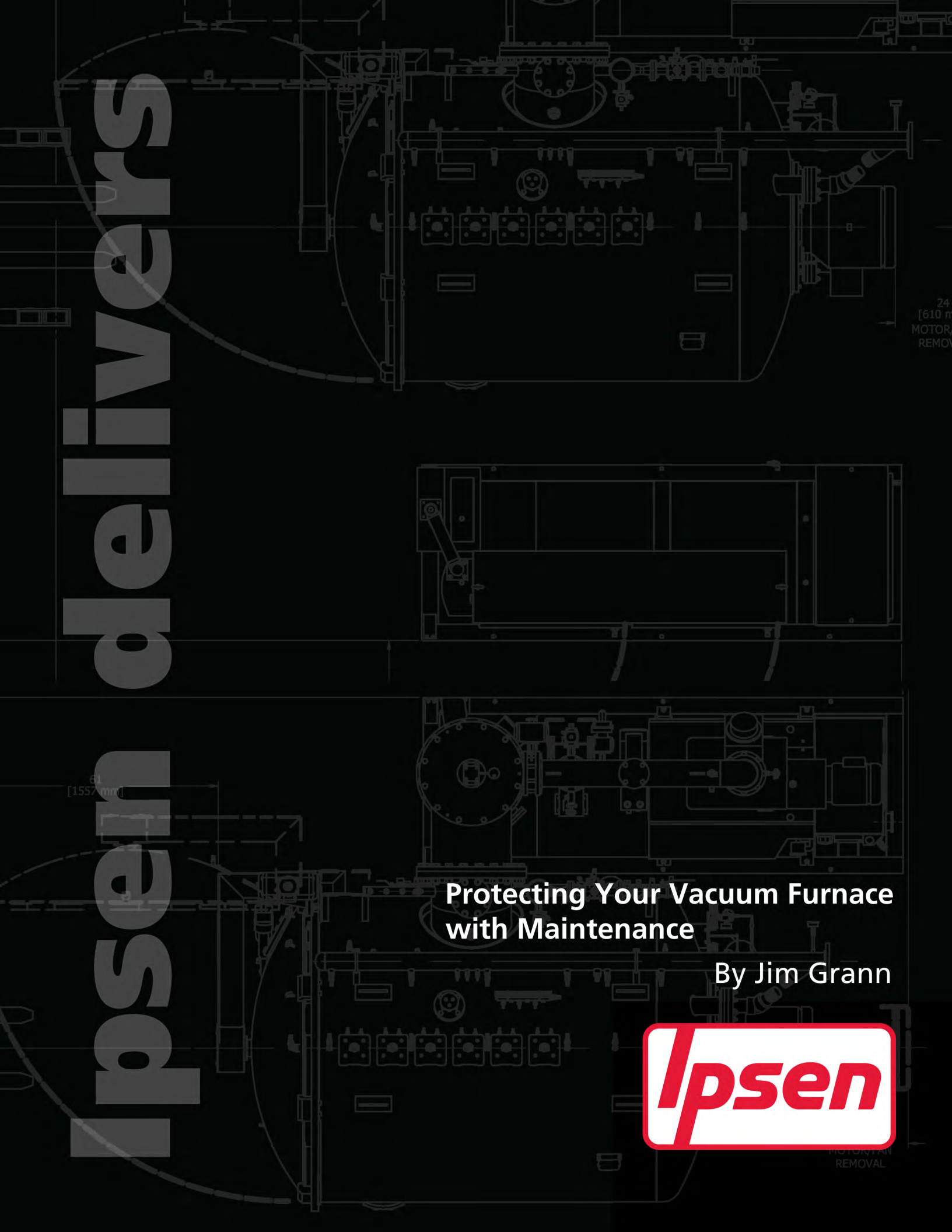


Protecting Your Vacuum Furnace with Maintenance

By Jim Grann

Ipsen

Protecting Your Vacuum Furnace with Maintenance

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Abstract

Today's competitive world and business environment often requires one to do more with less – to make equipment last longer and run more efficiently. Successful operation and maintenance of a vacuum heat-treating system not only requires strict adherence to a carefully scheduled maintenance program, but also a deeper understanding of maintenance best practices – such as how to properly detect, identify and correct leaks, repair and replace heating elements and more.

By following these maintenance tips for troubleshooting your vacuum furnace, you can ensure your furnace equipment has a long and healthy life span.

Introduction

As businesses invest in expensive capital equipment, knowing when and how to perform maintenance becomes a primary concern. After all, if not cared for properly, equipment can easily break down, thus creating unexpected costs and slowing down production throughput. As a result, one of the main challenges companies find themselves faced with is how to prolong the life of their furnace systems while also increasing productivity. This is why one of the first – and most essential – steps for protecting your investment is to routinely employ corrective, preventative and predictive maintenance in day-to-day operations.

Knowing how to properly maintain and troubleshoot your furnace system is an excellent way to protect your investment, as well as minimize downtime, increase productivity, ensure a long life span and cut down on operational costs. However, maintenance is a broad topic; some of the essential maintenance areas every furnace owner and operator should be familiar with include:

- Creating daily, weekly, monthly and yearly maintenance schedules
- Detecting, identifying and preventing leaks, from properly using a helium mass spectrometer to knowing the probable locations of leaks
- Repairing and replacing heating elements

This paper will cover these key areas for keeping your furnace running at peak performance, and by following these maintenance best practices, one can consistently achieve high-quality heat treating while also cutting down on operational costs and unplanned downtime.

Forms of Maintenance

Now that you and/or your company have made an investment in a heat-treating furnace system, it can be daunting to know where to start when it comes to maintenance. Before beginning maintenance on your vacuum furnace equipment, it is essential to understand the common forms of maintenance in use today: corrective, preventative and predictive maintenance

Corrective Maintenance

Considered one of the most basic approaches to maintenance, corrective maintenance is often performed after a furnace fails to function correctly. As such, it often involves looking at the furnace's common symptoms to determine the probable causes of failure and, ultimately, correct them.

Preventative Maintenance

Preventative maintenance, on the other hand, involves regular inspection and maintenance of the furnace equipment before any major failures occur. Having a preventative maintenance (PM) program in place is a key part of protecting one's equipment and generally includes regular inspection, equipment servicing, repair and replacement.

Overall, PM programs allow companies to schedule downtime in advance, and they help provide predictable annual maintenance costs. As such, preventative maintenance is often considered an effective method for protecting one's equipment and helping maximize uptime.

Predictive Maintenance

The goal of predictive maintenance is to apply analytics to detect a risk of failure, thus helping prevent the failure before it ever occurs. The ideal predictive maintenance program often incorporates a well-balanced mix of predictive, preventative and corrective maintenance to best maintain equipment. Yet it is the addition of predictive maintenance that helps create a cost-effective program. In the end, the integration of predictive maintenance helps furnace users plan ahead – whether that means scheduling

personnel to perform maintenance or ensuring the required furnace parts are in stock.

When you need to receive technical support, order parts, schedule service and more, call Ipsen's Aftermarket Support Helpline at **1-844-Go-Ipsen**: www.IpsenUSA.com/Helpline

Creating Maintenance Schedules

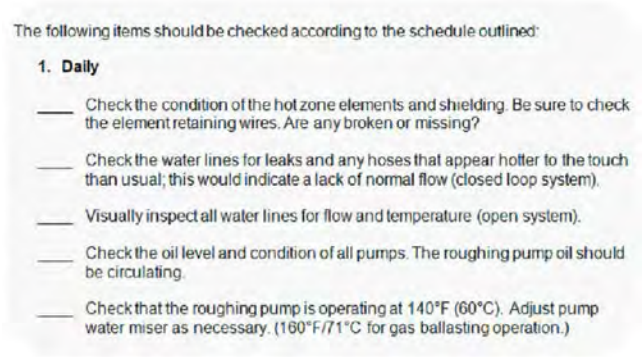
As one moves forward from an understanding of the two primary forms of maintenance to implementation, it is essential to start by creating accurate records if you are to maintain an efficient maintenance program. After you start up or commission your equipment, you should establish a performance log/baseline that records the following:

- Blank-off pressures of the mechanical pumps and pumping system package
- Pumpdown times from atmosphere to one micron
- Ultimate vacuum when the furnace is cold, dry and empty (CDE)
- Linear leak rate for when the chamber is blanked-off from the pumping system

The items listed above are of special importance in operating a vacuum furnace, which is why one must record every observation or change. Since the equipment's performance will deteriorate with age, being able to make an accurate diagnosis avoids the unnecessary dismantling of components.

For example, if you record the furnace's ultimate vacuum and linear leak rate from the beginning, as well as any changes that occur over time, you can then use the performance log to determine if performance in one of those areas has deteriorated. As a result, you are better equipped to narrow down and identify the probable cause of any corresponding issues, as well as the proper corrective actions, without wasting time and resources. Overall, maintaining historical logs is invaluable to maintenance personnel who are dealing with both preventative and corrective maintenance.

In addition to maintaining historical logs, another effective method for ensuring proper maintenance and care of one's heat-treating system is to adhere to a carefully scheduled preventative maintenance program. By utilizing daily, weekly, monthly and yearly maintenance checklists (Figure 1), one is better able to track all the items that should be regularly inspected.



The following items should be checked according to the schedule outlined:

1. **Daily**

___ Check the condition of the hot zone elements and shielding. Be sure to check the element retaining wires. Are any broken or missing?

___ Check the water lines for leaks and any hoses that appear hotter to the touch than usual; this would indicate a lack of normal flow (closed loop system).

___ Visually inspect all water lines for flow and temperature (open system).

___ Check the oil level and condition of all pumps. The roughing pump oil should be circulating.

___ Check that the roughing pump is operating at 140°F (60°C). Adjust pump water miser as necessary. (160°F/71°C for gas ballasting operation.)

Figure 1 – A checklist of preventative maintenance tasks that should be performed on a daily basis.

Find detailed preventative maintenance checklists at *The Ipsen, Harold* blog: https://goo.gl/uiwZ2d

Some essential maintenance activities that should be performed may include changing the oil in the vacuum pump every two to six months; replacing dynamic seals (such as door seals and poppet valve seals) every year; and replacing the jack panel (work thermocouples) assembly every year to maintain part temperature reading integrity.

Replacement of the control thermocouple should also follow applicable guideline, and vacuum sensing gauges need to be replaced, cleaned or rebuilt as required. While adhering to a set maintenance schedule is important, it is also essential to make sure equipment and load parts are properly cleaned during the maintenance process.

Cleaning of Load Parts

Now that you have established a maintenance routine, it is important to note that a portion of a vacuum furnace's maintenance involves ensuring that loads put into the furnace contain properly cleaned parts and are handled with care so as not to introduce contamination prior to heat treatment. It is essential to remember that what goes into the furnace will come back out – no matter how small or insignificant it originally seemed. Putting dirty parts into the furnace can increase the rate at which the hot zone deteriorates, as well as negatively affect production times and the quality of future parts.

All grease, oil and particulates must be cleaned off the parts' surfaces, and assemblers need to be careful not to transfer oils from their skin to these surfaces. Typical cleaning methods include vapor degreasing, hydrocarbon wash, aqueous washing, acid etching and vacuum de-oiling.

Oftentimes, sandblasting will be used to clean fixtures. However, such a cleaning method is generally not recommended without ancillary washing as it can cause untold amounts of damage to the furnace chamber. This is because there is often residue on parts, and every time an item is cleaned via sandblasting, particulates are removed and become mixed up in the sandblast material. Not only are these unknown particulates not rated for temperature or vacuum, but they can also cross-contaminate any items that are later sandblasted, thus negatively impacting the process and equipment.

Repairing and Replacing Heating Elements

Sandblasting fixtures and/or parts is not the only thing that can cause unexpected damage to one's furnace; not properly maintaining the heating elements can also negatively impact the furnace and its temperature uniformity. When it comes to the heating elements on a vacuum furnace, maintenance practices can vary depending on whether one is working with graphite or metal.

If you discover graphite elements are damaged, you would generally replace the heating elements rather than attempting to repair them. Considering graphite is not extremely brittle, you do not have to worry about accidently breaking surrounding heating elements during the replacement process. Molybdenum heating elements, on the other hand, can have a whole section replaced (just like graphite), or they can be repaired with an element patch.

Element patches allow you to clamp on small sections of metal to bridge the broken element, rather than having to unbolt the heating elements between connection points and replace an entire section. Such repair patches are typically preferred as molybdenum becomes far more fragile once it has been heated, making it easier to break surrounding elements during replacement. Breaking surrounding elements can quickly lead to additional, unexpected repair costs.

Note: *When replacing several molybdenum heating elements at once, it is strongly recommended that you perform a conditioning cycle to allow the new elements to expand and recrystallize at a slow rate. This helps avoid damaging the elements, hot zone and load when you resume normal operations in the furnace. A Temperature Uniformity Survey (TUS) will also most likely be required again.*

When replacing elements, it is extremely important that all replacements have the same resistivity (i.e., within eight percent) of the parent material used in the original fabricated elements. Depending on the manufacturer, the material can vary and have a different resistivity. If you end up changing out heating elements and the replacements have a different resistivity, it can negatively affect the furnace's temperature uniformity. Worst case, poor temperature uniformity can contribute to part distortion when running loads.

Overall, inspecting the appearance of the heating elements and insulation should be part of every maintenance schedule as missing, broken, cracked or loose components can lead to arcing and temperature-related problems, such as inadequate heating and poor temperature uniformity control. To determine if heating elements need to be replaced, one should check the resistance to ground, as well as inspect for signs of arcing, cracking and degradation. The heating elements and shields should also be observed daily for signs of abnormal discoloration, which can indicate contamination.

If parts of the hot zone begin to show signs of unusual discoloration, a leak check and/or furnace cleanup cycle may be required as a first step in troubleshooting the furnace and locating the source of the contamination. It is imperative that you identify and correct the source of the contamination to prevent continued discoloration and degradation of your hot zone.

However, it is essential to make sure your furnace can withstand the average cleanup temperatures before proceeding with a cleanup cycle – especially if you have an older furnace or one that has been out of production for some time. This is because a vacuum furnace must normally be taken higher in temperature and soaked long enough to reach a steady-state heat loss condition. The cleanup temperature is typically 100 °F (56 °C) higher than the maximum operating temperature attained during a normal process cycle, but should not exceed the maximum allowable furnace temperature. For most Ipsen-brand furnaces, it is recommended that average cleanup temperatures should not exceed 2,200 °F (1,204 °C).

Learn how to properly perform a cleanup cycle at *The Ipsen, Harold* blog:
https://goo.gl/uFSWRR

It is also vital that all low-temperature alloys – fixtures, grids and baskets – are removed before running a high-temperature cleanup cycle, as the alloys will melt onto the

heating elements, as shown in Figure 2.

If you are running a high-temperature cleanup cycle and realize you melted some lower temperature alloys, you should immediately stop the cycle, let the furnace high-vacuum cool and then wait several hours so it can reach 300 °F (149 °C) or less before checking the furnace. This allows the melted alloy to solidify before you attempt to remove it.



Figure 2 – Alloys left behind during a cleanup cycle melted onto the hot zone's heating elements.

In the end, by being proactive in replacing and checking heating elements, as well as knowing how to correctly repair or replace them when needed, you can help ensure your equipment continues to run smoothly for decades to come.

Leak Detection, Identification and Prevention

While implementing continuous maintenance can help ensure peak performance of the furnace, one isn't always able to prevent everything. Sometimes things simply go wrong. Which is why it is essential to not just know how to perform preventative maintenance, but also how to perform corrective maintenance on your furnace (i.e., troubleshoot different problem areas).

A prime example of this is dealing with the pumping systems. Since the pumpdown speed, ultimate vacuum and vacuum rate of rise characterize the performance of the furnace, it is essential that the pumps and chamber be kept clean and in good condition at all times. Any volatile material left inside the chamber will increase pumpdown time and the leak-up rate.

Enhance your vacuum furnace's performance by selecting the best pumping system for your specific process, as well as following a few simple tips for maintaining your pumping system: www.IpsenUSA.com/Pumping

However, one of the major problems that arises in vacuum furnace maintenance is that the furnace will not pump down. To determine the primary cause, one must then move from preventative maintenance to corrective maintenance, thus following a systematic procedure. Typically, loss of vacuum in the chamber during a leak rate test signifies outgassing and/or the presence of a real leak. Other types of leaks include permeation, diffusion, backstreaming, internal leaks and virtual leaks, as illustrated in Figure 3.

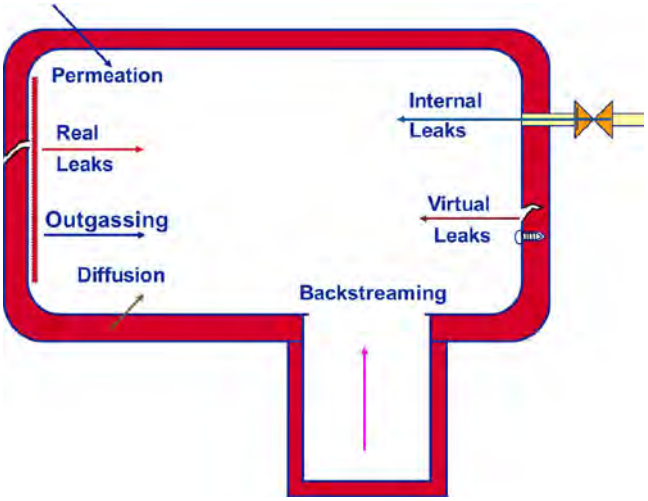


Figure 3 – The different types of leaks and ways they enter the furnace system.

In order to fully understand the maintenance procedures for identifying, correcting and preventing leaks, it is important to know what these different terms mean and how to deal with them, specifically outgassing and real leaks.

Outgassing

Outgassing is the release of absorbed (low vapor pressure) contaminants present in the vacuum system. These contaminants evaporate at various rates during the heat treatment process and the effect is a continuous rise in pressure.

Outgassing can be detected by comparing successive leak-rate values after long pumping cycles. If the leak-rate value improves with each comparison (Figure 4), outgassing can be considered a factor contributing to the total pressure rise.

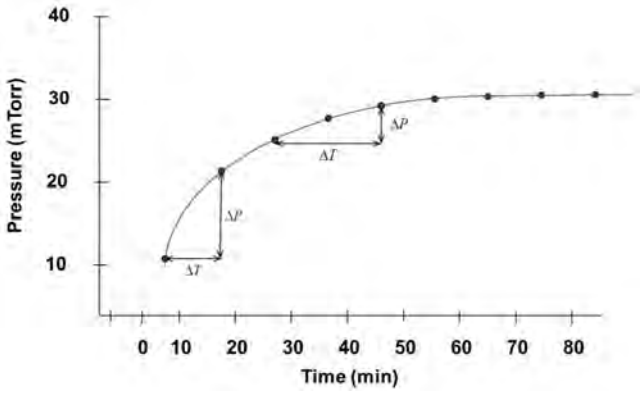


Figure 4 – The leak rate gradually improves over time, meaning the initial rise in pressure can be attributed to outgassing.

If the leak-up rate remains approximately the same (linear) after the successive long cycles (Figure 5), a real leak may be considered the principal cause. The first step here is to check the previous cycle in the furnace to see if it was normal.

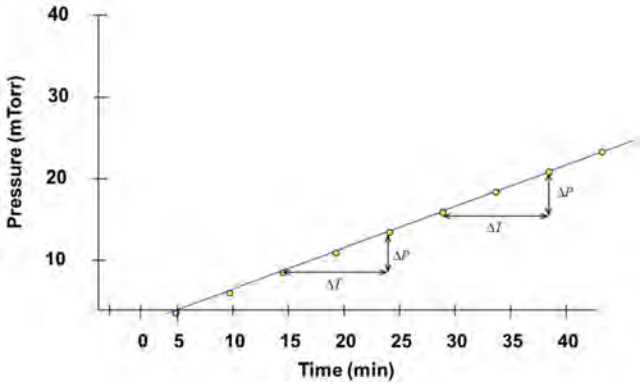


Figure 5 – The leak rate remains the same over time, signifying the presence of a real leak.

It is also important to note that foreign material can contaminate the vacuum gauge tubes. If maintenance was conducted prior to poor performance, there may be material left in the chamber that could cause excessive outgassing. Gauge tubes can be checked by utilizing a reference gauge tube.

Real Leaks

If one has ruled out outgassing and determined a real leak is the culprit, the next step is to identify and detect the leak. Leak detection can be done several ways, depending on the available leak-detecting equipment. The two most common methods for locating the presence of real leaks are utilizing either a solvent or a helium mass spectrometer.

Solvent Technique

Using a solvent, such as acetone, is a simple but effective method for locating intermediate-sized leaks. The procedure involves carefully spraying the suspected area with the solvent (acetone is preferred) and monitoring the most sensitive vacuum instrument of the chamber. If a leak is present in the area sprayed, the solvent will expand in the chamber, showing an increase in chamber pressure via the vacuum gauge.

The pressure increase may take five to ten seconds to appear, so it is necessary to wait this length of time before proceeding to the next area. The sensitivity of this procedure greatly increases with lower pressures. One should observe the usual precautions when using hazardous solvents. Do not spill solvent on painted surfaces as acetone will remove many finishes.

Helium Mass Spectrometer

If the solvent technique is not used, a helium mass spectrometer can also be employed to determine the leak's source. When utilizing a helium mass spectrometer to perform a leak check, it is recommended that you first calibrate the leak detector. To begin leak checking the furnace, the detector should be connected to the inlet side of the mechanical pump. Vacuum systems using a blower have a port for leak testing located between the blower and the mechanical pump. Using the blower and the diffusion pump employs the maximum sensitivity of the leak detector. It is also important to start leak checking at the top of the vessel and work your way down since helium is lighter than air.

View a how-to video on finding leaks in your vacuum furnace with a helium mass spectrometer at *The Ipsen, Harold* blog:
https://goo.gl/9Jc05X

Common Leak Problem Areas

When looking for leaks in the chamber, check the joints or fittings with a rotating or reciprocating movement. These are most susceptible to leaking. The door gasket is the most abused seal in the chamber; as a result, one should inspect it after each cycle and lubricate it daily.

The inert gas system can also be a problem area in furnace maintenance. Leaks in the gas system will cause discoloration of the workpieces being heat treated. The appearance of color on the workpieces after heat treatment is the best indicator of a leak or contamination problem; whereas, bright, clean 17-7 or 17-4 precipitation-hardening (PH) stainless steel is an indication of a clean, tight furnace.

Learn what it indicates when your parts turn certain colors during heat treatment at *The Ipsen, Harold* blog: https://goo.gl/042NPp

It is also vital to know that the liquid nitrogen/argon systems – which convert the liquid to a gas (with a holding tank at the furnace) – are more reliable than gas systems using bottled nitrogen or argon since bottled gases are usually not as pure as liquid gases. This is because the bottles often become contaminated when they are completely emptied and the valves are left open.

Finally, copper pipes and silver brazed joints are recommended for keeping all of the gas lines tight. This is because threaded pipe fittings may develop leaks and introduce air during quenching which will contaminate the furnace and discolor the workpieces.

If discoloration does persist after checking for inert gas leaks, the common practice is to vacuum cool some sample workpieces (a few pieces of austenitic and martensitic stainless steel specimens) and inspect for appearance. If the workpieces still experience discoloration, the nitrogen/argon system can be ruled out as a source of the problem and a leak in the chamber is evident.

Cold Linear Leak Rate

While knowing how to find and identify leaks is an imperative part of furnace maintenance, it is also crucial to perform a leak rate check and know the linear leak rate before you ever run the furnace. Knowing the cold linear leak rate before you first operate the furnace not only helps you determine if there are any initial leaks that need to be corrected, but it also allows you to establish a baseline against which you can compare your furnace's future performance. As a result, if the furnace's linear leak rate ever gets too high – as compared to the established baseline – it signifies the furnace has leaks that need to be found and corrected.

Determining the Linear Leak Rate

In order to determine the true linear leak rate, or the rate of rise, of the vacuum furnace, one would perform a rate of rise test – commonly referred to as the CDE (clean, dry, empty) linear leak rate. To do this, one would:

1. Pump the furnace down
2. Let it sit for a predetermined amount of time (depending on the temperature of the furnace and the processes being ran)
3. Stop the process cycle, which separate the vacuum pumping system from the furnace
4. Watch the rate of rise over a one-hour time period

However, this is an area where some often fail their mandated leak rate. This is because one cannot necessarily obtain a true linear leak rate in a one-hour time sample since no one can ascertain linearity from one simple; rather, one needs to take multiple samples to ascertain linearity.

For example, a leak rate of five microns per hour or less is required. The vacuum furnace is pumped down to one micron, shut off for an hour, and at the end of the hour, it has gone up to eight microns. This means the leak rate is seven microns/hr. If you looked at just this time sample, you would fail the mandated leak rate.

On the other hand, if you allow the furnace to sit for another hour, one is better able to determine if the leak rate is truly linear. If it is truly linear, the leak rate will double (go up by seven microns) in that second hour. At that point, you can say it is linear and it fails. However, if in that hour, it goes from eight to ten microns instead of doubling, then the furnace would receive a passing leak rate of five microns/hour.

All too often, people give up prematurely during this furnace and they have to either leak check the furnace again, run a cleanup cycle or call maintenance. As a result, a solid 24 hours of production time is needlessly lost because they did not allow the furnace to sit for one more hour.

By letting the furnace sit for another hour, one can confirm either:

1. It was linear and truly leaking, or
2. It was not linear yet, but now it passes and you are back in production after two hours rather than investing in 24 additional hours.

In the end, this extra time not only lets you cut down on unnecessary maintenance and lost production costs, but it also allows you to be proactive in protecting your investment.

Knowing the Acceptable Leak Rates

Knowing the cold linear leak rate is only one small component of the overall picture. When determining the acceptable leak rate for the furnace, there are two factors to consider. First, one should consider the acceptable leak rate for the furnace. Second – and sometimes more importantly – one should consider the acceptable leak rate for the parts being processed.

When working with Ipsen furnaces, it is important to know that Ipsen furnaces with all-metal hot zones historically ship at a linear leak rate of two microns/hour or less, and Ipsen furnaces with graphite hot zones ship at a linear leak rate of five microns/hour or less. The reason for the difference between the leak rates is due to the hygroscopic nature of the hot zone and its ability to maintain gases and water vapors; as a result, it is slightly harder to achieve lower leak rates on a graphite furnace. Nevertheless, these leak rates are acceptable for the furnace and are Ipsen's ISO Standard for Pre-Shipment Qualifications.

Sometimes, though, one has an older, dirty furnace with carbon buildup that is running low-quality production. The question then, is, what is an acceptable leak rate you can run the furnace at without damaging it?

If you want to look at just the furnace, you could consider 15 microns/hour (anything under 15 microns/hour is acceptable for most commercial vacuum heat treating).[1]

In other instances where you are going to run titanium and super high alloys, the parts are now driving the specifications. This is because to run titanium you might need a leak rate of three microns or less in a furnace with a graphite hot zone (even though Ipsen's furnace ships at five microns). In essence: the production often directs or mandates what acceptable leak rates can be. Other times, with less critical parts, the furnace mandates what the leak rates can be.

Why is this the case? Consider what happens if a furnace is ran at too high of a leak rate. It consumes itself – just like a lightbulb. For example, there is a vacuum inside the lightbulb with a filament. When one cracks the lightbulb's glass, air rushes in and hits the hot filament, vaporizing it. That is exactly what happens to the hot zone. If too much air is going inside, the hot zone starts to consume itself and vaporize. Which is why, if one has an excessive leak rate, one can actually destroy a hot zone in a matter of months.

If you just invested in a new furnace, you want to make sure it lasts as long as possible; this is why it is essential to carefully consider the acceptable leak rates for your furnace and your parts.

Understanding Leak Anomalies

In addition to acceptable leak rates, there is often confusion surrounding the process of leak checking. For instance, one needs to remember helium is lighter than air. Therefore, if you are leak checking a furnace, you should start at the top, as mentioned earlier, because helium floats upwards. This is especially important to remember when leak checking a large furnace because it will take longer for the helium to dissipate from surrounding areas.

One must always be cognizant of the surrounding environment when leak checking. If the wind were blowing in your face, you would not start on a 25-foot-long furnace with the wind blowing down its length; you would start at the end where the wind is blowing towards so, as you leak check, the wind blows the helium across areas that have already been checked.

Of course, there is more to leak checking than that. For instance, one also needs to consider if there are multi-pump or single-pump units, how to cycle the pumps, when to have the pumps on, when to have the pumps off, etc.

Let's say you are leak checking a furnace system with four diffusion pumps. While four pumps would give you a much lower vacuum, that does not mean you should end your final leak check with all four pumps on.

Rather, you should shut three of them off and just use one. The reason for this is that, when a leak detector is connected to a pump and there is a small leak, you are asking the helium to go across all of the remaining pumps to reach the final one. However, there may not be enough helium to reach the pump the leak detector is hooked up to. As a result, one needs to close the first three main valves so, if there are any leaks in the furnace, the only route of escape for the helium is the pump with the currently connected leak detector.

Hot Leak Rate

In the pursuit of correctly performing maintenance on your furnace system and protecting it from unnecessary damage, it is essential to remember the furnace also needs to be leak checked when it is at temperature. So many times a furnace can pass a cold leak check and a cold leak rate test, but when it is at temperature, something may start leaking.

For example, if the furnace has been previously leak checked with a helium mass spectrometer and the linear cold leak rate has been verified – but the parts have been exposed to oxygen and are coming out discolored – the furnace might be leaking when it is hot.

This is why, periodically, one needs to:

1. Heat the furnace up to 2,000 °F (1,093 °C)[2]
2. Let the furnace soak out for an hour to degas

[1] While 15 microns might be tolerable for most furnaces and the furnace will not be damaged, 15 microns is **not** a number Ipsen condones. Please follow the specifications outlined in your specific furnace manual.

[2] Refer to your furnace equipment manual for exact specifications.

3. Do a physical leak check on the furnace with a helium mass spectrometer, while also taking care of the energized feedthroughs

Trying to perform an automated leak test with the software on the furnace (or, in other words, a *hot leak rate check* with the software) yields a pass/fail point of reference only. It does not provide a legitimate linear leak rate or qualification.

Validation of the leak rate is a mechanical (either software or man-interface) manipulation of the furnace controls when the furnace is pumping, stopping, watching and calculating a leak rate of rise. That does not necessarily mean that is the true linear leak rate, but rather – as mentioned before – a pass/fail point of reference.

For instance, one opens the furnace door, closes it, pumps down for thirty minutes and does a leak rate check with the software for 10 minutes, ending up with a leak rate (rate of rise) of 30 microns. However, that is not the true linear leak rate. It simply means that – based on how you designed and performed the experiment – it is 30 microns for that day. If the same thing is done repeatedly every day and, if the furnace is operating correctly and the parts are clean, 30 is a good reference number. But if one day it goes from 30 microns to 300 microns and the parts come out blue, then there's a problem.

Ipsen's software, as demonstrated in Figure 6, is also capable of performing both hot and cold leak rate checks. Many operators of vacuum equipment routinely conduct a leak test before energizing the heating elements. This is particularly useful when the workload consists of very expensive material. In this case, the furnace is pumped down (e.g., to 10^{-4} Torr) for at least one hour (with the vacuum valve connecting the furnace to the pump closed), and the software is programmed to check the rate of rise in internal furnace pressure over a specified time interval. This allows you to get a data point known as either a *hot leak rate point or cold leak rate point.*

Again, this data point is not to be construed as the true linear leak rate; it is also to be considered a point of reference only.

Check out Ipsen's blog series, *Finding Leaks in Your Vacuum Furnace*, for videos and other resources on detecting, identifying and preventing leaks in your vacuum furnace:
https://goo.gl/ye1f8S

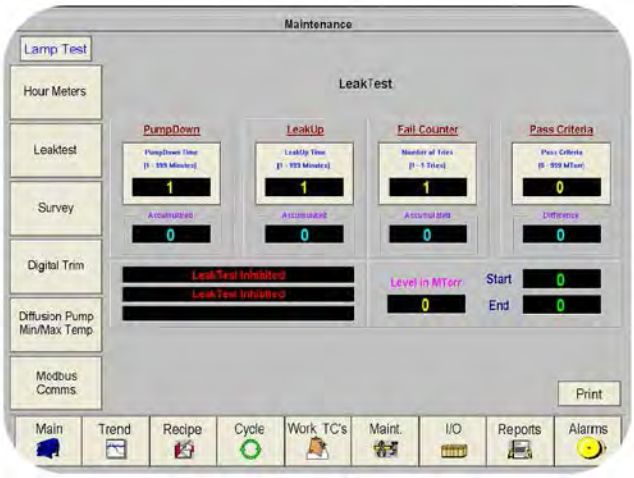


Figure 6 – Ipsen's automated leak check software performs hot and cold leak rate checks, helping signify if there are points of change that should be addressed.

Vacuum Valve Troubleshooting

Sometimes, though, knowing how to leak check a furnace, obtain a linear leak rate, etc. is not enough to solve the problem with the furnace. When performing corrective maintenance, it is also important to consider the vacuum valves as an extension of leaks because they can also cause issues with the furnace. Valves can leak between adjacent systems, which can then affect the leak rate, part colors and quality in the vacuum furnace. To check the seal integrity of the various valves, one should perform the following maintenance steps:

Main Valve

1. Pump down the vacuum chamber to 1,000 microns or less.
2. Press the *Process Cycle Stop* button to stop the pumping of the furnace.
3. Select the vacuum sensor tube that is reading the vacuum level of the diffusion pump (foreline). Normally, this will read somewhere in the range of 20 to 200 microns.
4. While you are watching the vacuum level in the diffusion pump, press the *Chamber Release* button.
5. As the backfill gas enters the main vacuum chamber, there should be no upward movement (loss in vacuum) in the diffusion pump's vacuum reading.
6. If the diffusion pump appears to be backfilling at the same rate as the main chamber, there is a leak at the main valve dish seal.

Roughing Valve

1. Pump down the vacuum chamber to 1,000 microns or less.
2. Press the *Process Cycle Stop* button to stop the pumping of the furnace.
3. While you are watching the vacuum level in the main chamber begin to slowly climb, have someone stop the roughing pump and air release the roughing line.
4. As air enters the roughing line, there should be effect on the chamber vacuum level.
5. If the chamber vacuum level rises (loss in vacuum) when venting the roughing line, the roughing valve seal is leaking.

Foreline Valve

1. Pump down the vacuum chamber to 1,000 microns or less.
2. Press the *Process Cycle Stop* button to stop the pumping of the furnace.
3. Select the vacuum sensor tube that is reading the vacuum level of the diffusion pump (foreline). Normally, this will read somewhere in the range of 20 to 200 microns.
4. While you are watching the vacuum level in the diffusion pump, have someone stop the roughing pump and air release the roughing line.
5. As air enters the roughing line, there should be no effect on the foreline vacuum level.
6. If the foreline vacuum level rises (loss in vacuum) when venting the roughing line, the foreline valve seal is leaking.

Holding Valve

Normally, if the oil keeps disappearing from the holding pump and there are no signs of external oil leakage, the holding valve is most likely leaking across its own seal, subsequently pulling the holding pump oil backwards into the diffusion pump.

In the end, by knowing the proper procedures for detecting, identifying and preventing leaks in a vacuum system – from using a helium mass spectrometer to troubleshooting the vacuum valves – you can ensure your heat treatment equipment is continuously kept in prime condition.

Conclusion

Overall, it is essential to know how to protect your investment, especially when working with expensive equipment in a highly competitive business world. After all, the regular performance of maintenance is a vital part of equipment upkeep and achieving and maintaining quality heat treatment.

By understanding how to implement and perform the essential basics of furnace maintenance and upkeep – such as diagnosing and troubleshooting the furnace, performing a leak check or repairing the heating elements – you can begin to extend the lifespan of your equipment, while also minimizing the cost to your company. In the end, with the proper utilization of preventative and corrective maintenance, one can begin to generate higher uptime percentages, reduce unplanned downtime situations and yield greater shop throughput.

Resources

1. www.IpsenHarold.com
    a. Preventative Maintenance Checklists: https://goo.gl/uiwZ2d
    b. Cleanup Cycle: https://goo.gl/uFSWRR
    c. Part Colors: https://goo.gl/042NPp
    d. Using a Helium Mass Spectrometer: https://goo.gl/9Jc05X
2. www.IpsenUSA.com
    a. Articles & Case Studies: www.IpsenUSA.com/Articles
    b. Tips to Keep the Heart of Your Vacuum Furnace System Healthy and Pumping: www.IpsenUSA.com/Pumping
3. www.IpsenUSA.com/Ask-An-Expert
4. www.IpsenUSA.com/Helpline: (**1-844-Go-Ipsen**)