HyperCyl®
By Aries Engineering Company, Inc.

# HYDRA-PNEUMATIC TROUBLESHOOTING GUIDE

## Problems, Causes, and Solutions

HyperCyl Hydra-Pneumatic cylinders heavy-duty design and construction provides years of trouble-free use. Known problems, causes, and solutions are discussed in this guide. We understand the importance of World Class Customer Support and offer this guide as a starting point to overcoming issues with our cylinders. We are available to discuss any issue, and can be reached at Service@HyperCyl.com whenever an issue arises.

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# Contents



# Introduction

The purpose of this guide is to help our customers understand how to troubleshoot issues that may occur with our product. We will explain the known issues and the main causes associated with those issues. We understand that every situation is unique, and are offering this document to help explain solutions to easily fixed problems. If your situation is not represented here, or the solutions offered don't fix your issue, please contact us 24/7 at Service@HyperCyl.com, or by calling the main office Mon-Fri 8am-5pm at 734-529-8855.

# Rod Doesn't Extend

## Improper Sequencing

The HyperCyl cylinder utilizes compressed air to move oil. The compressed air moves a reservoir piston that pushes oil to move a work piston and rod assembly. The cylinder acts like a standard air cylinder during this movement which we refer to as the Fast Approach Stroke. With air applied to the A1 port, and the B1 port allowed to exhaust, the work rod will move until it meets resistance or extends its full stroke. For this to happen properly, the high-pressure piston and rod assembly must be held in its retracted position (B2 energized). If the high-pressure rod is allowed to advance during the approach stroke, it will block off the valve block and prevent the transfer of oil. Once that happens, the work piston/rod will not advance any farther. Ensure that the High-Pressure valve (A2-B2) is energized in the retracted position until force is needed. See Appendix A.

## Flow Controls

In order for the work rod to advance, air must be exhausted from the B1 port. A ***meter-out only*** flow control may be installed on the B1 port to control the speed of advance. However, if that flow control is closed too much, or too small for the application, it may cause the unit to stop advancing or stutter. Ensure that the only flow control on the HyperCyl is a ***meter-out only*** on the B1 port, and the flow control allows air to exhaust during extension.

## Misalignment

Sideloading of the cylinder rod will cause the unit to wear prematurely. This could also cause a binding issue that will prohibit the work rod from advancing at all. HyperCyl cylinders may overcome this by increasing air pressure, but eventually that will only worsen the issue causing a need to rebuild the cylinder. We offer misalignment couplers that are designed to alleviate slight sideload issues. If the sideload is greater than the misalignment coupler can handle, the cylinder and tool will need to be aligned in order for the cylinder to function properly.

## Valve Malfunction

Directional control valves utilized in the operation of HyperCyl units should be checked periodically. If the valves are not shifting properly there will be a loss of pressure at the cylinder, or pressure at the wrong port during the sequence. Manually verify that the control valves are shifting as expected throughout the entire sequence.

## Insufficient Air Pressure

HyperCyl cylinders require a minimum of 30 PSI to advance and retract. Depending on the orientation of the cylinder, tooling weight, guide interference, and/or work being done, this pressure may need to be higher than 30. If there is not an issue with tooling weight or misalignment, 50 PSI should advance and retract the cylinder without issue. If the cylinder is not responding, and those issues have been addressed, please contact us to discuss the issue and potential options.

# Cylinder Rod Doesn't Retract

## Flow Controls

Once the HyperCyl's work is done, air is applied to B1 and B2 to retract the cylinder. Air must also be exhausted from A1 and A2 in order for the cylinder to retract properly. If there are flow controls on the cylinder they should be removed. The only approved flow control is a ***meter-out only*** flow control on the B1 port. This can be used to control the speed of advance in order to prevent slamming or marking the part on the Fast Approach Stroke. Restricting air flow in either direction at any of the other ports could cause the unit to stop functioning properly.

## Improper Sequencing

Proper sequencing is critical to the operation of the HyperCyl cylinder. Retracting the cylinder requires air pressure at the B1 and B2 port. This can be done simultaneously or by energizing the B1 port, waiting for a half second, then energizing the B2 port. Energizing only the B1 port will not move the cylinder rod until the B2 port has been energized. Energizing only the B2 port will cause air to be introduced to the oil section of the cylinder eventually causing loss of power and the inability to fully retract. Also, energizing B2 while A2 is still energized will only retract the cylinder rod a short distance until B1 is energized. See Appendix A.

## Misalignment

Sideloading of the cylinder rod will cause the unit to wear prematurely. This could also cause a binding issue that will prohibit the work rod from retracting at all. HyperCyl cylinders may overcome this by increasing air pressure, but eventually that will only worsen the issue causing a need to rebuild the cylinder. We offer misalignment couplers that are designed to overcome slight sideload issues. If the sideload is greater than the misalignment coupler can overcome, the cylinder and tool will need to be aligned in order for the cylinder to function properly. Misalignment can also cause air to be introduced into the oil section of the cylinder. This will lead to loss of power and the inability to fully retract the work rod.

## Valve Malfunction

Directional control valves utilized in the operation of HyperCyl units should be checked periodically. If the valves are not shifting properly there will be a loss of pressure at the cylinder, or pressure at the wrong port during the sequence. Manually verify that the control valves are shifting as expected throughout the entire sequence.

### Insufficient Air Pressure

Insufficient air supply will limit the HyperCyl's ability to retract. We recommend running the approach stroke valve at line pressure, and adjusting the power stroke regulator to accommodate necessary force requirements. Retract force of the cylinders can be found in Appendix B. However, required breakaway forces must be subtracted from the input PSI to properly calculate the cylinder retract force. Please refer to the Quality Assurance certificate attached to the cylinder for specific minimum breakaway air pressures.

## Cylinder Will Not Develop Power Stroke

### Insufficient Air Pressure

One of the advantages HyperCyl offers is the ability to independently regulate the Approach Stroke and the Power Stroke force by adjusting the incoming air pressure on the valves. Incoming air pressure determines internal Hydraulic Pressure which directly relates to Output Force. The Power Stroke incoming air pressure must be less than or equal to the Fast Approach Stroke incoming air pressure. If the Power Stroke pressure is higher than the Fast Approach Stroke pressure, you will increase the likelihood of inducing air into the cylinder. Please refer to the Output Force Table in Appendix B for specific forces for your cylinder. If your cylinder series is not listed please contact us for that information.

### Induced Air in Oil Reservoir

Separation of the air and oil sections of the cylinder ensures proper performance of the cylinder. Improper sequencing, misalignment of tooling, improper air pressure, and contaminants inside the cylinder can all cause the units to lose their air/oil separation. If contaminants have been introduced, the cylinder will need to be disassembled, cleaned, resealed, and filled and vented in order to stop the induction of air. We offer seal kits for emergency scenarios where the cylinder can't be returned to us for repair. We also offer rebuild services with the option of expediting the repairs. The other scenarios can all be corrected, and once the cylinder has been filled and vented it will return to functioning properly.

### Oil Reservoir Low

HyperCyl cylinders are designed and built to last for millions of cycles without needing any maintenance. With clean air and proper sequencing there should not be a need to add oil to the cylinder. If the cylinder is not developing pressure as expected, not travelling the full stroke, or the power stroke length is reduced, you may need to fill and vent the cylinder. Fill and vent instructions are available on our website www.HyperCyl.com and in Appendix C. We offer two different types of fill units which will work on any of our cylinders. We offer an HFP-2 manual (hand pump) and HFP-1 automatic (air powered) fill units. We suggest using the manual units for 8 ton and smaller cylinders, while the automatic units are better suited for 10 ton and above cylinders.

### Insufficient Power Stroke

Stroke lengths of each cylinder can be identified by the model number. This information is on a blue sticker located on the cap of each unit. If the information is worn or illegible the serial number of the unit is stamped into the cap underneath the sticker. If you do not know your specific model number please contact us with the serial number and we can identify the model number for you.

### Control Valves not Shifting

Directional control valves utilized in the operation of HyperCyl units should be checked periodically. If the valves are not shifting properly there will be a loss of pressure at the cylinder, or pressure at the wrong port during the sequence. Manually verify that the control valves are shifting as expected throughout the entire sequence.

## Leaking Air

### External

As with any product that uses compressed air, there is the potential for leaking air. The most common cause of air leaks is leaking fittings at the cylinder ports. There is also the potential for air to leak out of the bearing the work rod goes through, the tube junctions, and the breather on the side of the work section. All of these areas can be checked by applying soapy water to the area where a leak is thought to be. If the cylinder is found to be leaking air anywhere other than the fittings, contact us to discuss your options.

### Internal

An internal air leak on a HyperCyl cylinder will cause different issues depending on where the leak is. A leak in the high-pressure section will cause the unit to not develop expected pressures. A leak in the work or reservoir sections will cause the unit to induce air into the oil section. Internal leaks are most often caused by contaminants being introduced into the cylinder. Repeatedly losing pressure and/or not fully returning home are signs of an internal air leak. If you believe you have an internal air leak, contact us to discuss your options.

## Leaking Oil

### External

If oil is noticed on or around the HyperCyl unit it will need to be thoroughly checked to identify where the leak is coming from. HyperCyl units have a vent plug on the hydraulic cap, hydraulic fittings, a breather on the work section, low-oil indicator pins (some models), and tube junctions that could be potential areas of leaking. The following sections discuss these areas and their causes and solutions.

## Oil Vent Plug (Satellite and Tandem Only)

If the cylinder is vented while under pressure it will cause the o-ring on the vent plug to extrude. Once the o-ring is damaged, this area will start leaking oil and inducing air. The vent plug will need to be replaced, and the cylinder will need to be filled and vented to correct that issue. Contact us for a replacement plug and instructions.

## Hydraulic Fittings (Satellite Only)

The hydraulic fittings and disconnects will need to be inspected periodically to verify that they are properly tightened and sealed. They can be replaced to eliminate the leak. Once a leaking fitting has been replaced, the HyperCyl cylinder will need to be filled and vented to return to proper operation. Contact us for replacement fittings and instructions for removal and installation.

## Work Section Breather

The brass breather on the side of the work section tube allows open atmosphere for the work piston to move properly. If the work piston hydraulic seal or the tube wall is damaged it will allow oil to pass and leak out of the breather. If oil is found to be leaking from here, the unit should be returned for evaluation and repair.

## Low-Oil Indicator Pin

The low-oil indicator pins on some of the HyperCyl cylinders are designed to extend out when the reservoir section has lost the extra 30% of oil. If oil is found to be leaking from here, the unit should be returned for evaluation and repair.

## Tube Junctions

While extremely rare, the areas where the tubes contact the hydraulic caps and the valve block can potentially leak oil. If oil is found to be leaking from here, the unit should be returned for evaluation and repair.

## Internal

Loss of air/oil separation will cause the HyperCyl cylinders to leak oil internally. This will be noticed by oil coming back through the valves. If oil is noticed coming out of the valves, contact us to discuss your situation. The cause of the leak will need to be addressed by resealing/repairing the cylinder. The air lines and valves will also need to be cleaned and dried to ensure residual oil does not make its way back into the air sections of the cylinder.

# Filling and Venting Often

## Improper Controls

The most common cause of needing to fill and vent HyperCyl cylinders is improper controls. After the work has been done, the Fast Approach valve (A1-B1) must be energized before or simultaneously with the High-Pressure valve (A2-B2) as shown in Appendix A. Energizing the High-Pressure valve (A2-B2) first will cause a vacuum inside the cylinder and induce air into the oil section of the cylinder. Incoming air pressure of the High-Pressure valve must be equal to or lower than the Fast Approach valve. Higher air pressure on the High-Pressure valve can cause a vacuum inside the cylinder and induce air into the oil section. Valve size and function must be the same for both the Fast Approach and High-Pressure valves. Using different size or style valves can cause induction of air into the oil section. Once the sequencing issue has been corrected the cylinder will need to be filled and vented to return to proper operation.

## Excessive Tool Weight

Retract force of the cylinders can be calculated by using the General Specs Table in Appendix B. Required breakaway forces must be subtracted from the input PSI to properly calculate the cylinder retract force. Please refer to the Quality Assurance certificate attached to the cylinder for specific minimum breakaway air pressures. If you need assistance with calculating your specific retract force please contact us.

## Tool Binding

Misalignment of guides or binding of tools will increase the potential for induction of air into the oil section of the cylinder. Proper alignment and maintenance of guides and tools will prevent this from becoming an issue. We offer misalignment couplers that are designed to overcome these issues. If the misalignment is greater than the coupler can overcome, the cylinder and tool will need to be aligned in order for the cylinder to function properly.

## Leaking Fittings

Proper air pressure to each of the ports is critical for operation of the cylinders. Leaking air fittings will reduce the expected pressure at that port. This can lead to a loss in retract force which as previously discussed will increase the likelihood of inducing air into the oil. Proper sealing and tightening or replacement of the fittings will correct this issue. If air has been induced into the oil, filling and venting of the cylinder will return it to proper operation once the leaking fitting has been fixed.

## Oil Vent Plug (Satellite and Tandem Only)

If the cylinder is vented while under pressure it will cause the o-ring on the vent plug to extrude. Once the o-ring is damaged, this area will start leaking oil and inducing air. The vent plug will need to be replaced, and the cylinder will need to be filled and vented to correct that issue. Contact us for a replacement plug and instructions.

## Notes

## Appendix A

**CONTROL SEQUENCE TO BE FOLLOWED IN ORDER 1 THROUGH 5**

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| Step Number | Description of Operation | "A1" Port Condition | "B1" Port Condition | "A2" Port Condition | "B2" Port Condition |
|---|---|---|---|---|---|
| 1. | Home (Retracted) | Exhausted | Pressurized | Exhausted | Pressurized |
| 2. (Cycle Start) | Fast Approach Extend | Pressurized | Exhausted | Exhausted | Pressurized |
| 3. | High Pressure Extend | Pressurized | Exhausted | Pressurized | Exhausted |
| 4. (Cycle End) | Fast Approach Retract | Exhausted | Pressurized | Pressurized | Exhausted |
| 5. | High Pressure Retract | Exhausted | Pressurized | Exhausted | Pressurized |
| | (Cylinder now at Step 1) | | | | |

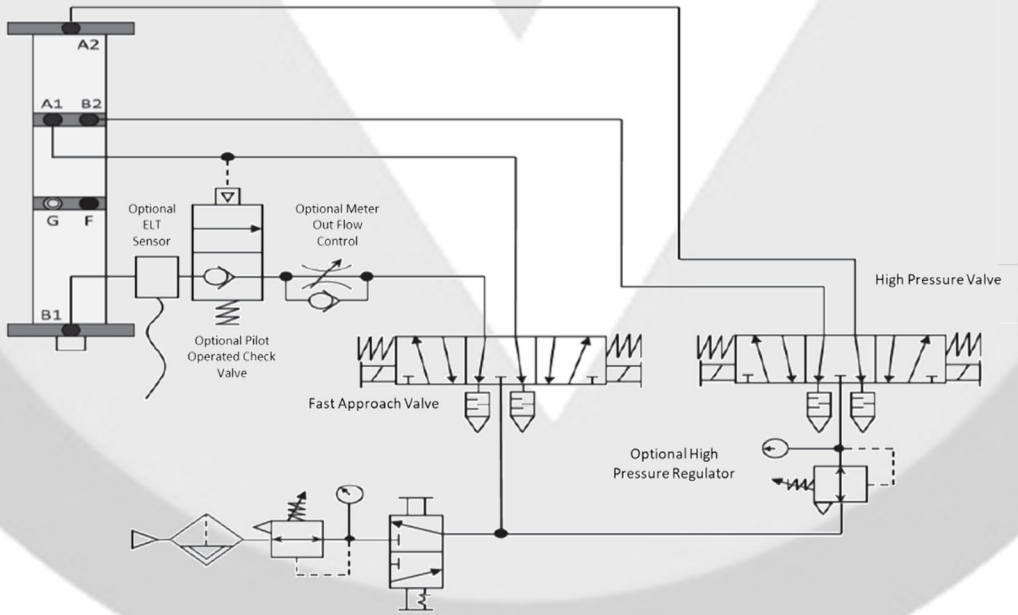
**In Cycle** (Steps 2 through 5)

The mid-position of the valves is used only for an E-Stop condition (cycle interrupted), or shutdown. Normally, the valve is shifted to one side or the other, and not in the mid-position.

**Not in Cycle** (Step 1)

When not in cycle, and the E-stop is cleared, B1 and B2 must return to their pressurized condition prior to the start of the cycle. For example, the operator breaches the light curtain to load, unload, or change a part. The machine is not in cycle. The valves shift to their mid-position. When the operator is clear of the light curtain, the valves must be shifted to the position in which B2 and B2 are pressurized before the start of the next cycle.

A TYPICAL 3-POSITION, EXHAUST-CENTERED SCHEMATIC:

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# Appendix B

## General Specs Table

| Size/Tonnage | Working Ratio (Force per PSI) | Service Ratio (Hydraulic per PSI) | *Approach Force per PSI (Lbs.) | *Retract Force per PSI (Lbs.) | (1) Volume / CFM (complete cycle) | Min Force Lbs. (@ 30 PSI) | Max Force Lbs. (@ 100 PSI) |
|---|---|---|---|---|---|---|---|
| 1 | 22.34 : 1 | 7.11 : 1 | 3.14 | 2.35 | 47.848 / 0.0277 | 670 | 2,234 |
| 2 | 54.54 : 1 | 11.11 : 1 | 4.90 | 4.11 | 96.024 / 0.0556 | 1,636 | 5,454 |
| 4 | 87.62 : 1 | 10.56 : 1 | 8.29 | 6.81 | 164.107 / 0.0949 | 2,628 | 8,762 |
| 8 | 158.86 : 1 | 12.64 : 1 | 12.56 | 10.81 | 285.234 / 0.165 | 4,765 | 15,886 |
| 10 | 259.63 : 1 | 13.22 : 1 | 19.63 | 16.49 | 460.482 / 0.2665 | 7,788 | 25,963 |
| 15 | 314.16 : 1 | 16.00 : 1 | 19.63 | 16.49 | 513.076 / 0.2969 | 9,424 | 31,416 |
| 20 | 387.85 : 1 | 19.75 : 1 | 19.63 | 16.49 | 578.941 / 0.335 | 11,636 | 38,785 |
| 30 | 651.44 : 1 | 23.04 : 1 | 28.27 | 23.37 | 942.495 / 0.5454 | 19,543 | 65,144 |
| 40 | 804.24 : 1 | 28.44 : 1 | 28.27 | 23.37 | 1084.44 / 0.6276 | 24,172 | 80,424 |
| 50 | 1050.44 : 1 | 20.90 : 1 | 50.26 | 43.20 | 1598.35 / 0.9249 | 31,503 | 105,044 |
| 60 | 1218.27 : 1 | 24.24 : 1 | 50.26 | 43.20 | 1781.49 / 1.0308 | 36,548 | 121,827 |
| 75 | 1551.41 : 1 | 19.75 : 1 | 78.54 | 65.97 | 2406.38 / 1.3926 | 46,542 | 155,141 |
| 100 | 1963.5 : 1 | 25.00 : 1 | 78.54 | 65.97 | 2840.95 / 1.6439 | 58,905 | 196,350 |
| 200 | 4071.51 : 1 | 36.00 : 1 | 113.10 | 93.46 | 5398.84 / 3.124 | 122,145 | 407,151 |

**NOTE:**
(1) Air consumption values for 4.00" Total and 0.50" Power stroke. Multiply CFM by cycles per minute for total CFM usage.
* Approach and Retract forces shown are theoretical, typical breakaway PSI is 20-25.

## Output Force Table

| Air Pressure (PSI) | 1 Ton Hyd PSI/Force lb. | 2 Ton Hyd PSI/Force lb. | 4 Ton Hyd PSI/Force lb. | 8 Ton Hyd PSI/Force lb. | 10 Ton Hyd PSI/Force lb. | 15 Ton Hyd PSI/Force lb. | 20 Ton Hyd PSI/Force lb. | 30 Ton Hyd PSI/Force lb. | 50 Ton Hyd PSI/Force lb. | 75 Ton Hyd PSI/Force lb. | 100 Ton Hyd PSI/Force lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 210/670 | 330/1636 | 316/2626 | 379/4766 | 396/7785 | 480/9422 | 591/11601 | 651/19540 | 630/31663 | 592/46542 | 750/58905 |
| 40 | 280/893 | 440/2181 | 422/3501 | 506/6355 | 528/10380 | 644/12641 | 788/15468 | 921/26053 | 840/42218 | 790/62056 | 1000/78540 |
| 50 | 350/1117 | 550/2727 | 528/4377 | 632/7943 | 661/12975 | 805/15802 | 985/19335 | 1152/32567 | 1050/52773 | 987/77570 | 1250/98175 |
| 60 | 420/1340 | 660/3272 | 633/5252 | 758/9532 | 793/15570 | 966/18962 | 1182/23202 | 1382/39080 | 1260/63327 | 1185/93084 | 1500/117810 |
| 70 | 490/1563 | 770/3817 | 739/6127 | 885/11120 | 925/18165 | 1127/22123 | 1379/27069 | 1612/45593 | 1470/73882 | 1382/108598 | 1750/137445 |
| 80 | 560/1787 | 880/4363 | 844/7003 | 1011/12709 | 1057/20760 | 1288/25283 | 1576/30936 | 1843/52107 | 1680/84436 | 1580/124112 | 2000/157080 |
| 90 | 630/2010 | 990/4908 | 950/7878 | 1137/14298 | 1189/23355 | 1449/28443 | 1773/34803 | 2073/58620 | 1890/94991 | 1777/139626 | 2250/176715 |
| 100 | 700/2234 | 1100/5454 | 1056/8754 | 1264/15886 | 1322/25950 | 1600/31408 | 1970/38671 | 2304/65134 | 2100/105546 | 1975/155140 | 2500/196350 |

*Typical cylinder break-away pressure is 35 PSI.
(1) Complete cylinder cycle @ 60 PSI.
Multiply value by cycles per minute for total SCFM usage.

**NOTE: The above specifications are theoretical forces. Frictional loads and lack of proper air supply may affect cylinder performance. Please multiply application force requirements by 1.25-1.50 to ensure adequate force is available.**

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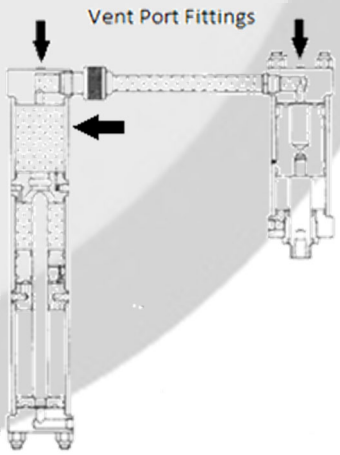
Appendix C

# HPS/HPX SERIES FILL AND VENT PROCEDURE – HFP-2

***If safety standards require tooling to be blocked do so before starting this procedure.***

1. Fill the HFP-2 fill unit with ISO 32 oil or equivalent.
2. Retract the cylinder rod (energize B1).
3. Remove the black rubber dust cover from the cylinder fill coupling.
4. Depress the inner ring on the fill unit coupling to allow oil to flow. With fill line coupling pointing into a container, repeatedly depress the fill unit handle until all air has been vented from the fill unit tubing. Close coupling.
5. Connect fill unit to fill coupling on cylinder.
6. Repeatedly depress the fill unit handle until the handle becomes difficult to depress. Do not allow the fill unit can to get completely empty. Refill as necessary.
7. While continuing to pump fill unit, slowly loosen the vent port fitting on the cap of whichever unit is lower. **DO NOT REMOVE PLUG.** Once all air has been vented from the vent port fitting (free from bubbles) tighten vent port fitting. Repeat process on whichever unit is higher, working the hydraulic hose to ensure all air is allowed to travel to the highest vent port.
8. Disconnect the fill unit from the cylinder.


*Note: Air pressure must be applied to port "B2" to extend or retract cylinder rod. Always remember that air will travel to the highest point in any system. Any coil in the hydraulic hose will trap air. This venting procedure will not remove air trapped in a coil of the hydraulic hose.*

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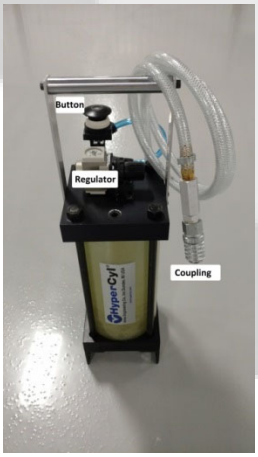
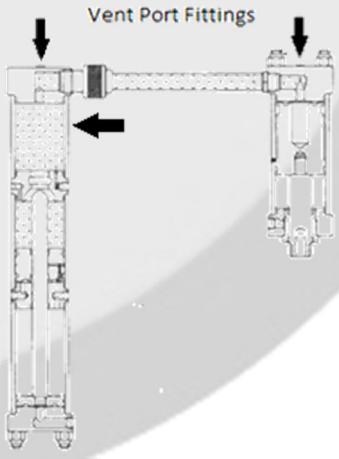
# HPS/HPX SERIES FILL AND VENT PROCEDURE – HFP-1

***<u>If safety standards require tooling to be blocked do so before starting this procedure</u>***

1. Fill the HFP-1 fill unit with ISO 32 oil or equivalent.
2. Attach air line to HFP-1, set regulator to 40 psi.
3. Retract the cylinder rod (energize B1).
4. Remove the black rubber dust cover from the cylinder fill coupling.
5. Depress the inner ring on the fill unit coupling to allow oil to flow. With coupling pointing into a container, depress the fill unit button and hold depressed until step 8. Once all air has been vented from the fill unit tubing, close coupling.
6. Connect fill unit to fill coupling on cylinder. Do not allow the fill unit can to get completely empty. Refill as necessary.
7. Once oil has stopped flowing from the fill unit, slowly loosen the vent port fitting on the cap of whichever unit is lower. **DO NOT REMOVE PLUG.** Once all air has been vented from the vent port fitting (free from bubbles) tighten vent port fitting. Repeat process on whichever unit is higher, working the hydraulic hose to ensure all air is allowed to travel to the highest vent port.
8. Release the fill unit button and allow air pressure to equalize.
9. Disconnect the fill unit from the cylinder.




*Note: Air must be applied to port "B2" to extend or retract cylinder rod. Always remember that air will travel to the highest point in any system. Any coil in the hydraulic hose will trap air. This fill and vent procedure will not remove air trapped in a coil of the hydraulic hose.*

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# HPI SERIES FILL AND VENT PROCEDURE – HFP-2

***If safety standards require tooling to be blocked do so before starting this procedure.***

1. Fill the HFP-2 fill unit with ISO 32 oil or equivalent.
2. Remove the black rubber dust cover from the cylinder fill coupling.
3. Retract the cylinder rod (energize B1).
4. Remove the fill line and coupling from the HFP-2 fill unit.
5. Depress and hold the manual override on the fast approach directional control valve (energize A1 port).
6. Place the open end of the fill line into a container of suitable size. Connect the fill coupling to the cylinder to purge oil and air from the cylinder.
7. Once oil and air stop flowing disconnect the fill line from the cylinder.
8. Depress and hold the manual override on the fast approach directional control valve (energize B1 port).
9. Connect the fill line to the HFP-2 unit.
10. Depress the inner ring on the fill unit coupling to allow oil to flow. With fill line coupling pointing into a container, repeatedly depress the fill unit handle until all air has been vented from the fill unit tubing. Close coupling.
11. Connect fill unit to fill coupling on cylinder.
12. Repeatedly depress the fill unit handle until the handle becomes difficult to depress indicating the unit is full. Do not allow the fill unit can to get completely empty. Refill as necessary.
13. Disconnect the fill unit from the cylinder.
14. Repeat steps 4 thru 13 until no air is noticed when purging the cylinder.


Note: Air pressure must be applied to port “B2” to extend or retract cylinder rod. Always remember that air will travel to the highest point in any system. The unit must be vertical with the rod facing down during this procedure.

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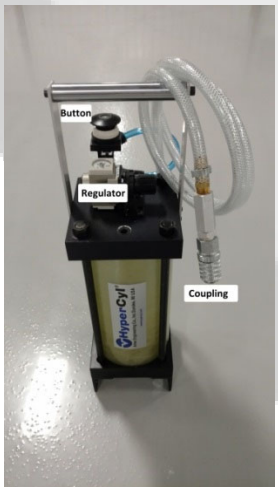
# HPI SERIES FILL AND VENT PROCEDURE – HFP-1

***If safety standards require tooling to be blocked do so before starting this procedure.***

1. Fill the HFP-1 fill unit with ISO 32 oil or equivalent, leaving enough room to drain the cylinder.
2. Attach airline to HFP-1, set regulator to 40 psi.
3. Remove the black rubber dust cover from the cylinder fill coupling.
4. Depress and hold the manual override on the fast approach directional control valve (energize A1 port).
5. Connect the fill coupling to the cylinder and allow oil and air to vent from cylinder. Do not allow fill can to overflow.
6. Once oil and air stop flowing disconnect the fill line from the cylinder.
7. Depress and hold the manual override on the fast approach directional control valve (energize B1 port).
8. Depress the inner ring on the fill unit coupling to allow oil to flow. With the coupling pointing into a clean empty container, depress the fill unit button and hold depressed until step 11. Once all air has been vented from the fill unit tubing, pull back coupling to close.
9. Connect fill unit coupler to fill coupling on cylinder. Do not allow the fill unit can to get completely empty. Refill as necessary.
10. Once oil has stopped flowing from the fill unit release button and allow air pressure to equalize.
11. Disconnect the fill unit from the cylinder.
12. Repeat steps 4 thru 11 until no air is noticed in fill unit tubing during venting or as air pressure is equalizing.




Note: Air pressure must be applied to port “B2” to extend or retract cylinder rod. Always remember that air will travel to the highest point in any system. The unit must be vertical with the rod facing down during this procedure.

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