COIL CLEANING GUIDE

Learn the impact of dirty coils and how to maintain peak efficiency.

SPEEDCLEAN®

HVAC School
For Techs by Techs

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Intro

Regular maintenance of HVAC systems reaps benefits far past efficiency gains. Regularly scheduled maintenance offers the trained technician the ability to identify possible problem areas and build a data set over time. New tools measuring available data points can help see issues coming down the pipeline. However, necessary cleaning is also a large part of system efficiency and increasing the lifespan of an HVAC system.

In this guide, you will learn the reasons why coil cleaning is a vital part of a well-performed maintenance program, and how to correctly complete cleanings, and tips on the right tools to use. (**Hint:** It's not just shooting water at the coil with a garden hose.) There are also specific data examples that show, not tell, about the importance of having clean coils.

Reasons For Coil Cleaning

Heat Transfer

The purpose of all HVAC/R coils is to transfer heat from one medium to another through the walls of the tubing. The most common type of coil is used for the direct transfer of heat from the refrigerant to air through the tubing or channels using fins or spines attached to the tubing. These fins assist in transferring heat by adding additional surface area for the air to contact the metal as it passes by.

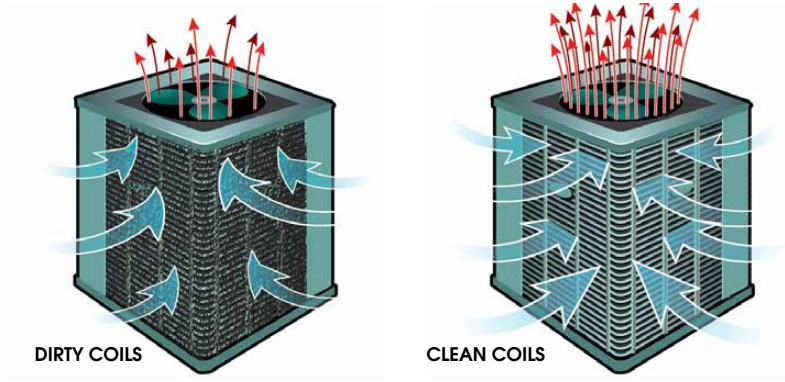
Metals like copper or aluminum are often used for coils because they have good thermal conductivity, which means heat moves through them easily. When coils get a coating of dirt on them, it can act as thermal insulation on the metal impeding the movement of heat in and out of the coil.

Therefore, because heat moves from higher temperature to lower temperature through materials via conduction any material on the coil (like dirt) with lower thermal conductivity and higher R-value results in lower heat transfer and therefore some potential performance impact on system performance.

Air Flow

When dirt and other contaminants block coil fins, it causes a more substantial air pressure drop across the coil, which results in either lower airflow over the coil or higher power consumption on the motor depending on the motor and fan type.

Axial fan blades with fixed single speed AC motors are common in air conditioning and refrigeration condensers. This type of motor and fan blade combination is heavily impacted by increases in air resistance known as "static pressure." As the coil gets dirtier, the motor moves less air, resulting in less heat transfer and lower efficiency.



DIRTY COILS

CLEAN COILS

Broad Impacts of Dirty Coils

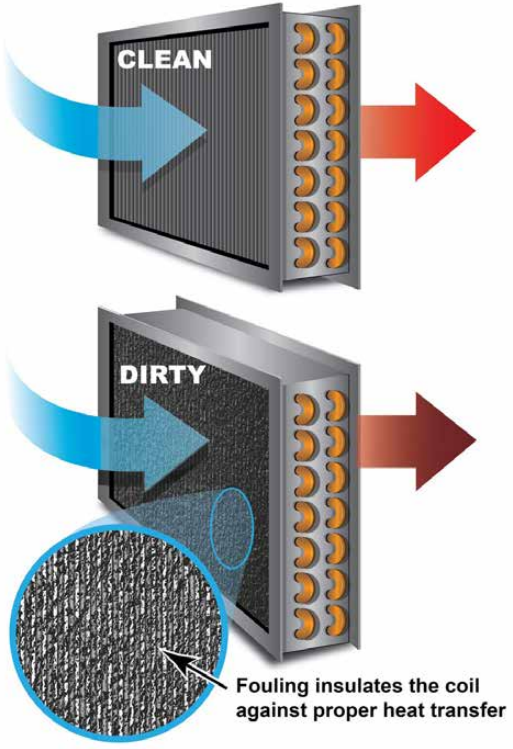
Inefficiency

The primary purpose of HVAC/R systems is to move heat from one place to another. Anything that inhibits this movement of energy results in an increased energy input on motors, compressors, and pumps to compensate. Cleaning coils is critical to maintaining peak efficiency with studies showing energy loss before cleaning of 10 - 37% depending on the type of system and the level of fouling.

Performance & Capacity

When coils get dirty, the amount of heat the system can move tends to decrease. Many applications require the system to work at full capacity during times of critically high load, and this is the very moment when dirty coils tend to cause the most significant issue.

Dirty evaporator and condenser coils both cause high compression ratio, which results in less refrigerant circulation by mass and fewer BTUs of heat movement per hour.



System Longevity

Dirty coils result in a high compression ratio, which causes the compressor to run hotter and harder. The overwork can result in early failure of the compressor as well as increased vibration, which can result in rub-outs and abrasion leaks. Dirty condenser coils also result in high head pressure, which makes leaks on the high side of the system more likely.

Dirty Evaporator Coils

The evaporator coil is responsible for absorbing heat from the space to be cooled in a DX (direct expansion) system. When the coil is dirty, it can impede both airflow and heat transfer resulting in less heat load on the coil. The loss of heat load reduces the amount of heat entering the refrigerant, which causes the pressure and therefore, the temperature of the coil to drop. These actions result in several common symptoms and system issues:

- Low Suction Pressure
- High Compression Ratio
- Coil Freezing
- Tripping Low-Pressure Switch
- Low Capacity
- Poor Efficiency
- Compressor Damage Due to Liquid Flood Back

Dirty Condenser Coils

The condenser performs the reverse function of the evaporator by releasing heat from the system. When the coil is dirty, the movement of heat out of the refrigerant is impeded, causing an increase in pressure and condensing temperature that may negatively impact the system in the following ways:

- High Head Pressure
- High Compression Ratio
- Compressor Overload
- Tripping High-Pressure Switch
- Oil Breakdown and Compressor Wear
- Low Capacity
- Poor Efficiency

Challenges to Proper Coil Cleaning

The objective of coil cleaning is to remove soil from the coils as completely as possible to restore operation without:

- Damaging the Fins
- Removing Factory Coatings
- Causing Damage from Water or Chemical Runoff
- Harming Techs or Occupants with Chemicals

It can also be challenging to get water and water pressure where it's needed to clean properly especially when equipment is located on the roof or in sensitive locations.

This is why acceptable coil cleaning outcomes require preparation and proper equipment and materials.

Coil Cleaning Preparation List

Be prepared with these essentials whenever cleaning coils:

- Gloves and Eye Protection
- Rags or Towels
- Drop Cloths
- Soft Bristle Brushes
- Garden Hose
- Wet/Dry Vacuum

Cleaning Tools for Coils

It's a good idea to have various cleaning options at your disposal for different cleaning applications. The most forward-thinking contractors recognize that custom designed solutions for the HVAC/R trade can often provide better results than repurposed, generic solutions.

CoilShot®

The CoilShot is designed to make condenser coil cleaning easier by eliminating the liquid cleaners and replacing them with a compact tablet that fits easily into the CoilShot gun. Switching between clean and rinse is as easy as turning a dial on the side of the gun.

CoilJet®

The CoilJet allows the effective cleaning of coils in tough spots where it was previously a challenge to get adequate water flow. The onboard water and liquid cleaner tank allow you to bring everything you need to the cleaning location for both cleaning and rinsing.

The CJ-125 has an onboard battery while the CJ-200E has a plug and cord connected to 120v power.

FlowJet™

The FlowJet allows you to clean larger and /or dirtier coils with a perfect 400 PSI continuous stream of water at a high 2.2 GPM flow rate and a cleaner feed tube. The FlowJet is excellent for commercial coil cleaning applications when you can get a hose to location, but the flow of a hose is insufficient.

Dry Steam Coil & Surface Cleaner

Many evaporator coils are in locations where water runoff and chemical cleaners can cause damage to the area, occupant sensitivity, or food product damage. The Dry Steam cleaner helps reduce these factors by cleaning with steam instead of chemicals, and because of the low moisture content in the steam, the water runoff is comparatively minimal.

CoilShot

CoilJet

FlowJet

Dry Steam
Coil & Surface
Cleaner

Wands & Accessories

SpeedClean offers a wide range of extension wands as well as 90-degree adapters, flexible wands and various tips and cleaning ends to help reach tough to clean spots. This comes in real handy when splitting a condenser coil or reaching into tight spots during an evaporator coil clean in place.

CoilShot Wand

90° Adapter

Extension Wand

Flexible Wand

Safe & Effective Chemicals

It is essential to choose a cleaning chemical appropriate for the job at hand. In fact, if a cleaning job can be completed with water only, then that is often the best way to go.

For maintenance cleanings of condenser coils, plain water or a mild cleaner such as the CoilShot® condenser cleaning tablets or SpeedyFoam® liquid cleaner with a low concentration would be appropriate in most applications.

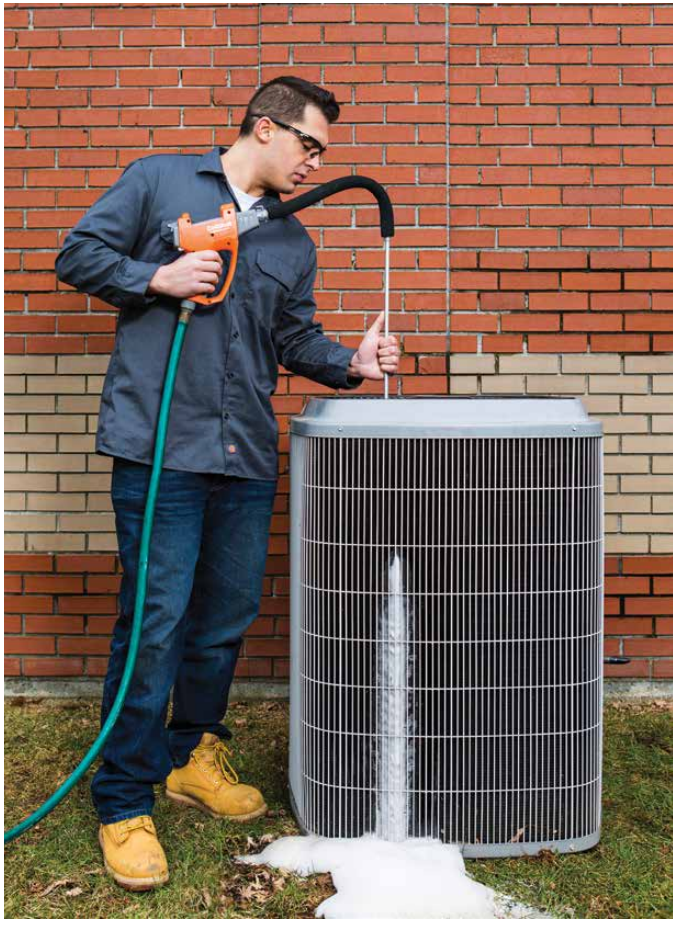
For heavier cleaning applications, the CoilShot-HD tablets or SpeedyFoam® at a high concentration may be a better choice.

For evaporator coils, you can choose to use a mild concentration of a non-acid foaming cleaner like SpeedyFoam® or use Dry Steam in cases where water runoff of customer sensitivities may be an issue.

CoilShot Tablets

CoilShot-HD Tablets

SpeedyFoam



Tips and Best Practices

Wear Proper PPE

Eye protection should be used in all cleaning applications, and gloves are a good idea when working with more caustic chemicals (which is generally not recommended).

Disconnect Power

Before removing panels and beginning to clean coils, it's crucial to ensure that electrical power is fully disconnected in the following steps.

1. Confirm your voltmeter is functioning to a known power source.
2. Disconnect power.
3. Check from each leg of power to each other leg as well as leg to ground to ensure no electrical potential is present.

Lock Out / Tag Out

When the disconnect is somewhere other than on the system directly under your observation and control, you must lockout and tag out the circuit breaker to ensure that someone else won't turn the power back on without your knowledge.

Protect the Equipment and the Area

- Ensure that all sensitive system electronics and motors are covered with panels or plastic.
- For indoor coil cleaning ensure that floors, walls, and surfaces are appropriately protected.
- Consider water and chemical runoff on roofs based on local environmental regulations and customer requirements.
- When cleaning evaporator coils ensure that water doesn't run off into return or supply ducts.

Pre-Inspection

Before performing a cleaning, ensure that the coil isn't brittle or corroded to the point that cleaning may cause additional damage and that there are no oil spots on the coil that could indicate a refrigerant leak. Ensure that the system is operational before cleaning so that the time spent isn't wasted on an inoperable system.

Use Appropriate Pressure and Water Flow

In cleaning evaporator and condenser coils, there is a fine line between having enough pressure to clean effectively and too much pressure that damages the fins. Even small pressure washers produce pressures of over 1,000 PSI, which is enough to easily damage a coil. Often pressure washers don't provide adequate flow for rinsing. If you are using heavy coil cleaners that can cause irreparable damage to coils. Additionally, pressure washers can also lead to more spillage and secondary water damage.

On the other side of the spectrum a pump sprayer has very low pressure and flow which results in poor cleaning penetration, ineffective rinsing and generally poor results.

125 to 400 PSI is ideal for coils, with the higher pressure being better for heavier & thicker commercial coils and the lower range being safer for smaller coils.

A water flow rate of ½ gallon a minute or better is effective for cleaning and rinsing most coils with higher flow rates being more effective for larger commercial coils.

Smaller tonnage, evaporator coils should use ½ gallon per minute flow rate, or less otherwise, the risk of overwhelming condensate lines becomes greater, as does the risk of damage.

Chemicals

Use chemicals appropriate for the cleaning job at hand. Stick with water or safe and mild cleaners whenever possible like CoilShot® tablets and SpeedyFoam® liquid cleaner. Only use chemicals and water approved for the application by the local government and customer specifications. This is especially pertinent in commercial cleaning applications.

Mix Cleaner

When mixing liquid cleaners, make sure to refer to the dilution guide to help ensure that you use an appropriate concentration of chemicals. The CoilJet has a chemical injection control knob to set the concentration easily.

SpeedyFoam® works best with a dilution of 4 parts water to 1 part cleaner for very heavy soil, down to 10:1 ratio for light cleaning.

The CoilShot® tablets allow you to dial-up or down the amount of flow over the CoilShot® tablet to set the mix appropriately.

The key is to only use as much chemical as is needed to do the job at hand.

Pre-Rinse

It is a good practice to pre-rinse coils before cleaning whenever practical to maximize the cleaning while minimizing chemical use. It is best to rinse and clean with water pressure forcing in the opposite direction of airflow or inside-out.

Apply Cleaner and Build Foam

During cleaning it is often most effective to apply cleaner against the flow of air during operation or inside out. When using a foaming cleaner, it is advisable to build foam from the bottom up to give the maximum amount of dwell time for the foam.

When using a low-pressure application in the 125 PSI range, it is a good practice to work close to the coil and target the fins between the tubing. Watch for the water and cleaner to spray through the coil from inside out which ensures you are cleaning all the way through.

Dwell Time

When using safe, foaming cleaners, it is a good practice to allow the cleaner to stand or "dwell" on the coil for 5 to 10 minutes after it is applied and before rinsing. On very large coils this dwell time may occur naturally due to the time it takes to apply the foam to the entire coil.

Rinsing

Rinse the coil entirely with a strong flow of clean water opposite the direction of airflow and look for a stream of water exiting the opposite side. Once the coil is completely rinsed you can work around the unit base and clean the other panels and structural members in the area to ensure that everything is free of visible dirt and grime. If not, repeat foam and rinse again.

The coil should be visually free of dirt, grass, lint, grease and any other contaminants to serve as visual evidence that the coil was properly cleaned.

Allow to Dry

Do not attempt to critically test the operation of the system or charge until coils have been allowed to dry as the water can cause unusual readings due to the thermal properties of water.

Inspect Coils

Double-check that the cleaning did no damage to the coil and take the time to repair any bent fins.

Microchannel

Many manufacturers of HVAC equipment are starting to utilize microchannel coils primarily in condenser coils and also in evaporators. These coils are generally all aluminum, and the refrigerant travels in tiny channels in flat aluminum plates with fins zigzagging between the plates like a car radiator. This coil type is more easily damaged because the refrigerant flows very near the exterior surface of the coil, making it more susceptible to leaks from both impact damage and corrosion.

When cleaning microchannel, it is essential to take extra care not to damage the channels and to follow the manufacturer's recommendations to ensure that damage does not occur.

Specific Applications

Ductless Evaporator Coil Clean in Place

Ductless coil cleaning requires extra care to clean the evaporator in place without damaging finishes in the room. A combination of the Mini-Split Bib® Kit and CoilJet® will help ensure you get the coil clean without making a mess. See the ***Contractors Guide to Mini-split Maintenance*** available at **www.speedclean.com** for more details.

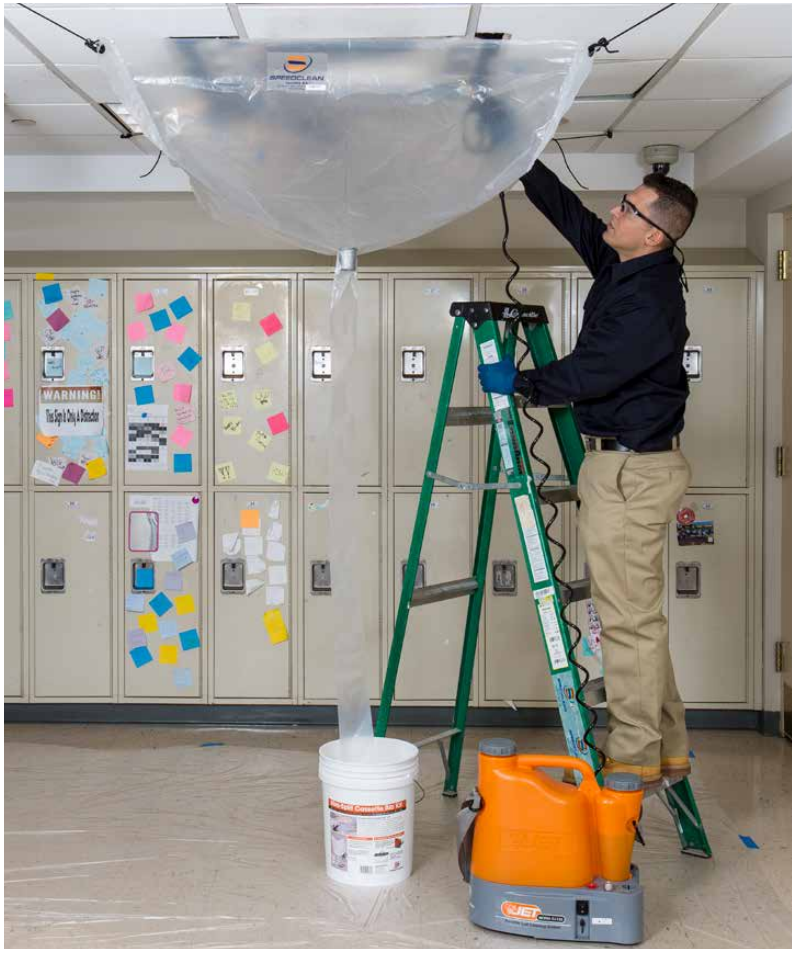
Residential Evaporator Cleaning

Many small residential evaporator coils, especially slant coils, can be cleaned in place by using a product like the CoilJet® in conjunction with active water management such as plastic sheeting, towels and a wet/dry vacuum. When cleaning a coil in place make sure to carefully protect all sensitive finished surfaces as well as any electrical components.

In some cases, the coil will need to be removed to fully clean them. In these cases, you would need to pump down or recover the refrigerant and remove the evaporator to the outdoors to clean it.

When removing an evaporator to clean it outside, you will want to take care to seal off the refrigerant lines completely. Rubber plugs left over and saved from replacement coils and copper tubing are great to have on hand for this purpose. Once you have it outside make sure to work in an area that will not cause damage to the driveway or lawn.

Allow the coil to dry well before attempting to bring it back inside. Some technicians use the discharge of a wet/dry vacuum or a cordless leaf blower to help speed up the drying of coils after cleaning.



Small Refrigeration

In small refrigeration applications cleaning can be tough due to the tight, heavily occupied spaces that some units are located in. When a refrigeration system has a remote condenser, that portion can be cleaned just like an A/C condenser. When the condenser and evaporator are both inside, you must be very careful to work in a clean and food safe manner.

A good strategy for cleaning small refrigeration coils is using a combination of Dry Steam Coil & Surface Cleaner, light degreaser, rags, a wet /dry vacuum and CoilJet when needed.

Make sure you cover all motors and electronics with plastic and remove surface dirt using rags and the vacuum. Use a food-safe degreaser/cleaner to clean away grease and / or the Dry Steam Coil & Surface Cleaner. When cleaning with water, make sure to use towels or rags in addition to the vacuum to manage the water.

Larger Coils

Larger coils are best cleaned with extensions and cleaning wands designed to reach in and clean the condenser and evaporator coils in place without the need to get completely inside the equipment.

Many larger condenser coils are multi-row and should be split periodically to clean them completely. Exactly how to split the coil and how successfully you can clean them once split varies from system to system, but the typical process involves:

1. Remove exterior coil guards and top as possible.
2. Disconnect ties on the free end of the coil.
3. Pull the outer layer of the coil away from the inner and rest it on a support to keep it from sagging or bending.
4. Wash each layer thoroughly with adequate pressure and flow.

For these applications, the CoilJet® or FlowJet® with an extension and spray wand is often the perfect solution to get into the tight gap between the coils and get them clean.

Coil Cleaning Dos and Don'ts

DO	DON'T
Wear Proper Safety Gear	Forget to Turn off Power and Confirm
Come Prepared With the Proper Equipment	Assume a Garden Hose Is the Answer to All Cleaning Challenges
Dilute Cleaners Appropriately	Assume Stronger Is Better
Inspect Coils Before and After Cleaning	Cause Damage to Fragile Coils
Clean Until There Is a Visual Difference	Spray Water Around and Call It Good
Use Appropriate Pressure and Flow	Use a Pressure Washer
Prep the Space to Prevent Damage	Cause Water Damage

Condenser Coil Before and After Cleaning Test

To demonstrate the very real impacts of condenser coil cleaning on system performance and efficiency we performed a comprehensive before and after test on a system that had a very dirty condenser coil. To keep the testing as accurate as possible we chose a real-world application and followed rigorous testing procedure.

Equipment Cleaned

2-ton 1999 Trane R22 10 SEER "Spine Fin" Heat Pump Split system with a direct return operating a 750 CFM indoor airflow* and 0.4" WC total external static pressure on the blower and a fixed piston type metering device.

Test Process

Allow the system to run 20 minutes continuously and take detailed measurements sufficient to compare wattage, total BTU/H removal and therefore the EER of the system using wireless connected digital instruments and the measureQuick app.

Clean the condenser coil only while performing no other cleaning or servicing and making no adjustments to refrigerant charge.

Allow the system to run continuously for another 20 minutes to ensure the coil is completely dry while confirming by measuring condenser air dew point entering and leaving. Retake the same measurements and compare the results.

Cleaning Method

The CoilJet using a typical neutral/alkaline cleaner and then rinse working inside out.

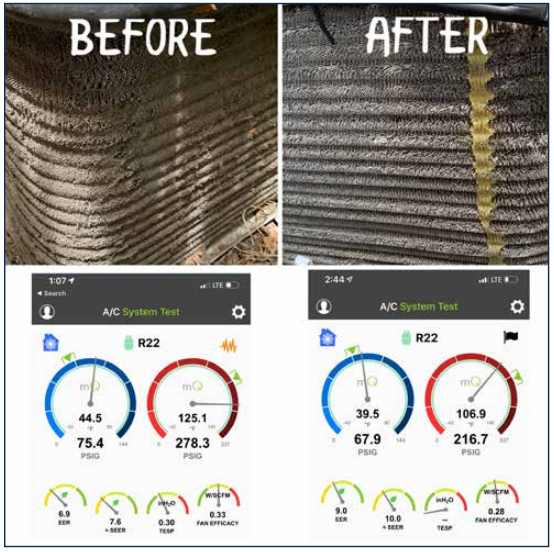
Results

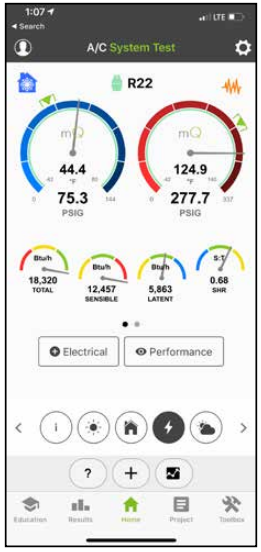
The initial testing results showed clearly that the head pressure and liquid line temperature were both high with a low subcooling and superheat. The measured system performance was poor even though the evaporator coil, air filter and blower wheel were quite clean considering the age of the system.

After cleaning the head pressure and suction pressure dropped, the subcooling and superheat increased and the compressor amperage dropped. It became clear after the cleaning, that the system was slightly low on refrigerant because it maintained a stable 31° superheat.

The system performed significantly better in terms of decreased wattage and increased BTU removal after the cleaning.

Before & After Cleaning Data





After this test was complete, we added 9 oz of R-22 to achieve the factory required superheat. After this the EER and total system capacity improved even further.

This illustrates that cleaning dirty condensers improves

- **System Capacity**
- **Performance**
- **System Longevity**

Before the cleaning, the superheat made the system appear overcharged because the high head pressure was causing elevated evaporator temperatures and near flooded compressor conditions. Afterwards the compressor is working at lower amperage and with a proper superheat which staztistically will prolong compressor life. For more information on the benefits of coil cleaning, please visit: ***http://www.dac-hvac.com/wp-content/uploads/Coil-Cleaning-Saves-Energy-Study.pdf***

* Factory fan curve were used based on static pressure and blower setting to find airflow. Since this test was before/after comparison this is an adequate method.

** Measured value on the after test was 0.1A lower, because nominal amount is within the uncertainty of the measurement we refactored based on the original wattage so as to make the data "worst case scenario" and not to give any unfair advantage to the after results.

	BEFORE	AFTER
Suction Pressure / Evaporator Temp	75.9 /44.9°	67.9 / 39.6°
Liquid Pressure / Condensing Temp	278.6 / 126.3°	216.5 / 107.5°
Outdoor Air DB	89.0	91.0
Superheat	1.3	31.5
Subcooling	3.0	11.9
Airflow CFM	750*	750*
Condenser Voltage	245	244
Condenser Amperage	11.4	10.3
Condenser Power Factor	0.87	0.85
Condenser Wattage	2412	2135
Blower / Fan Coil Wattage	232	232**
Return DB	72.6	75.9
Supply DB	56.6	59.2
Return WB	63.3	65.6
Supply WB	54.6	56.4
Compression Ratio	3.2	2.8
Total BTU Capacity	19,372	20,992
Total Wattage	2,644	2,367
EER	7.32	8.86

Notes

Notes

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