Tech tips from the pros

Keeping the Life in Your Pump

IMPORTANT
JB PUMPS ARE NOT TO BE USED ON AMMONIA OR LITHIUM BROMIDE (salt water) SYSTEMS. Pump maintenance is the responsibility of the owner.

Remember to change the oil. JB recommends changing oil after every evacuation and for larger jobs, you may need to change the oil a few times. Hydroflouric and hydrochloric acids and moisture collect in the oil. Left sitting in a pump, they act as an abrasive on internal surfaces, rusting and corroding them.


Figure 1

Cleaning and Testing Your Vacuum Pump

One of the easiest ways to spot if your pump is in need of a good cleaning is to look at the sight glass. If the oil looks milky, rusty, or full of debris, then the inside of the pump is in worse shape (Figure 1).


Figure 2

To clean, start the vacuum pump and allow it to run for about 15 minutes to warm up the oil. Make sure that you have allowed enough working room to safely drain and capture the oil. After the oil has stopped dripping, tilt the pump forward to remove any remaining excess oil (Figure 2). Then, stand the pump on the nose of the cover (Figure 3) to allow any trapped oil in the wells and stators to drain. Let sit for a few minutes and return the pump to its normal running position. Repeat tilting forward. Close drain valve. Dispose of contaminated oil properly.


Figure 3


Figure 4

Once the oil has been completely removed, return the pump to the position in figure 3 and remove either the 2 rubber feet from the bottom of the pump or remove pump base (depends on the age of the pump which option is available). Next, turn the pump on to the motor end (Figure 4) and remove the 6 socket head cover screws holding the cover in place (Figure 5). Remove the cover from the pump and wipe the inside surface with a dry, clean rag. The sight glass is more difficult to clean. Try pouring in some solvent and using a pipe cleaner.

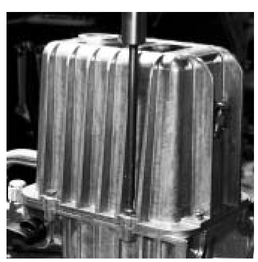


Figure 5

Next, remove the oil deflector which is held in place with a socket head screw (Figure 6). Wipe with a clean, dry rag. If needed, a wire brush can be used to clean any discoloration to metal parts (this will not affect the pump's performance once the cleaning is complete). Remove the cover seal and clean cover seal (Figure 7). Wipe the outside of the cartridge's surfaces with a clean, dry rag. A wire brush can be used on all surfaces including the exhaust valve and the intake relief valve. If they are discolored, they will still perform fine. **DO NOT DISTURB THE FOUR CARTRIDGE BOLTS OR THE TWO SMALLER HEX HEAD SCREWS (FIGURE 8).** These are the setting screws.


Figure 6

If the intake relief valve set or the exhaust valve set is damaged and needs replacing, these items can be ordered through your local wholesaler under JB Part Number PR-18. It is best to replace after completing the cleaning of the cartridge. Pay attention to the order in which they are assembled for correct reinstallation.


Figure 7

Reassemble the oil deflector (Figure 6). Clean out the channel for the cover seal with a clean, dry rag and smear some grease into the channel. This will help hold the cover seal in place for reinstallation of the cover. If the cover seal seems a little tight, stretch the seal a little and try again. All seals in JB pumps are designed to be reused. Reset the cover in place and replace the cover screws. Tighten in a crisscross pattern. Reattach feet or base.


Figure 8

DO NOT DISTURB THESE

Next, return the pump to its normal running position and place where you drained the oil. Open the drain valve, the 3/8" port on the intake, and the isolation valve. Have 1/3 cup of clean oil ready. Start the pump and pour the clean oil into the intake port. Let the pump run for 5 to 6 seconds and then shut the pump off. Drain the oil, tipping the pump forward as in Figure 2 to completely drain. Close the drain valve and dispose of spent oil properly after the flushing is complete.

Cleaning and Testing Your Vacuum Pump Continued

Figure 9

Now, fill the pump to the proper oil level and allow the pump to run with the isolation valve closed for 3 or 4 minutes to warm up the oil. Check all o-ring caps for dirt and proper seal. Connect a micron gauge (JB recommends the JB DV-22N pictured to the right) directly to either the 1/4" port or the 3/8" port on the intake tee (Figure 9). **Do not use a charging line**. Open the isolation valve.

Figure 10

Using a charging line, especially a new line, will give you a higher micron reading because you are reading the environment inside the hose (see Figure 10).

Figures 9 and 10 are the same, but figure 9 is a direct connection hook-up and figure 10 is a connection through a new charging line. Both hook-ups are allowed to run the same length of time, but #9 is at 20 microns while #10 is at 297. If left on, the charging line hook-up will come down in its micron reading, but it will take a much greater period of time. If the hose is cleaned out with alcohol and vacuumed for a long period of time, the micron reading will go lower.

This test can be performed on a pump with dirty, used oil and then with the pump cleaned and flushed, as described earlier, to see the difference that just maintaining the cleanliness inside your pump affects the performance for deep vacuum.

Isolation Valve

It is a quarter turn between on and off. There is no additional valve needed to isolate the system. When checking for pressure rise, slowly turn the handle counter-clockwise. The pause position is at 45 degrees and the valve is completely closed at 90 degrees (Figure 11).

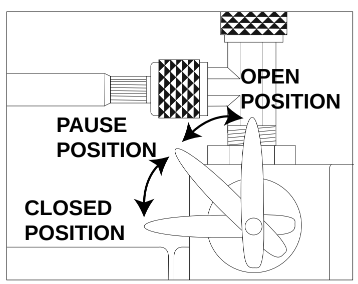


Figure 11

Using Charging and Testing Hoses for Evacuation

You probably think there is a leak. However, an evacuation/ dehydration hook-up requires a leak-proof design in all of the components. Only soft copper tubing, pure rubber hoses, or flexible metal hoses are absolutely vacuum tight. Charging hoses are designed for positive pressure. Even with the advanced technology of today's hoses, permeation through the hose compound still exists (Figure 12).

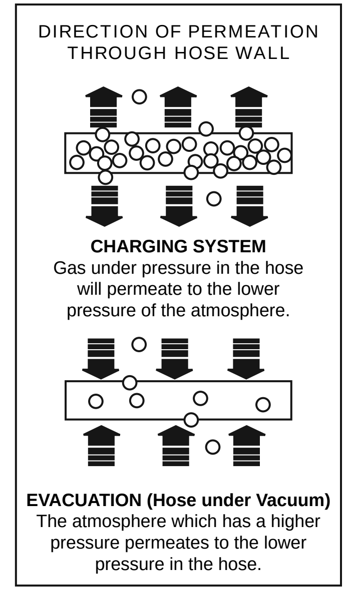


Figure 12

If you have blanked-off your pump to check pressure rise and your hoses and connections are not leak-free, the atmosphere will permeate to the lower pressure in the hoses. Your reading will slowly rise and you will spend time looking for system leaks.

Information on Testing the Vacuum Pump's Isolation Valve

The easiest way to test the isolation valve for leakage is to turn the pump on with the isolation valve in the closed position. Connect a charging line to the center port of the manifold (Figure 13), and have the high side capped off and CLOSED and the low side capped off and OPENED. Then, connect the charging line to the intake of the pump and wait. If, within 5 to 10 minutes, you do not see the low (compound) gauge going into inches of vacuum, there is no leak in the isolation valve.

Figure 13

What does happen when a micron gauge is connected directly to the intake of a vacuum pump with an isolation valve/ It is all related to the connections to, and including, the intake, the volume of what is being vacuumed, the depth of vacuum, and the length of time that the volume is in the deep vacuum.

Information on Testing Vacuum Continued

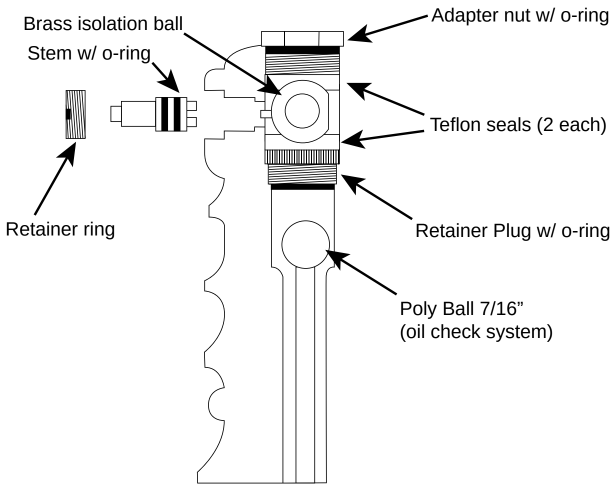


Figure 14

First, let’s look at the construction of JB’s isolation valve (Figure 14). This figure shows the isolation valve in the closed position. The brass ball is sandwiched between two Teflon seals, making a positive seal, with a solid brass surface blocking access to the intake chamber. The adapter nut on the top, outside of the pump, is where the intake fitting is connected. It is sealed with Loctite and an o-ring. If this nut has not been disturbed, the chances of a leak are very minimal. The stem has a dual o-ring seal and, even if this leaked, with the isolation valve in the closed position there would be no effect on holding a vacuum. A leak at the stem would effect the depth of vacuum the pump could achieve.

With a micron gauge connected directly to the intake of the pump and vacuumed to 50 microns, closing the isolation valve will result in a rapid rise in pressure, almost to atmosphere. Look closely at the area around the isolation valve. Even though small, air is trapped in this area. When we begin to close the isolation valve, there is a position of the ball that allows this trapped air to enter the vacuum being created. On a large system, this small amount of air would not create a conspicuous change in microns. However, with almost no volume, the sudden introduction of air to this direct hook-up is obvious and would be displayed on a micron gauge. Refer to the previous page for the isolation valve positions. When the isolation valve is put in the pause position, this gives the cartridge (the pumping mechanism) access to the air trapped in this area and within a few seconds, that trapped air is removed.

Moving to the connections on the pump, the factory intake is loctited into place and each pump is tested for leaks. If this is not disturbed, the chances of a leak

are virtually non-existent. Any leak would come from the connection at the port being used and to the connection to the system. One of the most common errors with both the o-ring and the gasket couplers is the wrenching down of these couplers with a pair of pliers or channel locks (Figure 15). Please refer to our “Principles of Deep Vacuum” article. This article can be found on JB’s website www.jbind.com under technical information/ troubleshooting. Or type http://www.jbind.com/tools/userfiles/file/Deep_Vacuum.pdf into your web browser to take you directly to the page.

Figure 15

DO NOT WRENCH DOWN COUPLER

As this article shows, there is a need for sealing with a vacuum tight o-ring (Figure 16). Gaskets, like those used in charging lines, are made for pressure. What wrenching of the coupler does is to smash the brass cup that holds the gasket or o-ring against the male flare fitting. This causes the brass cup to expand outward against the threads of the coupler and makes it tight to turn. This causes the o-ring to fall out of the cup that is holding the o-ring or gasket in place.

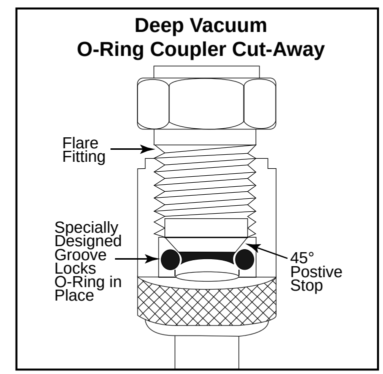


Figure 16

Another error that we see is that technicians have a brass adapter fitting on the intake of the pump with no copper gasket. The first time you wrench the adapter into place, it might seal. But, as soon as you break the seal and retighten, there is a chance for a leak. The best hook-up that guarantees there are no leaks in the system is by using JB’s DV-29. This hook-up is depicted in Figure 17. The DV-29 consists of a flexible metal hose, ball valve with depressor, a 90° male flare with coupler, and valve assembly with male connections. The hook-up and parts are depicted in JB’s catalog, version 42 on page 13.

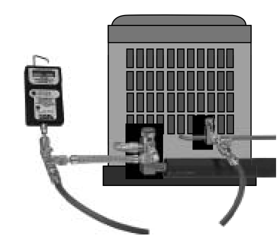


Figure 17

Charging lines have been used for many years for the vacuum end of air conditioning and refrigeration servicing. Charging line use

Information on Testing Vacuum Continued

stretches back as far as when Inches of Mercury (inHg) was the way measuring of a vacuum on a system was taught. A charging line hose can be vacuumed to 50 microns if it is clean. New environmental hoses, fresh off of the shelf, will only reach about 300 microns until they are cleaned out with alcohol and vacuumed out for a while. Why is this? First, the charging lines are mostly gaskets made for positive pressure. Second, they are permeated. See page 5 for how charging lines and permeation occur. The only vacuum tight hose is a flexible metal hose. Third, the compound of the hose inside will outgas when under a vacuum until it is cleaned out, as discussed earlier.

Another source of leakage is the gasket seal in the valve and hose couplers. This seal is designed for charging and will not give a perfect seal required in deep vacuum service. An o-ring seal coupler, like the ones JB makes, forms around any irregularities in the flare fitting. When the coupler is screwed down, we get a metal to metal seat and the o-ring lies around the lip of the flare giving it a positive seal.

If you are used to using a compound gauge when testing for a leak or holding a vacuum, using a digital gauge will be a little tricky the first time you use it. Digital vacuum gauges, like JB's DV-22N, will display microns jumping up and down in measure. You might think that the gauge is erratic or that there is a leak in the system. The reason for the changing microns is due to a whole other area of understanding the environment inside a system being vacuumed. We will discuss this event in the next section "Information on Digital Micron Gauges".

To help show the difference of a digital and analog displays in microns, and a compound gauge display in inches of mercury (inHg) as it relates to their displays of vacuum, we need to hook them up. Take a compound gauge, an analog gauge, a digital micron gauge, and an empty refrigerant tank. This hook-up is illustrated on the next page in Figure 18. This allows you to demonstrate the four components in holding a vacuum: the connections, the volume, the depth of vacuum, and the length of time that volume is in deep vacuum.

Link all three gauges together by solid brass adapters and o-ring couplers and couple to the tank. The tank is connected by an o-ring coupler to one of the intake ports of the pump by way of braided metal hose with o-ring connections. Then, with the isolation valve in the open position, we can begin to vacuum this hook-up and watch the readings on the various gauges move into deep vacuum. Within seconds, the compound gauge's needle should be nearing 27-29" while the digital and analog gauge readings are still heading into deeper microns.

After the digital and analog gauges are at 500-600 microns, close the isolation valve. You will see the digital and analog readings start a pretty rapid rise in micron readings. Notice that the compound gauge's needle has not moved.

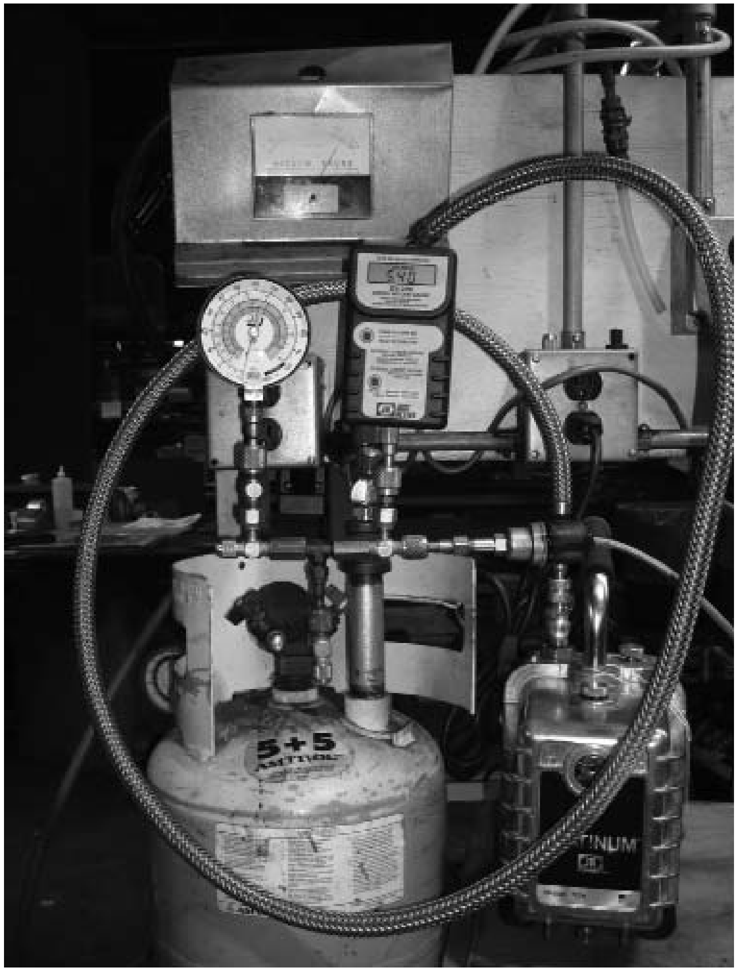


Figure 18

(NOTE: If the compound gauge's needle does move toward zero on the scale, you have an air leak in your connections). Open the isolation valve again and this time let the hook-up vacuum for 5 minutes. Then close the isolation valve again and watch. Open the isolation valve for about a minute, then move the valve to the pause position for about 5 seconds, then close the valve completely. This removes that trapped air around the isolation valve. You will still see a rise in pressure, but not as rapid. The readings will start to stabilize the longer this hook-up is allowed to vacuum down and use the pause position of the isolation valve the slower and lower the rise in pressure.

If you increase the volume of the cylinder and follow the same procedure, you will notice a slower and lower rise. If you watch your compound gauge, you will notice there is no movement.

Information on Digital Micron Gauges

There are three main complaints that are stated on the returns that JB receives from the DV-22N and DV-24N. First, "inaccurate readings". Second, "erratic readings". Third, "will not hold a vacuum". Each of these complaints involves both the understanding of the gauge functions and the principles of vacuum.

Inaccurate Readings: Please note, for the DV-22N and DV-24N we have a stated accuracy that references AVERAGE accuracy. Thus, between 250 and 6000 microns the unit is +/-10% AVERAGE accuracy and between 50 to 250 microns it is +/-15% AVERAGE accuracy. This does not mean our gauge has a large accuracy discrepancy.

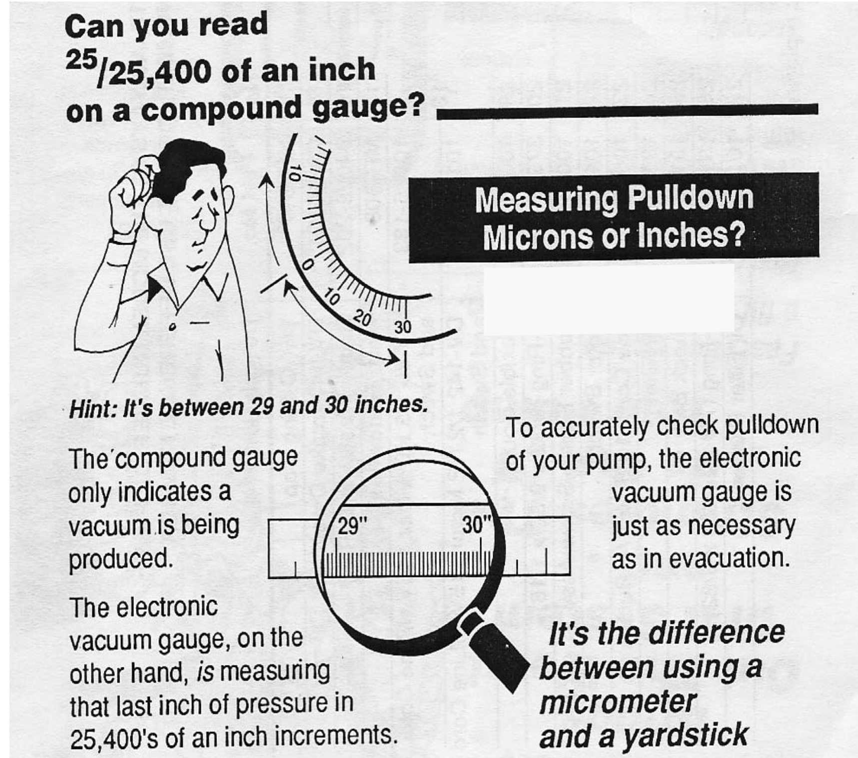
The term AVERAGE is an important part of this accuracy description. The number of increments displayed on the JB digital micron gauge between 50 and 250 microns are 97. Between 250 microns and 6000 microns, there are 232 increments. If you take a comparison reading between the DV-22N and the MKS Baratron master gauge at each of the increments displayed on the Digital micron gauge the average accuracy would be +/-10% in one range and +/-15% the average in the other range. Also, the number of increments decrease from the lower micron readings to the higher micron readings.

For example, from 250 to 300 microns there are 16 increments, from 650-700 microns there are only 7 increments, between 1000 and 1050 there are 4 increments, and between 4000 and 4500 there are 4 increments. So at 650 to 700 microns the gauge has the ability to show 650-658-667-675-680-685-690-695. But at the micron range of 4000 to 4500, the gauge only displays 4125-4250-4375. This is important because when the system has an actual micron level of 4260, the digital micron gauge will show a reading of 4375 because the threshold for the lower value that the gauge displays, 4250, has not been reached. Once that threshold has been reached, the gauge will display that lower value of 4250. Because the readings in these higher micron ranges only need to show the movement through them , the difference between 4375 and 4250 is of no concern in reaching the ultimate vacuum desired. This is why the JB DV-22N is designed with the most increments in range that are going to be the most critical in determining if the system is ready for charging.

If you understand the size of a micron, then small differences in ranges is nothing to be concerned about. For instance:

Micron Range	Micron Difference
60-100	10-20
200-350	30-40
500-700	50-60
900-1500	80-100
2500-4000	200-300

Information on Digital Micron Gauges Continued



When a DV-22N comes in for repair, it is compared to a secured system set up with a N.I.S.T. Certified analog gauge (DV-6 Hastings). Usually starting around (1)60-100 microns, then (2)200-350 microns, then (3)500-700 microns, then (4)900-1000 microns. These ranges of vacuum are the most common that people work with to determine deep vacuum. We have been comparing the DV-22N to the N.I.S.T certified gauge on a secured system for a number years and has proven to be highly accurate in all four ranges of vacuum. The average accuracy as stated earlier in this section has proven to be consistent against this measure.

Erratic Readings: There are three issues involved in the discussion of erratic readings. One is the understanding of the gauge's displayed micron increments that was just discussed. The second involves the re-sampling period. The third is the environment inside the system being evacuated. When the DV-22N is turned on, the display will show "JB" and the sensor will start to calculate the ambient temperature.

Once the gauge has finished calculating the ambient temperature, it will display the number "1" if it is not introduced to a vacuum level of 9000 microns or less.

Information on Digital Micron Gauges Continued

As the system is being evacuated and the micron level is dropping down through the increments of the gauge's display, the gauge will re-sample ambient temperature about every 60 seconds. When this function is taking place, the gauge's display will show "auto-cal" (older gauges may see that the display freeze prior to the re-sampling). The re-sampling lasts for about 15 seconds after which the micron level that the system is at will then be displayed. For instance, the system is at a micron level of 5500, the re-sampling begins, the "auto-cal" will be displayed until the re-sampling is done, then the micron level at which the system is at will be displayed.

There is also instability inside the system being evacuated. Liquids (moisture) are being turned into gasses and molecules are moving at different rates of collision with other molecules at different areas of the system at different times between the high and low sides. The deeper the vacuum, the further apart these molecules get and the less rubbing together. This decrease in friction changes the temperature around those molecules and the DV-22N is registering those changes by way of temperature changes at the sensor's filament. The environment inside a system being evacuated has more instability at higher micron levels (9000 to 1000) than at lower micron levels (700 to 50). This is evidenced when testing the DV-22N at the different ranges on a secured system. When in the range of 4000 microns, the DV-22N's display will show 4000 microns, then jump to 4350, then regress to 3875, then jump back to 4000. After being blanked-off at this level for a period of time, the changing back and forth will level out to changing from the incremental display of 4000 microns and the next incremental display up or down of either 4125 or 3875. But, when in a deeper vacuum like 350 microns, the changes in display on increments may be from 350 to 357 and back down to 350 or even 329 as the environment inside the system becomes more stable and the time period of these changes will be less as most of the out gassing has been done.

On an analog gauge, at a micron level of vacuum of 4000, the distance between 4000 and 4350 is between 2T and 5T. This is a distance of about 1/16th of an inch. This distance on other gauges may vary. Fluctuations of the needle as the out-gassing is happening are barely noticeable. The downside of the analog gauge is that magnification of the needle is needed in order to see it move between the two increments at this range or vacuum level (4000-4350 or 2T-5T).

Won't Hold a Vacuum: The sensors on JB's DV-22 digital gauges are brass with the sensor components sealed like a light bulb. The area where the hook shaped wire and the filament attach to the sensor's body is sealed with a glass like epoxy. The chances of this leaking are next to impossible. The rise in pressure experienced in the use of vacuum gauges on systems is discussed on the previous pages under "Information on Testing a Vacuum Pump's Isolation Valve".

Breaking Vacuum

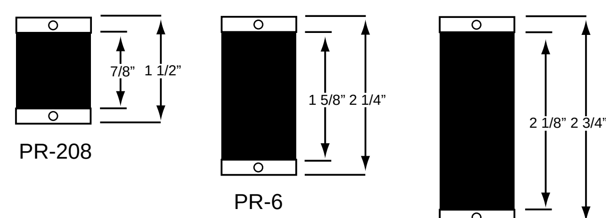
Breaking vacuum prior to shut down is important on larger cfm pumps. This procedure relieves the stress on the flexible coupler on the next start up. When a pump is shut down without breaking vacuum, the oil in the cover is pulled back into the cartridge and intake chamber of the pump trying to fill the vacuum there. Upon the next start up the pump has to clear the oil outof these areas and all the stress is on the flexible part of the coupler, especially if the oil is cold. You can see this occuring by shutting down the pump and watching the sight glass. The oil will start to drop down and appears as if you are low on oil. Then when you restart the pump the oil level returns to normal.

To break vaccum on the Platinum pumps, simply close the isolation valve with the pump still running and open the gas ballast valve all the way and allow the pump to run 2-3 seconds with the gas ballast valve opened and then shut pump off and close the valve.

To break vacuum on the Eliminator pumps. After blanking off at the manifold or an external isolation valve, if used, crack open the un-used intake port on the pump and allow to run 2-3 seconds and shut pump off.

Flexible Coupler

Flexible couplers are a three part assembly: 2 metal hubs that look like gears and a flexible middle section. The one hub is attached to the shaft of the motor and the other is attached to the shaft of the cartridge. NOTE: The color of the flexible middle section can be either black or yellow.



PR-208

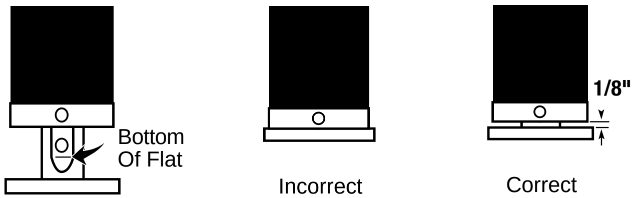
PR-6

PR-53

Middle section of PR-208 only can be ordered seperatley PR-308

Replacing Coupler (Motor Removed)

Coat setscrew threads with removable thread sealant. Align coupler setscrew with flat surface of cartridge shaft. Tighten screw so coupler slides on to shaft but stops at the bottom of the flat. Tighten until screw head is flush with coupler surface (approx. 40 in. lbs.).



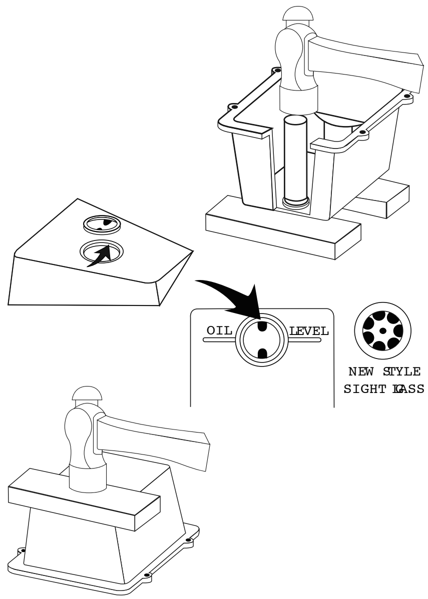
Sight Glass Repair

Step 1: With cover off of the pump, lay on two blocks of wood. Pop out the sight glass using a broom handle or other objects as a punch. For DV-85 series, DV-142 series, or DV-200 series use a 1” diameter punch.

Step 2: Clean the surface with acetone or nail polish remover. Put loctite on the inside surface of the hole.

Step 3: Install the new sight glass from the outside. The hole position does not matter with the new style sight glass.

Step 4: With the wood block covering the sight glass, tap the sight glass into place. Replace the cover on the pump.



Troubleshooting: Poor Pull Down

Possible cause: Check oil level
Possible cause: Missing or damages seals or o-rings

In order for your pump to pull to a near perfect vacuum, oil must be clean and moisture-free throughout evacuation.

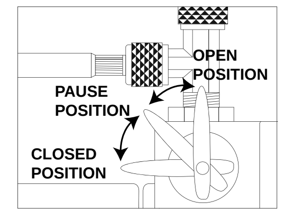
Step 1: With isolation valve closed, start pump. Oil level should be to the top of the oil level line embossed on the front of the pump’s cover. Just a teaspoon low can affect the ultimate vacuum.
Step 2: Flush pump and refill with fresh oil. See Cleaning and Testing Pump Section for review.
Step 3: Check all connections to pump and system for damaged or missing o-rings. If brass adapters are being used, make sure copper gaskets are in place.

Troubleshooting: Pump Hard to Start

Possible cause: Pump has not been shut down properly.

Step 1: Remove 1/4” cap.
Step 2: Move blank-off valve to OPEN position
Step 3: Turn pump on
Step 4: Run 2 to 3 seconds and close blank-off valve.

READ THE INSTRUCTION MANUAL FOR PROPER START UP AND SHUT DOWN PROCEDURES.



Step 1: Close blank-off valve.
Step 2: Open gas ballast valve.
Step 3: Run 2 to 3 seconds.
Step 4: Shut pump off.
Step 5: Close gas ballast valve.

NOTE: See previously discussed topic “Breaking Vacuum”

Troubleshooting: Motor Just Hums

Possible Cause: If pump has been dropped, the armature in motor may be out of alignment with the motor’s bell housing.

Step 1: Set pump on bench with motor standing up (Figure 3 of this booklet)
Step 2: Loosen the four motor bolts
Step 3: Shake motor and re-tighten motor bolts
Step 4: Start pump.

If this doesn’t work, the pump most likely will need to be sent in for repair.

Troubleshooting: Motor Runs but No Suction

Possible Cause: Flexible coupler is either broken or loose.

Step 1: Set pump on bench with motor standing up (Figure 3 of this booklet)
Step 2: Look between motor and pump housing from the bottom to see if the flexible part of the coupler is split or broken. If it is broken, see “Flexible Coupler” section of this booklet. If the coupler is not broken, the coupler may be spinning on either the shaft to motor or cartridge.
Step 3: Go to www.jbind.com and on the tool bar go to Technical. Select instruction sheets from the drop down menu and go to cartridge replacement instructions. These instructions are good for replacing: flexible couplers, motors, shaft seals, and cartridges.

Cross reference of Vacuum Measurements
Boiling Temperatures of Water at Converted Pressures

Temp. F°	Microns	Inches of Hg Vacuum	Pressure Pounds Sq. In.
212	759,968	0.00	14.696
205	535,000	4.92	12.279
194	525,526	9.23	10.162
176	355,092	15.94	6.866
158	233,680	20.72	4.519
140	149,352	24.04	2.888
122	92,456	26.28	1.788
104	55,118	27.75	1.066
86	31,750	28.67	0.614
80	25,400	28.92	0.491
76	22,860	29.02	0.442
72	20,320	29.12	0.393
69	17,780	29.22	0.344
64	15,240	29.32	0.295
59	12,700	29.42	0.246
53	10,160	29.52	0.196
45	7,620	29.62	0.147
32	4,572	29.74	0.088
21	2,540	29.82	0.049
6	1,270	29.87	0.0245
-24	254	29.91	0.0049
-35	127	29.915	0.00245
-60	25.4	29.919	0.00049
-70	12.7	29.9195	0.00024
-90	2.5	29.9199	0.00005
	0.00	29.92	0.00000

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