A-09 Freeze Dryer Vacuum Issues

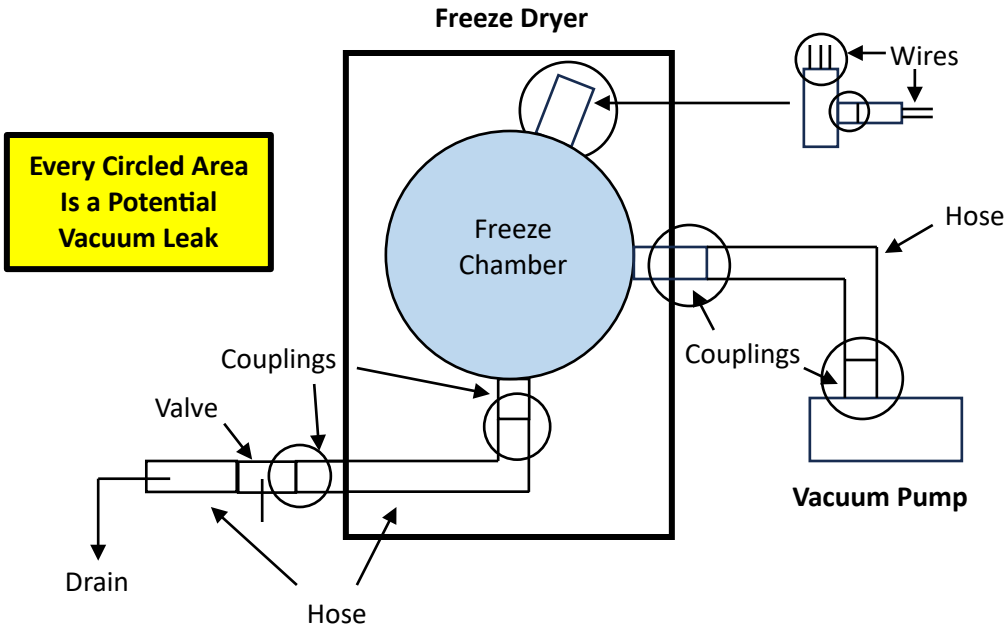
Background

The Harvest Right freeze dryer is not perfect. The reason is because there are significant mechanical forces that make the process possible. Principally this involve the extreme high-pressure vacuum which is driven by a pump. The freeze dryer itself, the big square box, is a comparatively simple system developed and perfected by Harvest Right. The issue of not-low-enough vacuum pressure revolves around connections to the freeze dryer chamber. Each of these connections is a potential source of vacuum leaks. This is the weak link in the Harvest Right freeze dryer system. In other words, you will eventually have to face this issue.

How the Vacuum System Works

When looking under the hood for the first time, it can appear a bit daunting. We were in this same position and were hesitant to start messing with the system. We were wrong because in fact it's really quite simple. The main point is that every threaded connection has the potential for a vacuum leak which can keep the pump from achieving its optimal operating capacity. These connections are where you will very likely need to concentrate your efforts.

The following diagram shows the location of these potential leak points. Basically, this is a closed-loop system from vacuum pump to freeze chamber to drain valve. The exception is the access points at the top of the freeze chamber for the wires that heat the trays and to monitor the vacuum within the freeze chamber. Plug all of these holes and the system should be tight.



Maybe Not a Leak

Although a leak is the most likely cause of a high mTorr value, there is also a possibility that something is wrong with the vacuum pump. Do not jump to this conclusion and automatically assume that a new pump is required. First rule out all other possibilities. See the end of this article for findings about pumps.

Run a Diagnostic

mTorr = millitorr = 1/000th of a torr
torr = unit of pressure = one millimeter of mercury
Lower torr values = Deeper vacuum = More effective drying

Before proceeding, test the system to identify potential problems.

Step 1	Plug in and turn on the freeze dryer and vacuum pump / Wait for the boot up
Step 2	Close the drain valve
Step 3	From the control screen, press the leaf in the top left corner
Step 4	Select the vacuum option and turn on / The pump will automatically start
Step 5	Note the mTorr value / As the vacuum pressure increases, the mTorr should decrease
Step 6	Check the seal on the front door / This should become a fat black line all around
Step 7	If the door seal is not correct, stop the vacuum, open the drain valve, and adjust the door
Step 8	When the door seal is good, watch the mTorr for a few minutes / It should go down
Step 9	Come back in about 15-20 minutes / Note the mTorr value
Step 10	If not mTorr is not declining, there is a vacuum leak in the system

Getting Under the Cover

To service the machine for vacuum leaks the back and top covers must come off. This doesn't interfere with the operation of the freeze dryer or pump.

Tools Required

⅛-inch Allen Wrench	Channel Lock Pliers	Cresent Wrench

Procedure

Step 1	Turn off the freeze dryer and pump / Unplug the cables from the back of the freeze dryer
Step 2	Disconnect the drain hose from the valve / Cresent wrench and channel lock pliers
Step 3	Disconnect the vacuum hose from the pump at the freeze dryer / Channel lock piers
Step 4	Turn the freeze dryer around so the back is facing out
Step 5	Starting at the bottom remove all of the screws holding the back panel
Step 6	Do not remove the screws holding the electric connection inner panel
Step 7	Lift off the back panel / Set aside
Step 8	Note how the top panel is held in place / There may be a few screws on top
Step 9	Work the top panel off the front and side panels / Set aside

Getting Oriented to the System

Using the above diagram, locate and get familiar with all of the connections. Do the same at the vacuum pump. Every one of the circled connections in the diagram has the potential for a vacuum leak. Considering the significant vacuum pressure, visually observing the system will not reveal any potential problems.

Taking Things Apart

The parts you're working with are very strong—it's highly unlikely that you could break anything so put a bit of muscle behind releasing the connections. They may be tight from having worked with high vacuum pressure. Particularly difficult might be the coupling at the bottom of the freeze chamber. It helps to increase leverage with a pipe on the wrench until the connection releases—one-inch PVC works well.

Step 1	Disconnect the vacuum hose from the pump
Step 2	Disconnect the drain valve from the drain hose
Step 3	Disconnect the drain hose from the bottom of the freeze chamber

Inspect the Parts

Drain Valve	Look in both ends of the valve / Expect to see crud and likely some corrosion
Drain Hose	Look in the couplings at the o-rings / Expect to see crud and likely wear
Vacuum Hose	Do the same inspection as with the drain hose

What This Means

You will need some replacement parts but wait before ordering directly from Harvest Right. The size and threads on the fittings are not proprietary to Harvest Right—there are better alternatives.

Drain Valve – The internal environment within the freeze chamber is slightly acidic. This can wear on the ball and chamber of the valve. It may look good but is likely leaking—this is common. The best replacement valve would be stainless steel.

Drain Hose – Similar acidic corrosion may be evident and likely there is degradation of the o-ring. There may also be some crud in the fitting area. This will not adequately clean—replace the hose. When ordered through Harvest Right the valve and hose will come as an assembled unit.

Corroded drain hose fitting

Vacuum Hose – The o-rings in these fittings are affected by initial pressure from the pump and vibration created by the pump. Since this is how the vacuum is initiated inside the freeze chamber, a larger diameter hose speeds pressure reduction and shortens operating time on the pump. The diameter of the hose does not affect the connections through the couplings. Replace this hose—consider a larger diameter.

Preps for Fixing Vacuum Leaks

Obtain the Parts

Before proceeding and further, wait until the parts arrive. Meanwhile, gather the tools and materials needed to further seal up the closed-loop vacuum system.

Materials Required

Start early with this to avoid delays and downtime because some will likely have to be ordered online since they're not normally used within the context of homestead maintenance and repairs.

Plumbing Tape / Grey Professional / PTFE	Silicone Tape / 1-Inch Wide / Special Order
Silicone Tube / Hand-Held Size	Plastic Gloves / Disposable / Not Painters

Tools Required

Threads on fittings will need to be thoroughly cleaned of old plumbing tape and any crud. All of these tools were used at different times, even if only briefly—without them the cleaning could not be done.

Sharp Pointed Hand Tool	Paring Knife	Old Tooth Brush
Small Plumber's Wire Brush	Sharp Scissors	Debris Container

Procedure – Plugging Potential Vacuum Leaks

This is a step-by-step process from the simplest to the most complex. Follow each step in order.

1. Clean the Front Door Seal Gasket

Step 1	Open the door and pull off the round rubber gasket
Step 2	Wash the outside and inner groove / Only water / No soap or other chemicals
Step 3	Air dry or use a lint-free cloth / Lint fibers are a potential source of vacuum leak

2. Remove the Tray Assembly

This can only be done with the gasket off the front of the freeze chamber. This will be needed later in the process of plugging vacuum leaks so it's good to get this out of the way now.

Step 1	Slide out the tray assembly and support where it won't slip or fall
Step 2	On the back of the unit will be a connector with wires / This must be disconnected
Step 3	Be careful with the disconnection / It's a two-step process
Step 4	Slide the red locking tab away from the connection / This does not release the parts
Step 5	Press into the connection a small black tab / This releases the parts
Step 6	Carefully separate the parts / Do not tug on the wires / Only handle the connectors
Step 7	Unscrew the back metal cover / Check all wire connections / Reattach the metal cover

3. Check the Front Door Seal

Step 1	Retrieve the gasket / If not yet completely dry in the groove take a break and wait
Step 2	Check the rim on the front of the freeze chamber / Damp clean with water
Step 3	Reattach the gasket / Thump around the gasket to be sure it's well seated
Step 4	Damp clean the outside of the gasket again for anything that collected
Step 5	Damp clean the inside of the door
Step 6	Close and seal the door against the gasket with the handle
Step 7	The result should be at least a continuous thin line of black against the front door
Step 8	If not, make adjustments with the screws at the hinges / Keep the door closed
Step 9	Upper screws affect the lower part of the gasket and the opposite for the upper part

4. Replace the Drain Valve and Hose

Step 1	Apply plumbers tape to the end of the hose / Four full wraps / Smooth into grooves
Step 2	Position the valve so the handle faces toward the drain and away from the machine
Step 3	Attach the valve to the hose / Cresent wrench and channel lock pliers
Step 4	Clean the threads on the bottom of the freeze chamber / Make sure the back is clean
Step 5	Apply plumbers tape to the fitting on the freeze chamber
Step 6	Attach the drain hose tight to the fitting / Cresent wrench
Step 7	Apply silicone around the top of the hose coupling and around the valve connection

Step 8	Wrap both connections with silicone tape

Note – When tightening only adjust inwards / Do not back out / If needed, disconnect and restart

5. Replace the Vacuum Hose

Step 1	Clean the threads on the side of the freeze chamber / Make sure all sides are clean
Step 2	Clean the threads on the top of the vacuum pump / Make sure all sides are clean
Step 3	Apply plumbers tape to both fittings
Step 4	Attach the vacuum hose tight to the fittings / Channel lock pliers until just snug tight
Step 5	Apply silicone around both couplings
Step 6	Wrap both couplings with silicone tape

These next steps are a bit more complex. Take your time and be careful.

Note: Some helpful YouTube videos recommend disconnecting multiple wire connections. This is not necessary so keep everything attached while working carefully.

Note: One very helpful video is from a fellow who repairs freeze dryers professionally. From his experience, he says that the following area is where he most often finds vacuum leaks. When checking our system, a key fitting had no plumber's tape or sealant in the threads entering the freeze chamber.

6. Disconnect the Vacuum Sensor

Step 1	This is at the side of the larger fitting coming out the top of the freeze chamber
Step 2	Carefully loosen and separate the small circuit board from the plastic fitting
Step 3	The circuit board will be very close to the insulation on the freeze chamber
Step 4	Disconnect the side fitting from the main fitting / Cresent wrench
Step 5	Remove remaining plumber's tape from the side and main fittings
Step 6	Apply plumber's tape to the side fitting / Reattach to the main fitting
Step 7	Note the position of the tab on the plastic connector
Step 8	Tighten the fitting so that the tab is in the four o'clock position
Step 9	Check for clearance with the small circuit board / Adjust as needed / Set this aside

7. Clean the Top of the Main Fitting

Step 1	This is a primary vacuum leak location / The top around the wires will be cruddy

Step 2	Carefully pick through and around the wires / Remove ALL of the material
Step 3	Note three very small holes around the wiring fitting / These must be cleared of debris

Top Cruddy Fitting

Note the white material. All must be removed.

Upper 30-40% Grade with Ditch Flow

Note one three ⅛-inch holes that must be plugged.

8. Remove the Main Fitting

Step 1	Loosen the main fitting from the freeze chamber tube
Step 2	Let the wires twist as the fitting is turned / Wires will flop around inside the chamber
Step 3	Thoroughly clean the fitting threads and the freeze chamber fitting threads
Step 4	Apply plumber's tape to the fitting
Step 5	Untwist the wires and further twist a few turns in the opposite direction
Step 6	Reattach the wire fitting to the freeze chamber fitting / Wires will untwist

9. Seal the Top Fittings

Step 1	Thoroughly glob silicone between and around all of the top wires / Cover the holes
Step 2	Apply silicone around the threaded parts of both fittings
Step 3	Cover both areas with silicone tape / Include tape about three inches up the wires.
Step 4	Reattach the small circuit board to the side fitting

Run Another Diagnostic Test

Do this while the silicone is soft and pliable—Immediately after top fittings are finished.

Step 1	Plug in and turn on the freeze dryer and vacuum pump / Close the drain valve
Step 2	From the control screen, press the leaf in the top left corner
Step 3	Select the vacuum option and turn on / The pump will automatically start
Step 4	Note the mTorr value / As the vacuum pressure increases, the mTorr should decrease
Step 5	Check the seal on the front door / This should be a fat black line all around
Step 6	When the door seal is good, watch the mTorr for a few minutes / It should go down
Step 8	Come back in about 15-20 minutes / Note the mTorr value
Step 9	If not mTorr is not declining, there is still a vacuum leak in the system
Step 10	With the mTorr declining, expect to run the system for 24 hours
Step 11	Check the mTorr value every three to four hours / It should continue to decline
Step 12	While the system is running, the vacuum is pulling the silicone into the fittings
Step 13	The silicone tape will also be pulled tight around the fittings
Step 14	After 24 hours, the mTorr reading should be in the mid-200 to low 300 range

Putting It Back Together

Step 1	Fit the top cover onto the front and sides
Step 2	Reinsert all of the screws onto the back
Step 3	Resituate the freeze dryer and vacuum pump in their operating locations
Step 4	As needed, detach the vacuum hose from the freeze dryer / Reattach with all sealants
Step 5	Remove the door gasket / Attach the tray wire connection / Reinsert assembly and gasket
Step 6	Open the diagnostic screen / Select Heater / Finger check each tray for warmth

Experience: Unable to Achieve Vacuum

When this message flashed on the control panel screen, out first assumption was that there was something wrong with the pump. The primary indication was a dirty oil fill sight glass. After changing the oil and trying again, the situation remained the same. The result was veggie products not drying.

Diagnostic Test

We ran the vacuum diagnostic test from the control panel screen and could only achieve about 900 mTorr.

First Investigation

We drained the oil a second time and removed the oil chamber cover—four screws. The chamber was filled with heavy oily sludge. This was a complete surprise and was startling because this could not possibly be good for the operation of the pump.

First Mistake – We didn't bother with trying to find out why there was oily sludge. We assumed this was because we had been reusing filtered oil, as recommended by Harvest Right. We also assumed that this was because the oil was somehow dirty from the freeze drying process, not knowing how the system worked with the oil never reaching the actual freeze dryer.

The tank and innards were cleaned and reassembled with fresh oil. Assuming that this solved the vacuum error issue, we loaded another batch of veggies with the same result as before. A second diagnostic test showed that cleaning out the oily sludge had no effect on the mTorr vacuum pressure.

Contact with Harvest Right

Second Mistake – We went forward with a tech assist before learning about the freeze drying system and the various issues that can affect mTorr vacuum pressure. Because we were ignorant, the tech assist process became laborious, slow, and frustrating. We were ignorant so they attempted to lead us by the hand from step to step to step. We had fallen into the trap of simply pressing the go button.

As this went on, it became evident that Harvest Right has contracted out its tech assist to somewhere else in the world with the "technicians" simply parroting a programmed script. When asked a questions outside of the script, they ladies could not provide an answer. On the plus side, the script is adequately thorough because mostly the issues are routinely repetitious and not complicated.

First Lesson Learned – Get past ignorance before wasting a lot of time. The whole tech assist, good as it was (no fault to Harvest Right) would have been much faster and more efficient.

Second Lesson Learned – It's not possible to order specific repair parts without going through the Harvest Right tech assist system. When out of warranty, this adds $40 to every part purchase and then only if you are persistent in your request.

Action Based on Assumption and Frustration

Third Mistake – We were in extremis because this happened at the peak harvest season and veggies were spoiling. With the "technicians" never having experienced our sludge finding, they blindly followed the script, bypassing the sludge issue, which unknowingly kept us in ignorance. We were left to assume that there was a fault within the pump that created the excessive sludge and that the sludge had somehow damaged the pump—still not knowing how or why the sludge had occurred.
The slow step-by-step tech assist process pushed us into purchasing an oil-free pump thinking this would be the magic fix. When running the diagnostic, yet again, the oil-free pump had only minimal effect on the mTorr pressure bringing it down from 900 to about 750. With the Harvest Right tech assist ticket still open and after finally getting less ignorant about the system, we proceeded with the steps outlined above. All of this ignorance on our part delayed the repair process by about 10 or more days.

Problem with the Oil-Free Pump

A key requirement in maintaining the longevity of oil-free pumps is to keep the inner workings free from moisture after running a batch. When reviewing features, key in our purchase decision was an automatic "dry flush" purge of water when activating the defrost option. When setting up the oil-free pump, we were

simply told from the tech assist script that we did not need any additional software update. We were told to run a batch and report back the findings with yet another tech assist contact.

When the automatic dry flush did not occur as expected (because this was clearly stated in the owner's manual for our version of the Harvest Right software) once again we were back to the tech assist. This is when we found out that the programming in the freeze dryer is somehow hard wired into the circuitry and that our system could not be upgraded to accommodate the automatic dry flush.

Another shortfall to the oil-free pump is that it's possible for condensation to occur within the pump when it's idle—like during the winter. This requires regular dry purging without having run the system. Considering that most homestead environments are not dry air conditioned, this would become an ongoing maintenance chore that could be easily missed. Shortened pump life would follow.

Considering the difficulty with having to do the dry flush manually as detailed below under all of these circumstances, we have requested a return of the oil-free pump and are returning to the Premier Pump. This is still pending and we are still without an optimally working freeze dryer. Meanwhile and with the vacuum leaks apparently well plugged, we are back to our original Basic Pump.

Recommendation

Before panicking, slow down and check out the numerous YouTube videos about vacuum pressure issues and how to fix the problem. There's a lot of very valid experience out there. Go back and forth from videos to the machine and put your hands on the components. In short order you'll be ready to work smart, with the Harvest Right tech assist being much more efficient, if needed at all.

About Oily Sludge and Pumps

With the vacuum pressure issues apparently solved, we returned to this conundrum. It turned out that the problem was indeed with the pump but not what we assumed.

Original Basic Pump

In the beginning when we finally committed to freeze drying, we proceeded under the premise that simple and basic is almost always better than paying for an upgraded option. We chose the Basic Pump and as described below, this pump is no longer offered—for good reason.

Findings – The sludge was created by moisture from the freeze drying process mixing with the vacuum pump oil. This was held in the front oil chamber on the pump. When we recycled the filtered oil, we were returning this water moisture back into the system. To avoid oily sludge from the beginning, **NEVER** reuse pump oil because it will have water which will gum up the system. This water issue mixing with pump oil is a fault in the design which is likely why this pump is no longer sold with the home freeze drying system.

Maintenance – To keep from having sludge build up from water contamination, the front oil tank needs to be removed and cleaned with the exposed parts. No soap or chemicals—only water. As far as we can tell, Harvest Right does not have a recommended number of cycles before cleaning out the oil chamber.

More Moisture = More Frequent Cleaning – It appears that this should be completed after about 30+ batches, depending on the moisture content of what is being processed. Moisture contamination is why the Harvest Right software programming for operation of the Basic Pump prompts for an oil change after five batches. Changing the oil with fresh and cleaning the oil chamber cannot be ignored.

Premium Pump

This has replaced the Basic Pump. To get the full jest of why this is an important improvement to home freeze drying, go to the Harvest Right website for details. The most important part of the upgrade is in separating water moisture from the pump oil with greatly reduced contamination. The upshot is changing the oil after only about 30 batches. It's also much lighter, quieter, and more compact.

A second important point is how pumps operate—they need lubrication provided by the oil. This keeps the inner working parts lubricated even when the pump is not working—constant lubrication facilitates pump life. It's also important to understand that mechanical systems, like vacuum pumps, are intended to be used and not sit idle. The more frequent the use, the happier the pump—even though there will always be eventual long-term maintenance because there will always be wear on parts. Stick to the preventive maintenance of prescribed oil changes and the impacts will likely be minimal.

Oil-Free Pump

Although no oil change is involved, it's not maintenance-free because water still gets into the system. After each batch, the pump needs to be dry flushed to purge out water. Otherwise and as mentioned in a Harvest Right video, the inner mechanism will rust the bearings. Harvest Right seems to acknowledge this shortfall in oil-free pumps when stating in the video that they will eventually require professional maintenance.

How to Dry Purge – Unplug the vacuum pump from the back of the freeze dryer and plug into a wall outlet. Disconnect the vacuum hose from the top of the pump. Turn on the pump and run for about five minutes. Moisture will blow out from the exhaust so place a towel to catch the water. If a very high moisture product was processed, run this cycle a few more times until the exhaust is dry. Reattach the hose and plug.

Finding – Even though not in use, an oil-free pump will accumulate condensation moisture unless in an environmentally controlled space with heat and air conditioning. Otherwise, at least monthly purging is required to minimize internal rust. When purchasing a freeze drying system it's important to ensure that an automatic purge cycle can be run from the mother board in the machine to keep from disconnecting hoses and plugs.

Recommendation

After getting past ignorance about oily sludge and its causes, an oil-free pump is probably not the best investment. Not only is it more costly, but it's bigger and much heavier. It seems that this pump is more for those who are scared of mechanical maintenance and potentially yucky oil. Get over ignorance and yuck. Go with the simpler and less costly Premium Pump.