

WEST VIRGINIA UNIVERSITY

PLASMA PHYSICS GROUP

INTERNAL REPORT PL-051

MD8 Diaphragm Pump Repair

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Replacing MD8 Diaphragms and Returning the Pump to Operability

Things you will need:

- 1.) Manual for the Vacuubrand ME16/MZ8/MD8 diaphragm pump
- 2.) 5 mm hex key
- 3.) Adjustable wrench
- 4.) Phillips head screw driver
- 5.) L vacuum grease
- 6.) Low-strength Loctite (These screws need to come out again, high strength is NOT an option.)
- 7.) Methanol (or isopropanol) and kimwipes
- 8.) A convectron pressure gauge
- 9.) NPT adaptor for the pressure gauge

Procedure:

- 1.) Consult and read the manual about how to replace the diaphragms (page 29) and the pump schematic (page 36-39).
- 2.) Pick a stage (any stage) to start with and do the following:
 - (a.) Loosen the thread adapters that connect the blue hoses to the swivel connectors (see Figure 1).

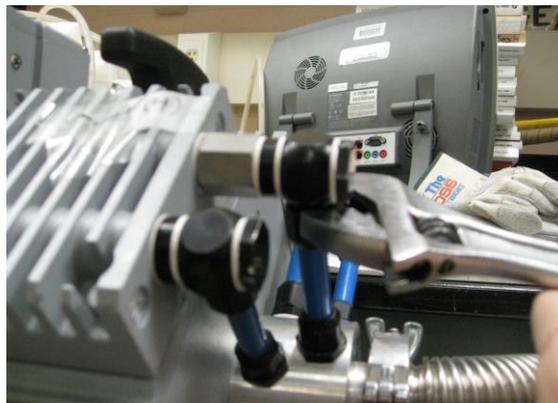


Figure 1: Loosening thread adapter.

(b.) Unscrew the swivel connectors from the housing cover (see Figure 2).

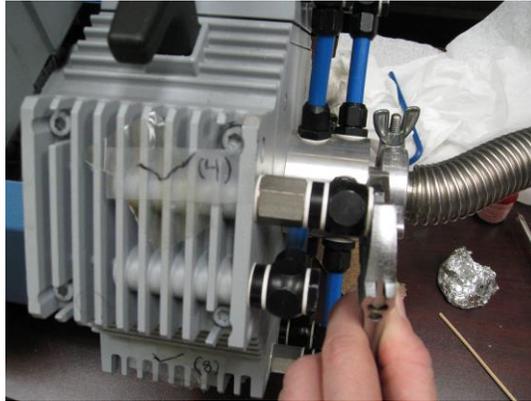


Figure 2: Loosening swivel connector.

(c.) Remove the swivel connectors from the hoses (see Figure 3) and set aside.

NOTE: Make sure to keep track of the white sealing rings as they can fall off and disappear very easily.

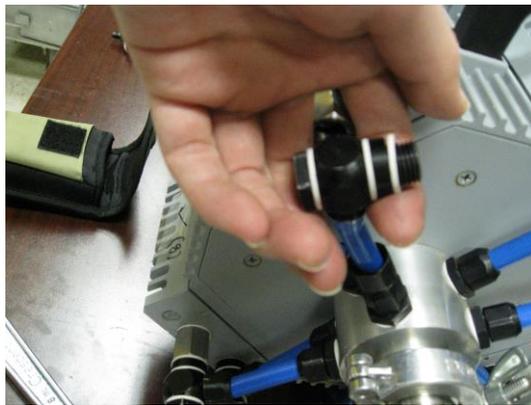


Figure 3: Removing swivel connector
(just tug until it pops off).

(d.) Remove the four hex head bolts with the 5 mm hex key and remove the housing cover.

(e.) Remove the head cover, complete with valves and green o-ring and set aside.

NOTE: This is generally quite difficult since the head covers are very well stuck to the diaphragms beneath them. There is no easy way to do this but to keep at it until the head cover pops off; tapping gently with the back of a screw driver or letting other folks give it a try may help the loosening process, but it ends up being sheer tenacity that gets them loose.

(f.) Using the appropriately sized Phillips screw driver, remove the screw holding the diaphragm assembly in place.

NOTE: There is a small amount of low-strength Loctite on the end of these screws which makes some of them difficult to remove. If you are in danger of stripping the screw head, STOP what you are doing and ask someone in the machine shop for help; they are generally quite friendly and know how to use an impact screw driver to solve the problem. If the screw head seems damaged or a bit stripped, discard it and replace it with a standard 5Mx25 metric countersunk-head screw.

NOTE: There are small metal shims (very thin metal discs) between the piston head and the diaphragm backing plate; be aware that these sometimes fall into the pump chamber when the diaphragm assembly is removed. If this happens simply retrieve the shim and put it back when you replace the diaphragm assembly. A small smear of L grease can be used to keep the shim stuck to the underside of the support disc or the top of the piston head during reassembly.

(g.) Separate the diaphragm from the tensioning and support plates (this can be almost as difficult as removing the head cover, just keep at it). Discard the old diaphragm as well as the old valves and clean the support plate and tensioning plate thoroughly with methanol or isopropanol. Make especially sure that any deposits from the old/deteriorated diaphragm have been removed from the sealing surfaces of the support and tensioning plates (vigorous scrubbing with a rough sponge and methanol may be necessary).

(h.) Place a new pair of diaphragms (the pump is designed to use a double diaphragm) between the support and tensioning plates. A small amount of L grease may be applied to both sides of the double diaphragm to make a better seal. (DO NOT apply any grease between the two diaphragms themselves, just a little to the outer sides of the double diaphragm pair.)

(i.) Apply L grease to the underside of the countersunk-head screw (a little more grease is better than less since this screw needs to seal against air leaking around it).

(j.) Apply a SMALL amount of LOW-STRENGTH Loctite to the end of the screw, insert through the tensioning plate/double diaphragm/support plate assembly, and reattach the whole diaphragm assembly to the piston head.

NOTE: Make sure that the original shim(s) are in place between the bottom of the support plate and the piston head (a small smear of L grease can be used to keep the shim(s) stuck in place during reassembly) and that the diaphragm is concentric with the hole where it rests.

(k.) Remove the old valves as well as the green o-ring from the head cover and clean it thoroughly. Make especially sure that any deposits from the old/deteriorated diaphragm have been removed from the sealing surface (the underside outer-edge) of the head cover (a rough sponge and rigorous scrubbing may be necessary to achieve this).

(l.) Place the fully-cleaned head cover in the proper orientation on top of the diaphragm assembly.

NOTE: Each head cover/housing cover pair has a small notch and ridge in one corner that determines the proper orientation based on the external connections (see Figure 4).

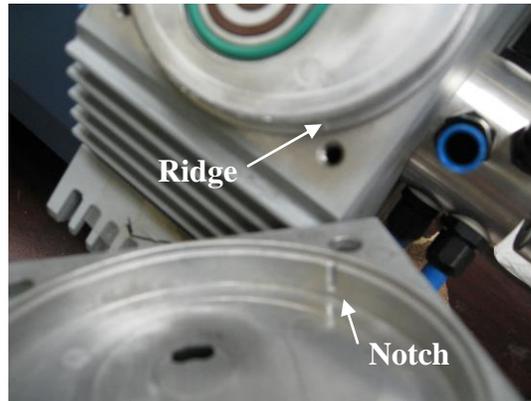


Figure 4: Notch and ridge for properly fitting the housing cover to the head cover.

(m.) Clean and apply a generous amount of L grease to the green o-ring; then return it to its groove in the head cover.

(n.) Place the new valves on the head cover in the proper orientation (see Figure 5, or page 28 of the manual).

NOTE: It is extremely important that nothing interferes with the proper opening and closing of the valves! Clean the valves thoroughly with methanol prior to installing them. **DO NOT** apply any L grease to the valves or their sealing surfaces; this will actually inhibit pump performance.

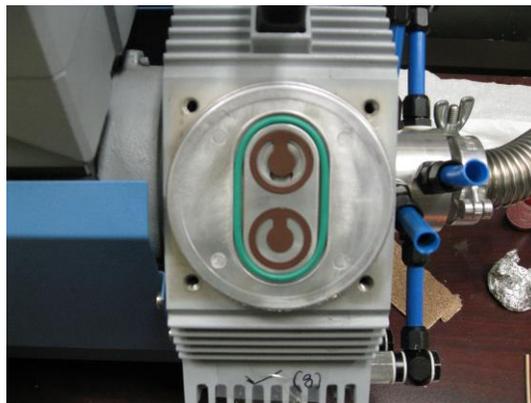


Figure 5: Example of properly aligned valves.

- (o.) Thoroughly clean the inside of the housing cover with methanol or isopropanol.
- (p.) Align the housing cover with the head cover and gently set in place. Hold the housing cover immobile with one hand while inserting the four hex-head screws and tightening them in place.
- (q.) Connect the convectron gauge to the inlet connection (marked IN) of the housing cover (see Figure 6). DO NOT over-tighten the connection as this will damage the brass NPT threads.

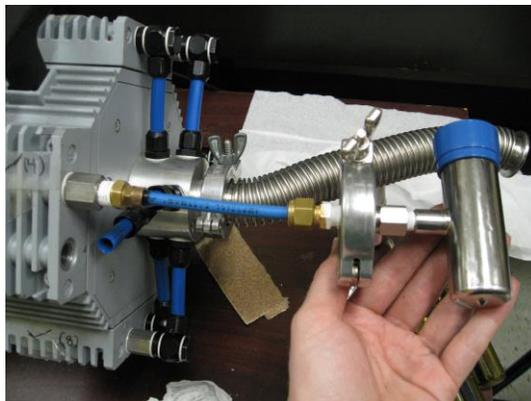


Figure 6: Convectron gauge attached to NPT adapter and connected to inlet.

- (r.) Turn the pump on and record the inlet pressure.
- (s.) If the inlet pressure is below 82 Torr (110 mbar), this stage is operational; proceed to step (w).
- (t.) If the inlet pressure is above 82 Torr (110 mbar), remove the pressure gauge and the housing cover and try the following:
 - i.) Check the position/orientation/cleanliness of the valves (these can easily slide around or slip during reassembly of the housing cover). (The valves are the most likely problem.)
 - ii.) Check that the head cover is sitting evenly against the diaphragm and has no residue caked along the sealing edge.
 - iii.) Check that the countersunk-head screw is fastened as tightly as possible (be VERY careful not to strip the screw head).
 - iv.) Apply a little more L grease to the underside of the countersunk-head screw.
 - v.) Remove the green o-ring, clean it again, cover it evenly with L grease and replace it in its groove.

(u.) Replace everything (head cover, valves, housing cover) as described above (in steps (l.)-(p.)) and recheck the inlet pressure. If the pressure is below 82 Torr, proceed to step (w). If the pressure is above 82 Torr, recheck the valves (realign and clean as necessary).

NOTE: It is not unusual for several repetitions of checking, cleaning, and realigning the valves to be necessary before the desired inlet pressure is achieved.

(v.) If a particular stage has a pressure in the 85-90 Torr range and several repetitions of checking/cleaning the valves does not improve the situation (or makes it worse), try the following:

i.) Remove the diaphragm assembly and flip the double diaphragm over (so the side that was originally against the support plate is now against the tensioning plate and vice versa).

ii.) Reassemble as before (applying a small amount of L grease and Loctite to the countersunk-head screw in the appropriate places again), replace the head cover and valves as well as the housing cover and recheck the inlet pressure.

NOTE: It is quite likely that valve alignment is the problem and that several repetitions of checking and realigning the valves are necessary to achieve the desired inlet pressure. Only resort to flipping the double diaphragm over if you are sure your technique for placing the valves and reassembling the housing cover is very good. (If this problem is occurring on the first or second stage you are working on, try working on a few other stages and then coming back to this one before resorting to flipping the diaphragm.)

(w.) Reattach both swivel connectors to the housing cover and their blue hoses.

(x.) Tighten the threaded adapter connecting each swivel connector to its blue hose.

3.) Repeat step 2 for all 8 individual stages.

4.) Connect the convectron gauge to the inlet of the pump (see Figure 7) and check the total pressure.



Figure 7: Convectron gauge attached to pump inlet.

- 5.) If the total pressure is 1.5 Torr (2 mbar) or less, the pump is fully operational.
- 6.) If the total pressure is above 1.5 Torr, check that all of the swivel connectors and threaded adapters are fastened tightly.
- 7.) Remember that a run-in time of approximately one hour may be necessary after the valves or diaphragms are replaced before the ultimate pressure is reached. If the total pressure is close to 1.5 Torr and you have checked the tightness of all the swivel connectors and threaded adapters, try leaving the pump running for about an hour and see if it reaches the desired base pressure.
- 8.) If the desired base pressure has not been reached, return to the stage(s) with the highest pressure and improve them (while 82 Torr is the maximum inlet pressure for an individual stage, it is ideal if most of the stages are below 70 Torr).

NOTE: The best place to start when trying to improve a stage is to clean and reposition the valves.

Things to Keep In Mind:

- 1.) Each individual stage should have an inlet pressure less than 82 Torr (110 mbar).
- 2.) The pump should reach a base pressure of 1.5 Torr (2 mbar) or less when it is fully operational.
- 3.) If the diaphragms or valves have been replaced, a run-in time of approximately one hour may be required before the pump reaches its rated ultimate vacuum.
- 4.) An example of a newly-repaired pump that reached a total pressure of 1.1 Torr had the following inlet pressures:

Individual Inlet Readings (in Torr): 33, 18, 72, 66, 38, 56, 28, 78
- 5.) Be patient and do the best job you can each time (trying to take a shortcut will just leave you with another problem to fix later).