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7 HEAVY DUTY PLUS PUMP MODULE

7.1 Description (Figure 7.1)

The Heavy Duty Plus Pump Module (HD+), hereafter referred to as Pump Module, is comprised of a ceramic piston and cylinder set, pump case, piston entry cap, end cap, seals, and O-ring. Certain components of the Pump Module, the ceramic piston and cylinder set, end cap seal, and O-ring, are in the direct liquid path. The Pump Module has been designed to be easily disassembled and detached from the Motor/Base Module for ease of cleaning, decontamination, and sterilization.

The Pump Module's piston/cylinder set provides positive liquid displacement. Table 7.2 describes the total volumetric output of this pump.

NOTE

Never remove a safety cover while the motor is running. Moving parts are located under these covers. Physical harm to individuals is possible.

Figure 7.1 HD+ Pump Module

7.2 Operation

When the Pump Module is mounted on the Motor/Base Module, the piston is driven by a spherical bearing mounted within a rotating spindle. This drive arrangement imparts both reciprocating and rotary motion to the piston. The magnitude of the piston's stroke is adjusted by varying the angle of the axis of the pump head relative to the axis of the motor shaft. This displacement range is infinitely adjustable within the pump specifications (refer to Table 7.2). The angular displacement value is read directly from the Motor/Base Module's vernier scale. Repeatability of 0.1% is obtainable once the stroke length is established.

On each rotation of the piston, the ports are opened alternately and exclusively, first to the inlet and then to the outlet. During the rotation, the limited piston flat creates the void that allows the flow from only one port at a time, positively displacing the liquid. The piston flat acts as a rotary valve, completing one pressure stroke and one suction stroke per revolution as the pump rotates and reciprocates synchronously.

The end of the piston is never drawn back beyond the inlet and outlet ports in normal operation. The piston flat allows only one port to communicate with the interior chamber of the pump cylinder at any one time. The effect is positive mechanical valving, eliminating the need for check valves under normal operations.

The pump, which cannot be driven by either inlet or outlet pressure, acts as a closed valve when the unit is not in operation.

Pump speed will depend on the particular application, material being pumped as well as tubing, fitting, and nozzle choices. For best results the Pump Module should operate below 600rpm.

7.2.1 Piston/Cylinder Set

The piston/cylinder set is constructed of high-density alumina ceramic. The ceramics are compatible with most acids and bases. The precision piston/cylinder set has a radial clearance between the piston and cylinder wall of approximately 3.2 micron (.00013") which minimizes fluid slip.

The ceramic piston operates within the ceramic cylinder with no lubrication other than the liquid being dispensed or metered. The natural crystalline structure of the ceramics displays zero porosity, ensuring zero retention and carryover of one liquid to the next.

The combination of the ceramic material's mechanical and thermal stability allows it to be machined and operated with a close running clearance. This means that no compliant dynamic seals are needed, eliminating parts requiring frequent replacement in other pump designs.

7.2.2 Case

The stainless steel case design provides ease of disassembly for cleaning and maintenance. The ceramics, end cap seals, and O-rings, are all serviceable parts. The ceramics are easily accessed by removing the Pump Module from the Motor/Base, the fittings, and the piston entry cap.

7.2.3 Installation

Installing the Pump Module into the Motor/Base Module involves the following: (refer to Figure 7.2). Refer to Section 7.4.5.1 for removal procedure.

CAUTION

Make sure the power is OFF and all hazardous liquids have been flushed from the system prior to performing any disassembly or assembly procedures.

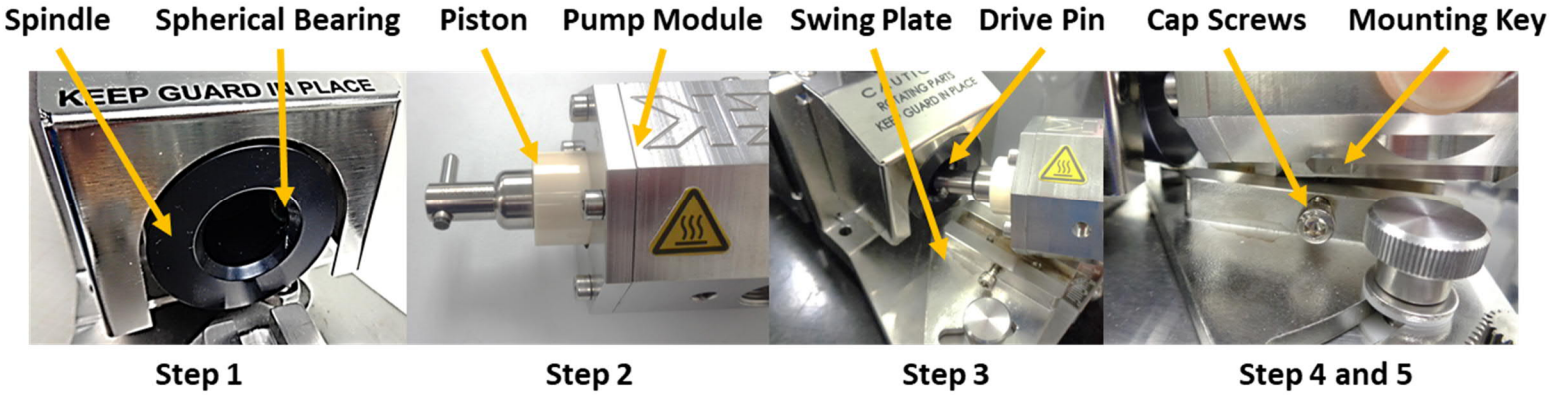

Figure 7.2 Pump Module Installation

Lubricate the drive pin with IVEK spindle bearing lubricant (IVEK part number 052046) prior to assembly. Failure to lubricate the drive pin may result in damage to the Pump Module and Motor/Base Module.

1. Rotate the spindle on the Motor/Base Module so the spherical bearing is at the 3 O'clock position.
2. Extend the piston, which is housed in the Pump Module, approximately 1/2 of the way out of the cylinder.
3. Slide the drive pin, which is pressed into the piston end cap, into the center bore of the spherical bearing.
4. Position the Pump Module on the swing plate with the locating pin of the swing plate inserted into the slot of the Pump Module mounting key.
5. Secure the Pump Module to the swing plate by tightening the two #10 socket head cap screws on the swing plate using a 5/32" hex key.

NOTE

Figure 7.3 shows the orientation of the Pump Module on both the Single Ended and Double Ended Motor/Base Modules.

7.3 Options

IVEK Corporation offers a variety of options to best meet the customers' needs. Following is a list and description of available options for the Pump Module. Refer to the Title Section of this manual for the list of options provided with this system.

7.3.1 Special Piston/Cylinder Bore Clearances or Modifications

For certain applications, special clearances or machined modifications are required for the piston/cylinder. IVEK Corporation determines these clearances by performing application specific testing. Contact IVEK Corporation for more information.

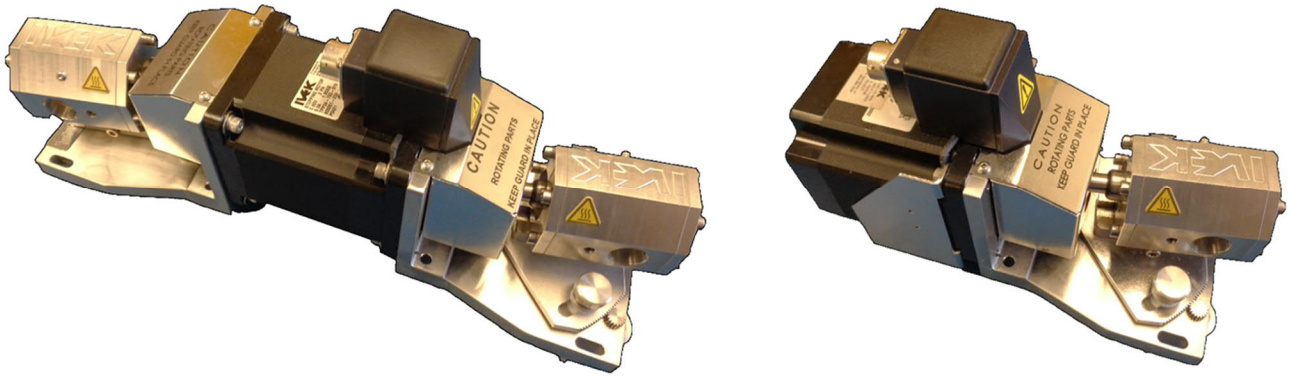

Figure 7.3 Pump Module Orientation

7.3.2 Rinse Gland

An annular groove can be added to the cylinder in which liquids can flow to rinse the rear portion of the piston. This can prevent metered liquids from reaching the rear of the pump, and also reduce the chance of the piston binding in the cylinder.

7.3.3 Cartridge Heater Ports/Cartridge Heaters

Optional cartridge heater ports and cartridge heaters are available. The 1/4" diameter ports are located in the pump case 180º apart. Cartridge heaters can be mounted in the cartridge heater ports. A temperature controller and thermocouple may also be provided. If a controller is provided, instructions for the controller are provided in Chapter 11. IVEK Corporation will assist the user in determining the optimum heater specification. Pump head heating is used to maintain liquid temperature. Heating is not used to increase liquid temperature.

7.3.4 Fittings

Fittings are available for the Pump Module. Barbed pump adapter fitting assemblies are recommended, IVEK part number 142608. Chapter 9 lists the IVEK part numbers for the available fittings and associated seals and sleeves when required. Not all fittings shown are applicable to the Pump Module.

7.4 Maintenance

CAUTION

Never connect or disconnect the cable from the Controller or Motor/Base Module connector while power is on. Damage to the equipment may result.

7.4.1 Preventative Maintenance

The ceramic components for the Pump Module have been designed to last for millions of repetitions without wear.

Preventative maintenance should include careful handling of the piston and cylinder when they have been removed from the Pump Module. Always take great care when removing the piston from the cylinder and replacing the piston into the cylinder. Never clean ceramic parts in such a way that they can contact each other. This could cause chipping.

The piston and cylinder are a matched set and should always be kept together. Each piston and cylinder are identified with a number which match the parts as a set.

The piston drive pin and Motor/Base spindle bearing will need to be re-lubricated, with IVEK part number 052046, every few million cycles depending on cycle speeds and material being pumped. Degradation or discoloration of lubricant indicate when cleaning and reapplication is required. Failure to adequately maintain lubrication of the drive pin may result in damage to the Pump Module and Motor/Base Module.

CAUTION

Ceramic piston/cylinder sets are particularly sensitive to neglect and may “freeze” if allowed to dry out without adequate cleaning.

7.4.1.1 General Applications; Routine Cleaning Procedure

1. Disconnect inlet tubing from process liquid supply container.
2. Cycle pump in continuous mode until remaining process liquid has been purged from the Pump Module liquid path.
3. Connect the inlet tubing to an appropriate cleaning solution supply container.
4. Cycle pump in continuous mode at a high volume and rate to flush the cleaning solution through the entire liquid path.

NOTE

Routine flushing with a compatible solution after shutdown may provide sufficient cleaning for many applications.

7.4.2 Storage Options

Storage refers to any extended time that the system remains idle. The main concern is liquid drying in the piston/cylinder area, causing the piston to freeze in the cylinder. The duration of idle time requiring storage procedures is based on the liquid being pumped, the Pump Module configuration, and the operating environment. The system can either remain wetted with cleaning liquid, disassembled, or a liquid loop can be created.

7.4.2.1 Wetting With Cleaning Liquid

This option involves leaving the liquid circuit and Pump Module assembled in place. Load the liquid circuit with a compatible cleaning liquid and leave the system wet until the next use when the stored liquid can be purged during setup for operations.

7.4.2.2 Disassembling

If it is desired not to leave cleaning liquid in the system, after rinsing with cleaning liquid as described in Section 7.4.1.1, empty the system of cleaning liquid.

Disassemble the liquid circuit and Pump Module, remove the piston from the cylinder and store the component parts disassembled until the pump is again required. The instructions for disassembling the Pump Module are found in Section 7.4.5 of this chapter.

NOTE

If applicable, the disassembled liquid circuit and Pump Module components may be immersed and soaked or further cleaned in an ultrasonic cleaning device using a compatible cleaning solution.

7.4.2.3 Liquid Loop

Fill a loop of flexible tubing with a compatible cleaning liquid or other chemical that will thin or neutralize the last liquid pumped. Connect one end of the tube to the pump inlet port and the other to the outlet port. Cycle the pump a few times in any operational mode to ensure the piston and cylinder are wetted by the cleaning liquid. With this loop positioned above the pump head, the ceramic surfaces and seal areas will stay moist and mobile for extended idle periods.

7.4.3 Extended Storage

If a pump is to be stored assembled for an extended period of time, it is recommended that after cleaning, the piston and cylinder be dried before reassembly or stored separately in protective packaging. Wet components will have a tendency to bind after materials have evaporated, leaving residue.

7.4.4 End Cap and Seal Assembly

The end cap seal and O-ring at the front of the Pump Module serve to contain liquid within the pump.

When properly maintained in a clean condition, the original seal and O-ring may be expected to last for extended periods. If removed for any reason, the seal and O-ring should be carefully cleansed of all foreign particles prior to reassembly. The seal seating area must also be free of particles and scratches to prevent leaks when reassembled.

7.4.5 Assembly/Disassembly Procedures (Refer to Figure 7.5)

The Pump Module contains the following replaceable parts.

- End Cap, End Cap Seal and O-Ring (2, 4, 5)
- Piston Entry Cap and Seal Spacer (7, 6)
- Piston and Cylinder Set (3)

CAUTION

Make sure the power is off and all hazardous liquids have been flushed from the system prior to performing any disassembly or assembly procedures.

7.4.5.1 Pump Module Removal (Figure 7.4)

Removing the Pump Module from the Motor/Base Module involves the following. Refer to Section 7.2.3 for the installation procedure.

1. Rotate the spindle on the Motor/Base Module so the spherical bearing is at the 3 O'clock position.
2. Loosen the two #10 socket head cap screws securing the Pump Module to the swing plate using a 5/32" hex key.
3. Lift the Pump Module and pull up and away from the swing plate until the piston fabrication is approximately 1/2 of the way out of the cylinder.
4. Move the Pump Module laterally until the pin in the piston fabrication slides out of the spherical bearing.

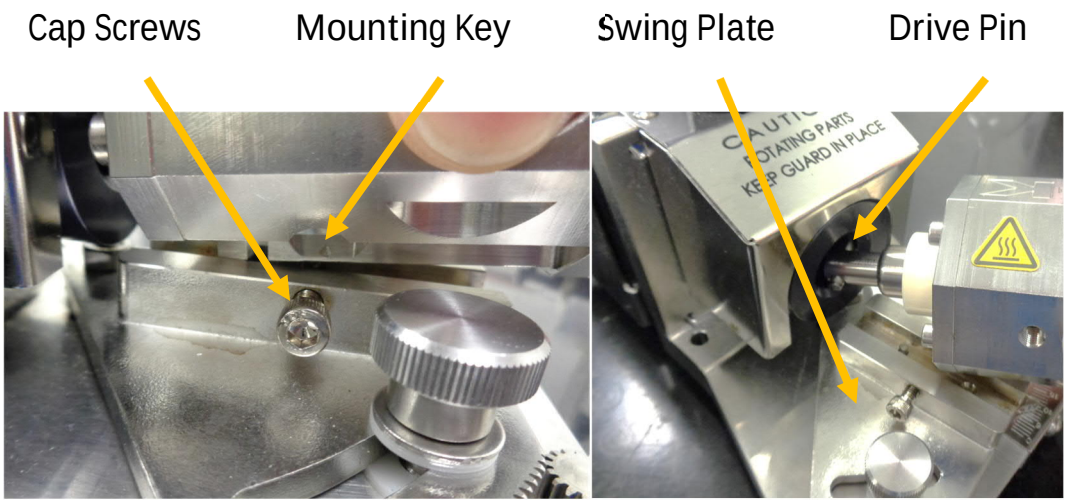

Figure 7.4 Pump Module Removal

7.4.5.2 Piston Entry Cap and Seal Spacer (Figure 7.5 Items 7, 6)

Disassembly

1. Remove the piston fabrication by carefully pulling it out of the pump module.
2. Remove four M4 socket head cap screws (8) using a 3mm hex key. Remove piston entry cap (7) and seal spacer (6).

Assembly

1. Position seal spacer (6) against end of ceramic cylinder and cover with the piston entry cap (7), tighten four M4 socket head cap screws (8).

2. Carefully install the piston fabrication.

7.4.5.3 End Cap, End Cap Seal and O-Ring (Figure 7.5 Items 2, 4, 5)

Disassembly

1. Remove five M4 socket head cap screws (8) using a 3mm hex key. Remove end cap, end cap seal, and O-ring (2, 4, 5) from pump case (1).

Assembly

1. Position O-ring (5) in end cap seal (4) and position in end cap (2) as shown in Figure 7.5.
2. Position end cap (2) on pump case (1) and tighten five M4 socket head cap screws (8).

NOTE

If installing the same end cap seal and/or O-ring, make sure it is clean and free of defects before installing. Assure that the fluid ports of the ceramic cylinder are aligned in the center of the case fitting ports before tightening endcap screws.

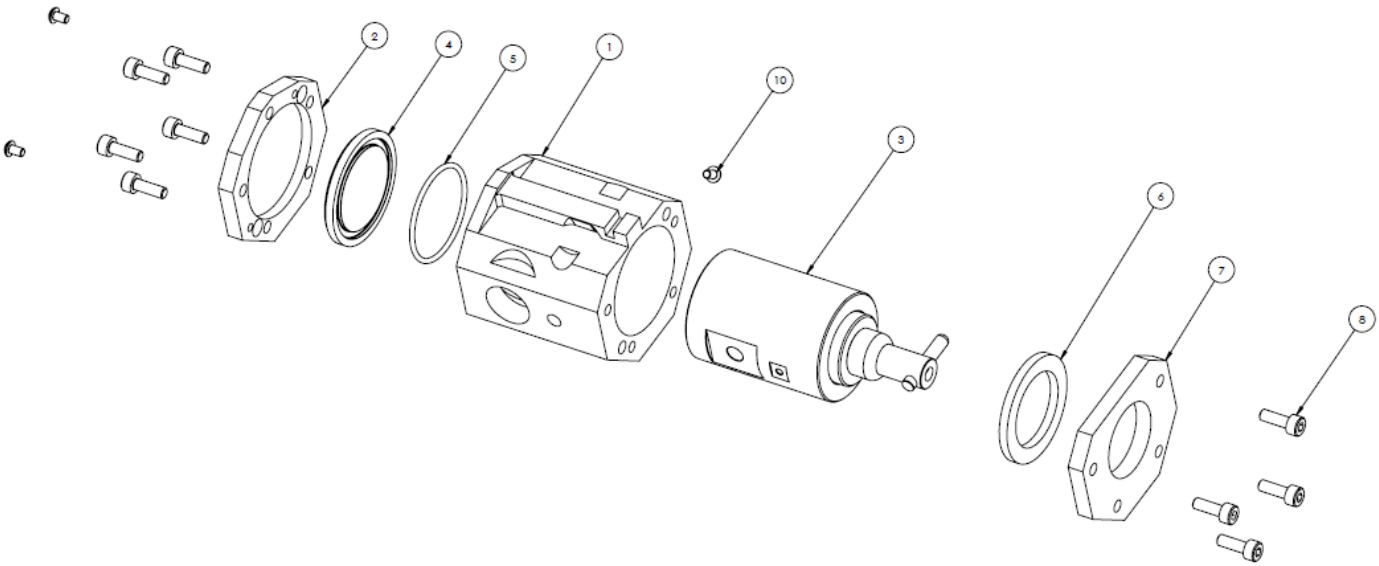

Figure 7.5 HD+ Pump Module Exploded View

7.4.5.4 Piston and Cylinder Set (Figure 7.5 Item 3)

Disassembly

1. Remove the Pump Module from the Motor/Base Module as described in Section 7.4.5.1.
2. Remove the fitting sets from pump case (1).
3. Remove the piston fabrication by carefully pulling it out of the pump module.
4. Remove four M4 socket head cap screws (8) using a 3mm hex key. Remove piston entry cap (7) and seal spacer (6).
5. Remove the cylinder by carefully pulling it out of the pump case (1).

Assembly

1. Install the cylinder by inserting it into the pump case so that the cylinder end near the metering ports rests against the O-ring (5).
2. Align the ceramic fluid ports with the 3/4-20 threaded case fitting ports.
3. Position seal spacer (6) against end of ceramic cylinder and cover with piston entry cap (7), tighten four M4 socket head cap screws (8).
4. Carefully install the piston fabrication.
5. Install fitting sets into pump case (1) and tighten jam nuts if applicable.
6. Install the Pump Module on the swing plate as described in Section 7.2.3.

7.4.5.5 Fitting Sets

Assembly

1. If using barbed pump adapter fitting assemblies, IVEK part number 142608, tighten fittings to 1.4 N-M (12 in-lbs.), and then tighten jam nut.
2. If using fittings with castellated threaded sleeves, IVEK part number 142084, tighten to 1.4 N-M (12 in-lbs.) using IVEK spanner wrench 052308. Castellated sleeves are not recommended with larger tube sizes because they tend to loosen and leak.

7.5 Problem Guide

7.5.1 Piston Frozen in The Cylinder

If the piston gets frozen in the cylinder perform the following steps.

CAUTION

DO NOT TRY TO FORCE THE PISTON FREE! Damage to the piston/cylinder set may occur.

1. Carefully remove the Pump Module from the Motor/Base Module. Remove the piston and cylinder from the case then soak in a compatible solvent.
2. If the Pump Module is not conveniently removable, the liquid loop described in Section 7.4.2.3 of this chapter may permit solvent to dissolve the “frozen” residue in reasonable time.
3. If the aforementioned procedures fail, contact IVEK for technical help. It may be necessary to ship the Pump Module back to the factory. Provide a note describing, in detail, what conditions caused the seizure and what liquids are being pumped.

It may also be necessary to return the Controller and Motor/Base Modules along with the Pump Module should readjustment of the pump drive components be required to free the pump.

Table 7.1 contains a list of possible problems, causes and solutions for the Pump Module.

7.6 Specifications

Table 7.1 Common Operational Problems and Solutions

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Power is on, Controller Module accepts trigger, motor spindle rotates, but Pump Module does not move any fluid.	Loose fittings or seals	Check port seals and end cap seal.
	Broken piston or loose piston cap	Remove and inspect piston/cylinder set.
Fluid is leaking from front of pump.	Leaking seals	Inspect for defects or contamination, replace and clean if necessary.
Fluid is leaking from back of pump.	Loose/damaged fitting	Inspect and tighten fitting.
	Cylinder flat not square to fitting	Partially disassemble and rotate cylinder in case to better align fitting.
Piston does not rotate or rotates slowly.	Piston seized	Clean by soaking.
	Port fittings are too tight	Loosen port fitting and recheck piston.
If none of the above solves the problem, contact IVEK technical support for assistance.		

7.6.1 Volume

The volume represents the liquid displaced for a single revolution of the motor. If this system is used for dispensing, the controller's "dispense volume" setting will determine the total number of revolutions or strokes for each dispense cycle. The dispense cycle total volume should be verified experimentally. Table 7.2 list the recommended minimum and maximum displacement per stroke for the Pump Module.

Table 7.2 Pump Module Displacement Specifications

Size	Max Displacement Per Stroke	Recommended Min Displacement Per Stroke
5mL	5.0mL	0.25mL

7.7 Model Number

The model number provides important information about the specifics of your Pump Module. Refer to this number when contacting IVEK Technical support. The model number for your Pump Module is located in the Title Page section of this manual.

092342 - ## # # # # #

Displacement
- **05** – 5.0mL

Port Size
- **0**- 6.35 (.250")

Piston / Cylinder Material
- **0** – 99.5% Alumina / 99.5% Alumina

Gland
- **0-** Without Gland
- **1-** With Gland

Heater Ports and Case Material
- **0-** Without Heater Ports, 316 Stainless Steel
- **1-** With Heater Ports, 316 Stainless Steel

O-ring Material
- **1** - Buna-N
- **2** - EPDM Ethylene Propylene
- **3** - FFKM Perfluoroelastomer (Black)
- **4** - Polyurethane
- **5** - Silicone
- **8** - FKM Fluorocarbon (Black)

An example of a Pump Module model number would be **092342-0500008**. This would be a HD+ Pump Module with 5mL displacement, 6.35mm fluid ports, 99.5% Alumina Piston and Cylinder, without gland, without heater ports, and with a FKM O-ring seal.

7.8 Illustrated Parts Breakdown

The illustrated parts breakdown (Table 7.3) contains the information required for identifying and ordering parts for the Pump Module. See Figure 7.5 for exploded view and drawing index numbers.

Table 7.3 Illustrated Parts Breakdown

Module Tab #	Dwg Index #	Part Number	Description	QTY
092342 - #######			**PUMP MODULE, HEAVY DUTY PLUS, STYLE A**	
	4	092345-01	SEAL, END CAP, WITH O-RING GROOVE, HEAVY DUTY PLUS, STYLE A; PTFE	1
	8	182009-0412	SCREW, SOCKET HEAD CAP, 18-8, METRIC; M4 X 12	9
092342 - ########			**DISPLACEMENT**	
05	6	092348-0501	SPACER, SEAL ALTERNATIVE, HEAVY DUTY PLUS, STYLE A; 5.0ML, VIRGIN PTFE	1
05	7	092347-0501	CAP, PISTON ENTRY, HEAVY DUTY PLUS, STYLE A; 5.0ML, 316 STAINLESS STEEL	1
092342 - #######			**DISPLACEMENT, PORTS, PISTON/CYLINDER SET, GLAND**	
05000	3	022481-050001	PISTON/CYLINDER SET, HEAVY DUTY PLUS, STYLE A; 5.0ML, 1/4" PORTS, 99.5% ALUMINA, ROTARY, WITHOUT GLAND	1
05001	3	022481-050101	PISTON/CYLINDER SET, HEAVY DUTY PLUS, STYLE A; 5.0ML, 1/4" PORTS, 99.5% ALUMINA, ROTARY, WITH GLAND	1
092342 - #######			**HEATER PORTS AND CASE MATERIAL**	
0	1	092346-01	PUMP CASE, HEAVY DUTY PLUS, STYLE A; WITHOUT HEATER PORTS, 316 STAINLESS STEEL	1
0	2	092344-01	END CAP, HEAVY DUTY PLUS, STYLE A; WITHOUT HEATER PORTS, 316 STAINLESS STEEL	1
1	1	092346-02	PUMP CASE, HEAVY DUTY PLUS, STYLE A; WITH HEATER PORTS, 316 STAINLESS STEEL	1
1	2	092344-02	END CAP, HEAVY DUTY PLUS, STYLE A; WITH HEATER PORTS, 316 STAINLESS STEEL	1
1	10	182014-0305	SCREW, BUTTON HD SOC CAP, 18-8, METRIC; M3 X 5	3
092342 - #######			**O-RING MATERIAL**	
1	5	142294-02701	O-RING, AS568; -027, BUNA-N	1
2	5	142294-02702	O-RING, AS568; -027, EPDM	1
3	5	142294-02703	O-RING, AS568; -027, FFKM	1
4	5	142294-02704	O-RING, AS568; -027, POLYURETHANE	1
5	5	142294-02705	O-RING, AS568; -027, SILICONE	1
8	5	142294-02708	O-RING, AS568; -027, FKM	1

01/20/2023	INITIAL RELEASE