hoses are used, they should be as short as possible, 4ft or less. This ensures compliance with EPA's de minimis requirements.
- Calculate the maximum allowable weight for the recovery tank being used.
- Never fill a recovery tank beyond 80% of its capacity.
- A recovery tank can be placed in ice to lower its pressure and speed up the recovery process.
- Never mix two different refrigerant types in the same recovery tank.
- Recovered refrigerant can only be reused in the system from which it came or in other equipment that is owned by the same individual or entity.
- If the refrigerant that is being recovered is to be reused, it should be recovered into an empty recovery tank. .
- Once filled to capacity, a recovery tank should be brought to a collection center to be sent for reclamation.

Introduction to Evacuation

Evacuation, also referred to as *pulling a vacuum*, is the process of removing moisture, air, and other non-condensable gases from a sealed refrigeration system. Evacuation reduces the system pressure to below atmospheric pressure (0 psig), creating a vacuum.

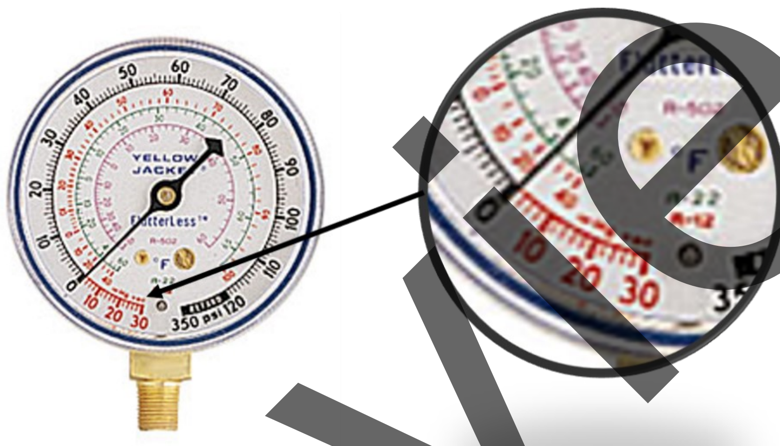
The term *non-condensables* is used to describe any gas that will not condense to a liquid in the vapor-compression refrigeration cycle. The two most common non-condensables found in HVACR systems are air (oxygen) and nitrogen. Air and moisture can enter the refrigerant circuit anytime it is opened to the atmosphere. Nitrogen is commonly used to pressurize systems for leak detection purposes. If these gases were present in the system during operation, they would cause higher operating pressures and temperatures, which would decrease efficiency, and in time, result in system failure.

Refrigerant oil is hygroscopic, which means it readily absorbs moisture. When a system is opened to the atmosphere, moisture may enter the system. Moisture can be in the form of water vapor or water droplets. Small amounts of moisture can react with the refrigerant and oil in the system, causing acid to form. Once in the system, acid can cause copper electroplating on steel surfaces such as the compressor's internal components. These copper deposits may cause some components to seize. Acid can also damage the insulation of the compressor motor's windings, which can result in compressor motor burnout. Moisture may also cause the system oil to break down and form sludge. This sludge can clog orifices, filter driers, and valves, causing system failure. The only two substances that should be present in the refrigerant circuit are refrigerant and oil.

3/8-inch diameter hoses have a flow rate of about 2 CFM, and 1/2-inch hoses have a flow rate of about 3 CFM. Removing the valve cores and using two 1/2-inch evacuation hoses, one on the low side and one on the high side, has the potential to deliver a flow of 6 CFM to the vacuum pump.

Micron Gauge

A micron is a very small unit of measurement, used in the HVACR industry to measure a deep vacuum. Atmospheric pressure (0 psig) is equal to 760,000 microns. Most refrigerant gauge manifolds measure a vacuum in inches of mercury (inHg). This unit of measurement is too large to be used for a deep vacuum. Note the vacuum scale on the gauge in the image. At 28 inHg, the system is at 50,800 microns; at 29 inHg it is at 25,400 microns; and at 29.90 the system is at 2,540 microns. The industry standard target for evacuation is 500 microns (29.98 inHg). Trying to measure a deep vacuum with this scale is impossible. Technicians must instead rely on a digital micron gauge.



A micron gauge should be attached as close to the system as possible. The gauge port on the side of the core removal tool is an ideal location. It should be mounted in the upright position to prevent any oil from entering the gauge.

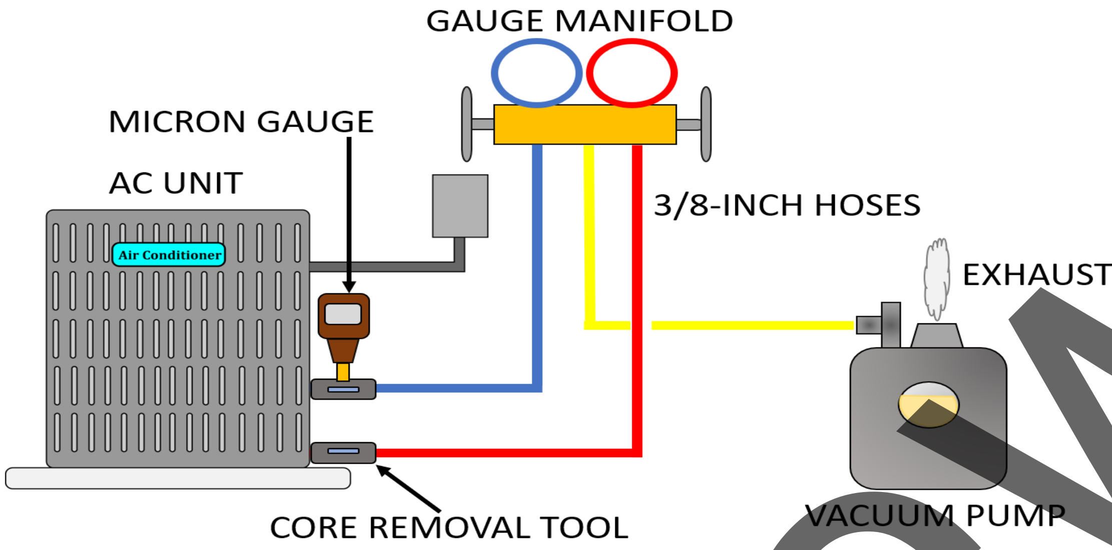
There are several models of micron gauges, each with a slightly different operation. Some gauges will not begin to display a reading until the vacuum pressure has been reduced to 20,000 microns or less. Other gauges will start at 760,000 microns and continue to measure for the entire evacuation. Refer to the manufacturer's instructions for proper use, cleaning, and storage of the gauge.

Digital micron gauge

Evacuation Procedures

It is very important to remember that when a new system is being assembled, or an existing system is opened for service, that the lines be kept clean and dry. This can cut down on evacuation time and produce better, overall evacuation results. There are many factors that can affect the speed and efficiency of an evacuation, including:

- the size of the equipment being evacuated;
- the capacity of the vacuum pump and hoses being used,
- the level of moisture/contamination in the system and lines,
- the ambient temperature.



Evacuation with a gauge manifold

The following is a general description of an evacuation of a residential cooling system (EPA Type II appliance) using the evacuation equipment previously described. It is always best to begin an evacuation with fresh, clean oil in the vacuum pump.

The pressure of the system being evacuated should be reduced to 0 psig. A vacuum pump should not be connected to a pressurized system, the pressure in the system may discharge into the vacuum pump. This can damage the pump and may result in the rapid discharge of the pump oil from the discharge port of the vacuum pump. If there is refrigerant in the system, it might be rapidly discharged to the atmosphere with the pump oil, a violation of the Clean Air Act. Also, care must be taken if a vacuum pump is connected to a system that is already in a deep vacuum. If proper procedures are not followed, the vacuum pump oil may be pulled out of the pump and into the system being evacuated.

Connect the core removal tools, evacuation hoses, vacuum pump, and the micron gauge to the system to be evacuated. If a gauge manifold is used, it should be as large as possible to allow more flow to the pump.
Energize the pump. Monitor the micron gauge and the quality of the pump oil during evacuation. If an oil change becomes necessary during evacuation, the system should be isolated from the pump by closing the ball valves on the core removal tools.

Allow the vacuum pump to run until the evacuation target is reached, typically 500 microns. The time necessary to reach this level may vary greatly from one system to the next.

Once the target is reached, isolate the system from the pump and monitor the evacuation level as the system stands for a period of time, typically 20-30 minutes for residential systems. The pressure should not rise considerably, typically more than 1,500 microns. This is called a decay test. (There are several micron gauges that can be paired to a wireless device for monitoring evacuation and decay through an app.)

If the system pressure rises and levels off, there is most likely air and/or moisture still in the system. The vacuum pump should be restarted. If the system pressure rises and continues to rise to atmospheric pressure, there is a leak. The leak should be found and repaired, and the system evacuation performed again.

Some vacuum pumps are equipped with a gas ballast which can be useful when evacuating a wet or contaminated system. When opened, a gas ballast provides a way to allow air to enter the pump during the initial stage of the

13. For most residential and light commercial heat pump and air conditioning systems containing less than 200 pounds of either R-22 or R-410A, the required recovery level is ______________.

14. The process of removing moisture, air, and other non-condensable gases from a sealed refrigeration system is called ______________.

15. The two most common non-condensables found in HVACR systems are ______________ and ______________.

16. Refrigerant oil is ____________________________________, which means it readily absorbs moisture.

17. Refrigeration system evacuation is a combination to two processes: ______________ and ______________.

18. Small amounts of moisture can react with the refrigerant and oil in a system, causing the formation of ______________.

19. A deep vacuum is measured in ______________.

20. Moisture must be ______________ before it can be removed from a system by a vacuum pump.

21. Evacuation can be considered complete when the system pressure has been reduced to about ______________ microns and, when valved off from the vacuum pump, does not rise more than ______________ microns.

22. An evacuation method that introduces nitrogen into the system between multiple evacuations is called ______________.

23. A ______________ allows air into the vacuum pump which can help prevent water vapor and contaminants from condensing in the pump oil.

24. During evacuation, the micron gauge should be located as ______________ to the system as possible.

25. A ______________ removes moisture and particulate from the refrigerant in a sealed refrigeration system.

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