Industrial Maintenance

Metering Pump

Courseware Sample

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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
⎓	Direct current
∿	Alternating current
⎓ ∿	Both direct and alternating current
3∿	Three-phase alternating current

Safety and Common Symbols

Symbol	Description
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

Table of Contents

To the Instructor

NCCER Accreditation

Contact the National Center for Construction Education and Research (NCCER), at *www.nccer.org*, to obtain the requirements relative to the NCCER accreditation of this course.

Care and Maintenance of the Pumps Training System

Every week

- Check the general condition of the Pumps Training System.
- Check the condition of the snap-grip clamps on the hoses.
- Make sure the expanding work surface is solidly fixed on the bench. Check the condition of the four (4) push-lock fasteners.

Once a month

- Check the operation of the ground fault circuit interrupter (GFCI).
- Make sure that an O-ring is present and in good condition in each hose coupling.

Every 6 months

- Replace the water in the reservoir.
- Add the following solutions to the water in the reservoir:
  – 2 fl oz (60 ml) of Antibacterial solution, Lab-Volt p/n 38097
  – 8 fl oz (240 ml) of Rust inhibitor, Lab-Volt p/n 38096

Sample Work Order

Extracted from

Metering Pump

Metering Pump

Description

The Metering Pump of your training system is shown in Figure 1-1. It consists of a solenoid-operated, single-diaphragm pump that utilizes a pressure differential to alternately create suction and positive fluid pressure. As shown in Table C-1 in Appendix C, a diaphragm pump is a positive displacement reciprocating pump.

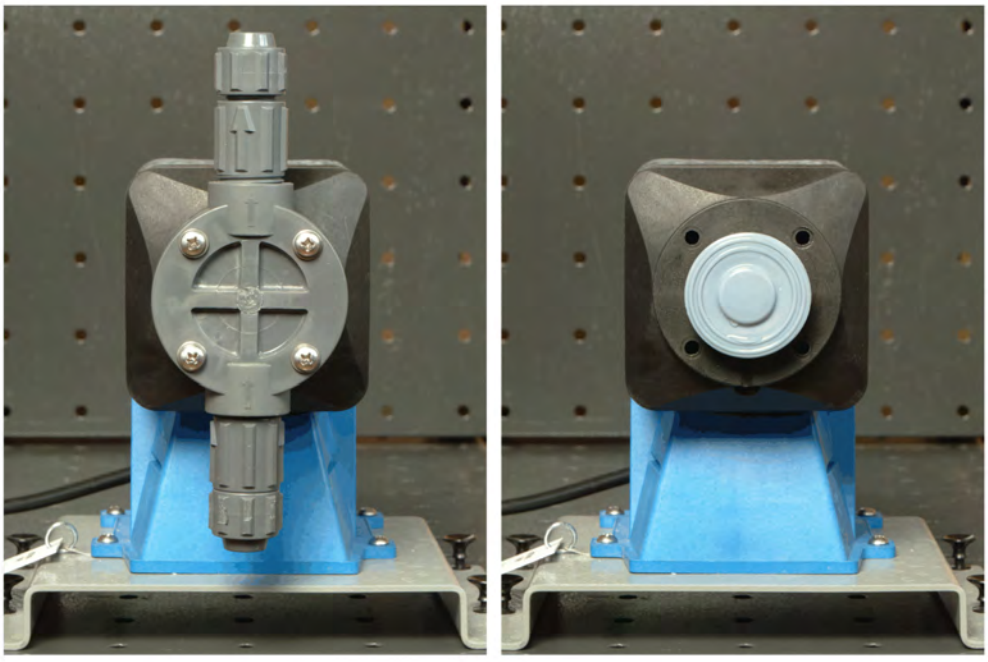

Figure 1-1. Metering Pump with and without pump head.

How it works

As the diaphragm is pulled away from the pump head, the cavity increases in size. This creates a vacuum that draws in the liquid through the inlet check valve. See Figure 1-2.

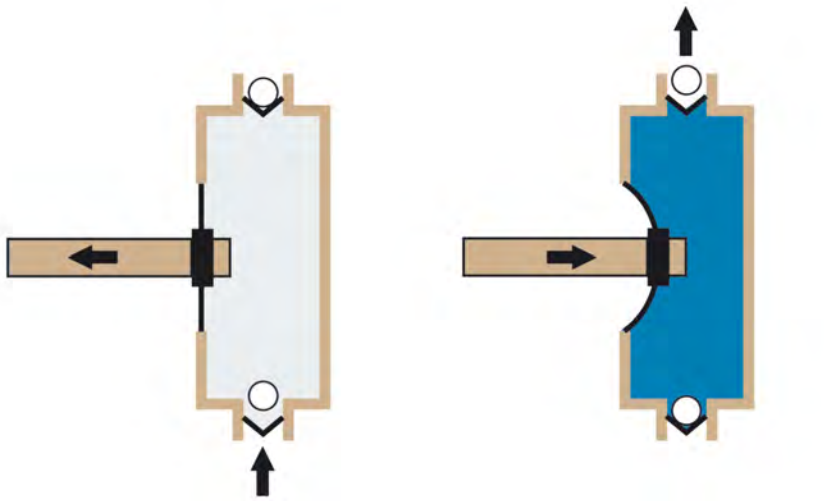

Figure 1-2. Fluid flow in a single diaphragm pump.

As the diaphragm is pushed toward the pump head, the cavity decreases in size which forces the liquid out through the outlet check valve.

The movement of the diaphragm of the Metering Pump of the training system is controlled by a solenoid. The mechanical stroke length and stroke rate are set via control knobs.

Advantages and disadvantages

Advantages: metering pumps can run dry without damage, and are self priming.

Applications

Metering pumps are used where two or more liquids must be proportioned or where mixture ratios must be controlled. They are used for general water conditioning. They are also called dosing pumps, and chemical pumps.

Maintenance

The maintenance required by metering pumps consists in:

- Routinely check the physical operating condition.
- For optimum performance, the check valve cartridges (see Figure 1-3) should be changed every 6-12 months.
- Check for leaks around fittings.
- Keep the pump free of dirt and debris.

Characteristics of the Metering Pump of the training system

Maximum flow rate: 30 gal US/d (4.73 l/h) at 80 psi (560 kPa)
Maximum discharge pressure: 80 psi (560 kPa)
Maximum strokes per minute: 125

Metering Pump

Task: To inspect, lubricate, install, operate, and troubleshoot a metering pump.

PROCEDURE

CAUTION!

Before proceeding with this procedure, complete the safety checklist in Appendix B.

☐ 1. Refer to Figure 1-3 to locate and identify the various components of the Metering Pump.

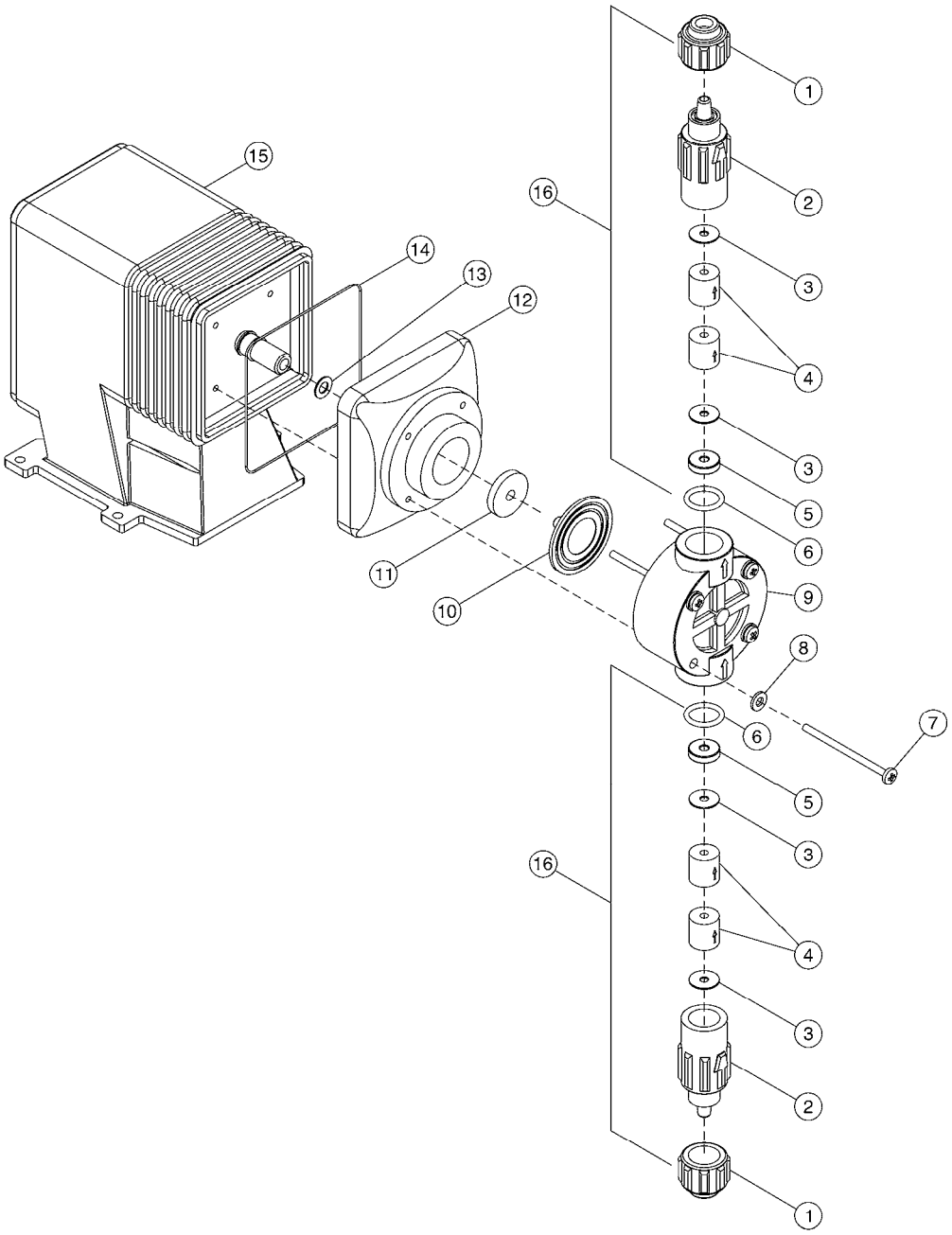

Figure 1-3. Exploded view of the Metering Pump.

1	Nut	9	Pump head
2	Cartridge	10	Diaphragm
3	Washer	11	Deflection plate
4	Check valve	12	Adaptor
5	Cartridge cap	13	Shim
6	O-ring	14	O-ring
7	Screw	15	Electronic power module
8	Washer	16	Check valve cartridge assy

Disassembly of the Metering Pump

☐ 2. Connect the Metering Pump to the Emergency Stop Station.

Set the stroke length knob (upper knob) to 50% and disconnect the pump.

Note: *Do not turn the stroke length knob when the pump is stopped.*

☐ 3. Disassemble the pump as follows:

- Remove the screws, and the pump head.
- Unscrew the check valve cartridges, and disassemble.
- Remove the diaphragm by grasping it at the outer edge and turning it counterclockwise until it unscrews from the electronic power module. Do not lose the deflector plate or shims which are behind the diaphragm, they are needed for reassembly.
- Remove the adaptor and O-ring.

CAUTION!

Do not disassemble the electronic power module.

Inspection

☐ 4. Clean all components, remove all hardened residues.

☐ 5. Check the components as follows:

- Inspect the diaphragm, look for indications of the Teflon face being overstretched or the elastomer on the back of the diaphragm being worn.
- Inspect the solenoid shaft for wear.
- Inspect the O-rings for apparent damage.

Note: *Notify your instructor if any parts seem damaged.*

Observation of the solenoid shaft movement

☐ 6. Connect the Metering Pump.

Set the stroke rate (lower knob) to 100%.

Vary the stroke length from 20 to 100% while observing the solenoid shaft extension movement. What can you conclude from your observation?

_____

_____

☐ 7. Set the stroke length to 100%.

☐ 8. Vary the stroke rate from 10 to 100% while observing the movement of the solenoid shaft. What can you conclude from your observation?

_____

_____

Reassembly of the pump

☐ 9. Set the stroke length to 50%, and disconnect the pump.

☐ 10. Reassemble the pump as follows:

- Install the adaptor and O-ring.

  Note: *Make sure the orientation of the adaptor is correct. The drain hole must be at the bottom.*

- Apply grease to areas of the diaphragm that contact the deflection plate.

  Note: *Make sure to use the grease supplied with the Lab-Volt Lubrication Kit, Model 46792.*

- Install the shim(s) and the deflection plate.
- Screw the diaphragm clockwise until the deflection plate and shims are tight against the solenoid shaft and the diaphragm stops turning.

  Note: *Be careful to prevent damage to the diaphragm.*

- Install the pump head.
- Reassemble the check valve cartridges.

  Note: *Make sure that the arrows point in the correct direction.*

- Screw the check valve cartridges to the pump head (hand tight).

Lubrication

Note: *There is no lubrication required other than the areas of the diaphragm that contact the deflection plate.*

Circuit setup

☐ 11. Set up the circuit shown in Figure 1-4.

Note: *The discharge and bleeding tubes should be approximately 4-ft (1.2-m) long.*

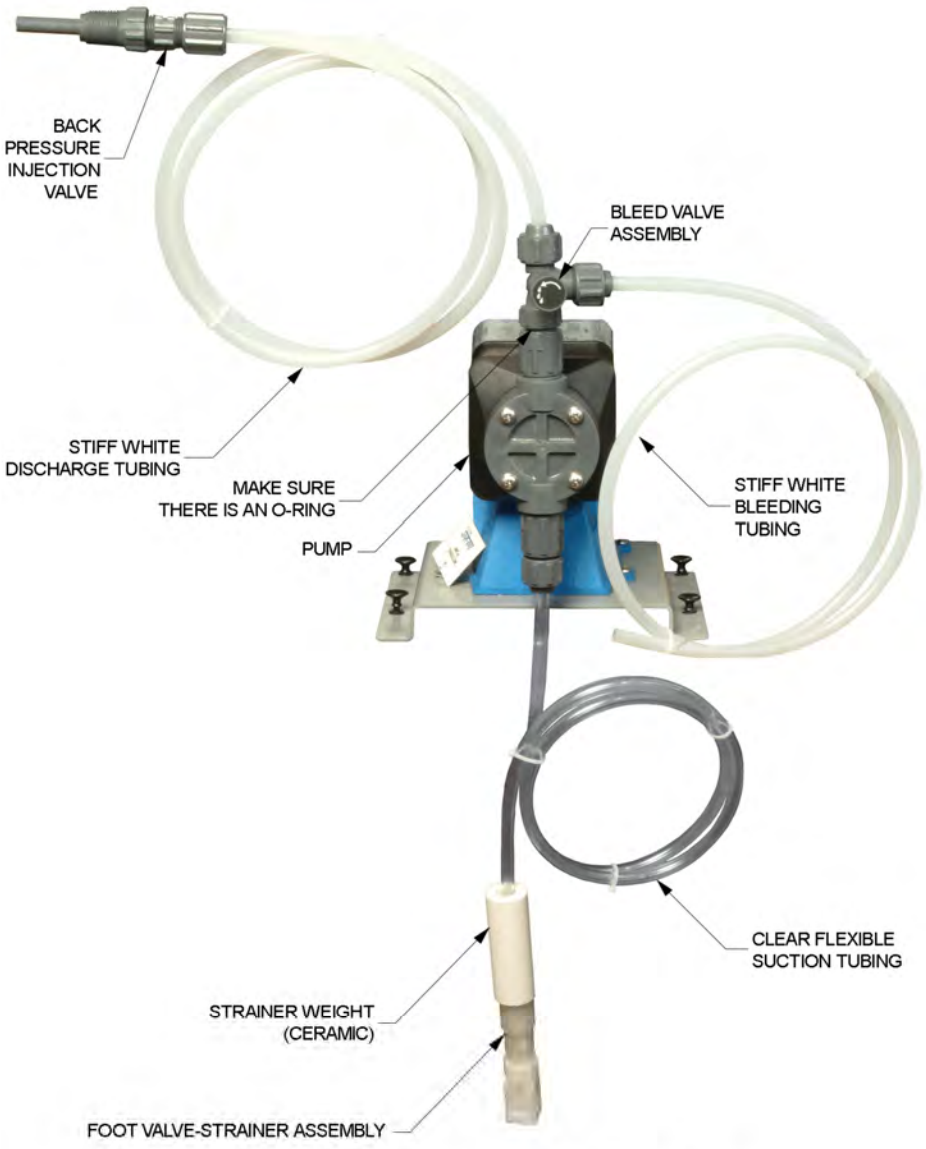

Figure 1-4. Pumping circuit using the Metering Pump.

☐ 12. Install the Metering Pump on the Pump Bench as shown in Figure 1-5.

Figure 1-5. Installation of the Metering Pump on the Pump Bench.

☐ 13. Place the 600-ml beaker in the tank of the suction assembly.

- Remove the cover of the reservoir.
- Place the suction tube and bleed tube in the reservoir.
- Place the back pressure injection valve in the beaker.

Note: *The injection valve is used to maintain metering performance. The spring in the injection valve adds 17-20 psi (117-138 kPa) to the line pressure. Best practice is to install the injection valve at the point of chemical injection.*

- Close the bleed valve by turning the knob fully clockwise.

Note: *The bleed valve is used to empty the tubing at the pump discharge. It is also used to purge the air from the pump head during priming of the pump when connected directly to a pressurized system.*

- Connect the pump and set the stroke length and stroke rate knobs to 100%.
- Run the pump until the tubing is filled with water. A solid stream of fluid should come out of the injection valve in the beaker.

Flow rate measurement procedure

Note: *Since the flow rate produced by the Metering Pump is low, it will be determined by measuring the volume of water pumped during a period of time.*

☐ 14. Determine the flow rate as follows:

- Remove the injection valve from the beaker.
- Empty the beaker and return it to the tank of the suction assembly.
- Measure the volume of water pumped during exactly one minute when the stroke length and stroke rate knobs are set to 100.

Volume of water: _____

Flow rate: _____

☐ 15. Compare your measured flow rate with the nominal flow rate shown in the motor name plate (adapt the value to fit the units). Are they approximately the same?

☐ Yes ☐ No

Note: *The nominal flow rate shown in the motor name plate is determined for a discharge pressure of 80 psi (560 kPa). Output flow rate is higher when feeding against less than the rated pressure.*

Flow rate setting procedure

☐ 16. Perform the following steps to set the flow rate:

- Set the stroke length to 100%.
- Adjust the stroke rate as determined by the following formula. This corresponds to the coarse adjustment.

$$\text{Stroke rate} = \frac{\text{Required flow rate} \times 100}{\text{Measured flow rate}}$$

Note: *Repeat this procedure for required flow rates that correspond to 40 and 60% of the flow rate measured when the stroke length and stroke rate were set to 100%.*

- Measure the flow rate.
- If the measured flow rate is less than the required value, increase the stroke rate and measure the flow rate again.
- Adjust the stroke length for fine flow rate control.
- Measure the flow rate and make sure that the required value is obtained.

Bleed valve operation

☐ 17. Perform the following steps to familiarize yourself with the operation of the bleed valve:

- Place the injection valve in the tank of the suction assembly.
- Set the stroke rate and stroke length knobs to 80%.
- Once the discharge tube is full, stop the pump.
- Open the bleed valve by turning the knob counterclockwise while observing the extremity of the bleed tube over the reservoir. Does water flow? Explain.

_____

_____

☐ 18. Start the pump, and observe the extremity of the bleed tube over the reservoir. Does water flow?

☐ Yes ☐ No

Note: *This operating condition is similar to a pump whose discharge is connected to a pressurized system and the pump head is purged of its air.*

☐ 19. Stop the pump.

Troubleshooting

☐ 20. By referring to the Troubleshooting Chart in Appendix D, identify three symptoms that worn or damaged check valves may cause.

_____

_____

_____

☐ 21. By referring to the Troubleshooting Chart in Appendix D, name ten possible causes for a pump that fails to pump.

_____

_____

_____

_____

_____

☐ 22. Ask your instructor to check your work.

☐ 23. Disconnect your setup, replace the top of the reservoir, and return the equipment to the storage location.

Name: _____ Date: _____

Instructor's approval: _____