Vacuum System Diagnostic Test Tips

Introduction

There are many things that can go wrong with your vacuum system. Save time by starting here to find the most common ones.

The usual vacuum furnace problem is caused by a high leak up rate or high pump base pressure. If the system is processing aerospace parts, then leak up rates must be no greater than about 15 millitorr per hour. This requires a very tight furnace that is thoroughly outgassed.

In our many years of field leak detection, we have found the following problems (starting with the most frequent).

1.) Customer's leak detector is out of calibration and not "seeing" helium.

2.) Improper leak check procedure: not using the "puff into the ballast valve test" to verify that the leak detector is sensing helium, helium flow rate is so large that small leaks are not identified, etc.

3.) Thermocouple leaking around or through inner sheath

4.) Water leaks on internal cooling coils (ice may be plugging the leak).

5.) Water leaks on the inside shell of the furnace

6.) Vacuum gauging out of calibration

7.) Blank off plates that leak during pump base pressure measurements, because the plates are too flimsy.

8.) Leaks on vent valves and back fill valves that allow nitrogen or argon to be continuously bled into the furnace

9.) Leaks on power ports

10.) Leaks on door seals

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Common System Issues and Solutions			
Symptom	**Possible cause**	**Solution**	**Comments**
Slow pump down times	Vacuum seal leaks on chamber ports, feedthroughs, doors, etc.	Use a leak detector. Test around all seals and inspect for damage, especially O-rings on doors or feedthroughs. Repair or replace leaking seals.	Be sure the leak detector is calibrated, and the helium wand flow rate is not set to high. A known leak should be valved into the furnace and probed to verify leak detector operation.
	Vacuum seal leaks on piping	Test and inspect seals and welds on flanges and flexible couplings. Repair or replace leaking seals or piping.	Metal bellows and rubber vacuum hoses often develop cracks that leak.
	Vacuum seal leaks on valves	Test and inspect seals on flanges and seats.	Proper leak check on gas inlet and vent valves will require opening the upstream side and probing with helium.
Unable to attain required process vacuum levels	Determine whether the cause is a leak or contamination	Test system for leaks using a leak detector, or a combination of acetone and a Pirani vacuum gauge, and fix the leaks. Contamination may be removed from the chamber by a bake-out at 2250°F, but first be sure the chamber is leak tight.	Acetone will alter the conductivity of the residual gas and cause the Pirani gage to quickly drift up or down scale. On a log-log graph of pressure vs. time, a true leak plots as a straight line; contamination plots as a curved line.

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If you suspect there's a problem with your pumping system, isolate the pump from the chamber and run a "blank-off test" to evaluate it. You can close the roughing valve and test the ultimate pump pressure with a Pirani gage when it's included with your system. Otherwise, use a blank-off plate on the pump's inlet (see photo). This pump is "basing" at 3.4 x 10-1 Torr or 340 microns. It has a bad shaft seal, causing a high base pressure.

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Common Pump Issues and Solutions			
Symptom	**Possible cause**	**Solution**	**Comments**
Unable to attain required process vacuum levels	Mechanical vacuum pump problems	Run a blank-off test to check pump performance. Isolate piston pump, and test pump performance with its inlet closed off. An ultimate pressure of less than 40 millitorr indicates proper operation.	Call on MHV when you need help on pump repair, rebuilding, or system troubleshooting.
	Leaky pump inlet flange gasket or flexible connector	Use a leak detector to check	Replace components as required
	Leaky pump shaft seal	Use a leak detector to check	Replace items as required
	Contaminated pump oil	Draw off sample and visually inspect for liquid or solid contaminants (see note 1). Replace oil if contaminated.	Water and similar liquids, if present, will collect on the bottom of the pump's oil reservoir. Running with gas ballast, and / or with higher oil temperature will reduce or eliminate water collecting in the oil.
	Internal pump wear	Disassemble pump and check piston and other critical clearances. Replace worn parts.	MHV can remanufacture pump internal parts to like-new condition.

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Common Pump Issues and Solutions (continued)			
Symptom	**Possible cause**	**Solution**	**Comments**
	Faulty pump discharge valves	Disassemble pump and check valves. Replace worn or damaged valves.	Visually inspect for wear. Valve discs and springs should be replaced every 12 months. Bad valves will cause "pulsing" current draw on motor, but pump base pressure is usually not affected.
Noisy or vibrating pump	Slipping v-belts	Check v-belts for tension and glazing. Replace as needed.	
	Worn internal pump parts	Replace bearings, and bring all internal clearances back to factory specs	Heavy "pounding" is usually caused by worn bearings and / or excess eccentric clearance.
	Damaged or faulty vibration mounts	Inspect and replace as needed	
	Flexible inlet and outlet piping	Inspect. Replace, reinforce, or brace as needed	
	Improper gas ballast setting	Check operation of gas ballast valve. See Note 2.	The gas ballast valve can be cracked slightly open to quiet down the pump, but can affect the pump's ultimate pressure.

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Common Pump Issues and Solutions (continued)			
Symptom	**Possible cause**	**Solution**	**Comments**
Pump does not turn over	Faulty electrical power	Check system voltage and pump controls. Repair or replace as needed.	
	Faulty motor	Disconnect motor to test and / or replace as needed.	
	Broken v-belts	Replace as needed.	
	Slipping pulleys or missing or broken shaft key	Inspect and replace as needed	
	Seized pump internals	Disconnect pump and attempt to turn over manually. If pump is seized, remanufacturing will be required.	Call on MHV when you need help on pump repair, remanufacturing, or system troubleshooting.

Note 1. If oil appears “milky” due to water contamination, make sure the oil is at normal operating temperature, then run gas ballast for 30 minutes and see if it clears. Oil temperatures of 140°F - 150°F will help. Several oil changes may be necessary to get clear oil and an acceptable base pressure.

Note 2. On gas ballasting, open gas ballast valve(s) just enough to quiet the oil slap (knocking sound). Opening more will ruin base pressure. It’s a good idea to run a small amount of gas ballast all the time. Hooking up the gas ballast to a 20 psig regulated nitrogen source prevents pulling moisture-laden air into the pump.

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