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HYPOCHLORINATION O&M GUIDELINE

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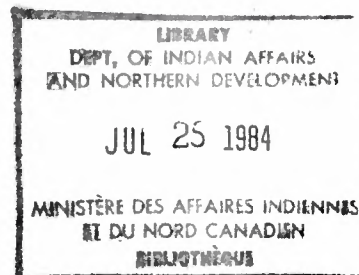
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HYPOCHLORINATION O&M GUIDELINE

January 1983



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Guide d'emploi et de maintenance du
matériel d'hypochloration

HYPOCHLORINATION O&M GUIDELINE

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HYPOCHLORINATION O&M GUIDELINE

1.0 INTRODUCTION

The purpose of this document is to describe the method, chemicals and equipment used to disinfect water and/or treated wastewater. It describes the operation and maintenance of the equipment and the safe handling and storage of chemicals.

This document is intended for use by water and wastewater treatment plant operators, maintenance supervisors, and others requiring technical details for this type of operation.

2.0 GENERAL REMARKS

Hypochlorination is one method of disinfecting water and wastewater. The chemicals used are called hypochlorites. The equipment used is called a 'hypochlorinator'.

3.0 HYPOCHLORITES

3.1 Composition

There are two types of hypochlorites used in water and wastewater treatment:

- a. calcium hypochlorite, commonly referred to as "HTH" (High Test Hypochlorite) in water and wastewater applications; and
- b. sodium hypochlorite.

3.2 Mixing

Both these chemical compounds are mixed with water to form a liquid disinfectant.

3.3 Strength

The strength of the disinfectant depends on how much water is used to mix the hypochlorite and also on how much chlorine becomes available from the hypochlorite.

4.0 AVAILABLE CHLORINE

4.1 Amount of Chlorine

The term "available chlorine" is used to refer to the amount of chlorine in the hypochlorite compound; for example, the most common strength of calcium hypochlorite (HTH) is 70% free available chlorine. This means that 100 kilograms (pounds) of 70% calcium hypochlorite contain 70 kilograms (pounds) of available chlorine.

In water and wastewater disinfection the most common strength of sodium hypochlorite is 15% free available chlorine; for example, if you had 200 kilograms (pounds) of this solution you would have 30 kilograms (pounds) available chlorine.

4.2 Contact Time

The term 'contact time' is used to refer to the time necessary for the chlorine residual to achieve disinfection. It is also the time at the end of which chlorine residual is measured. It is essential that contact time be a minimum of 15 minutes for potable water and 30 minutes for sewage effluent.

5.0 CALCIUM HYPOCHLORITE

5.1 Appearance

Calcium hypochlorite (HTH) is a white solid material. It usually comes as a dry powder, or could be compressed into tablets or pellets. The pellets are usually used in small chlorination systems, like home pools.

The powder form is used in plants. In water and wastewater applications, calcium hypochlorite is referred to as HTH (High Test Hypochlorite). HTH is shipped in 22.5 or 45 kilogram (50 or 100 pound) plastic lined drums. These containers should be resaleable.

5.2 Properties

The strength of HTH needed for water and wastewater treatment is 70% available chlorine. This is a relatively high amount of available chlorine, so reasonable care must be taken when handling HTH.

Calcium hypochlorite has to be kept dry, tightly covered and must not be heated. When it gets wet chlorine gas is released. If heated, chlorine gas and an irritating dust will be released. Should heat exceed 175°C (350°F) oxygen gas will also be released. It is very important therefore to keep HTH away from combustible materials like paper or wood and oxidizable material like oil, grease or gasoline vapour.

5.3 Handling and Storage

When using HTH the following basic safety precautions must be observed.

HTH must be stored indoors in the original sealed containers. There must be a separate room used only for storage of HTH. There must not be any automatic sprinklers and no below-ground areas where chlorine gas could collect. The containers must be stored so that they can be quickly moved outdoors in case of fire or other emergency.

Proper ventilation is necessary to control dust. Even so, chances cannot be taken when handling HTH. Wear proper protective equipment for the skin, eyes, and lungs. Calcium hypochlorite dust will react with skin moisture to burn and damage tissue.

Use up all material in a container by carefully dissolving it completely in water. If an opened container of HTH must be stored, be sure that it is properly resealed to prevent any chlorine gas from escaping.

6.0 SODIUM HYPOCHLORITE

6.1 Appearance

Sodium hypochlorite is a clear, pale yellow liquid. It has a chlorine smell. The usual strength is about 15% free available chlorine.

Since it is in liquid form and has a relatively low available chlorine percentage, sodium hypochlorite is bulky to handle. Because of this it is seldom used in isolated areas owing to high shipping charges.

For water and wastewater disinfection, sodium hypochlorite is only sold as a solution. This means that it is safer to handle than calcium hypochlorite.

6.2 Properties

Even though sodium hypochlorite is safer than liquid chlorine or HTH, it still contains chlorine. In other words, be careful with it. It is corrosive: it can damage eyes or skin, and harm metals and other construction materials.

Because it is at a lower concentration, sodium hypochlorite will freeze, at around -14°C . But the solution will still be as strong after it has thawed. However, sodium hypochlorite solution will lose strength over time. This loss in strength can be reduced by being careful with storage.

6.3 Handling and Storage

How well sodium hypochlorite will keep its strength depends on its temperature, exposure to light, initial strength and whether it is contaminated by iron or other metal.

Sodium hypochlorite loses its strength quickly as its temperature increases. Actually the rate of strength loss just about doubles with each 5.5°C increase in temperature. This means that outdoor storage tanks should be white or silver to reflect sunlight.

Sodium hypochlorite will decompose in the presence of strong light, especially direct sunlight. This means that storage tanks should not have large open tops, and should be made of material that will prevent the entry of light.

6.3.1 Strong Sodium Hypochlorite Solutions

These will lose their strength faster than weaker solutions. A solution of 12 to 15% available chlorine stored under cool, dark and clean conditions might lose strength at about 0.1% a week. Under bad conditions, a 15% solution might drop to 13% in only one day. If care is not taken with storage, money can easily be wasted or water not properly disinfected. It may be more economical to buy small quantities of sodium hypochlorite frequently, rather than trying to store large quantities. If long

storage is unavoidable dilute the solution with clean water, since weaker solutions will keep their strength longer.

Sodium hypochlorite is corrosive, so it must not be shipped or stored in metal containers. The solution is usually shipped in rubber lined drums or tank trucks or in polyethylene containers. Hypochlorite storage tanks must meet requirements of the local regulatory agency. Usually outdoor storage is preferred. This helps protect other plant equipment from corrosion. If the solution is stored underground it may be difficult to detect leaks.

Large storage tanks should have outside fill pipes, with the discharge line at the top of the tank. There should be a pressure relief and overflow pipe that discharges to a safe area. Since the solution is corrosive, there should be a special area set aside for the hypochlorination equipment. This makes it easier to control any leaks, without damage to other plant equipment or the treatment process.

Also, because it is corrosive use non-metal piping and valving to handle sodium hypochlorite.

7.0

THE HYPOCHLORINATION SYSTEM

The basic parts of any hypochlorinator are a container for the sodium hypochlorite solution, and a pump and piping to move the solution into the water or wastewater stream.

8.0 HYPOCHLORINATION EQUIPMENT

8.1 The Solution Tank

Both calcium hypochlorite (HTH) and sodium hypochlorite are mixed with water to form a stock solution. It is this stock solution that is applied to a water or wastewater stream. A tank is needed to mix and hold this stock solution.

The solution tank is usually polyethylene or fiberglass to prevent corrosion. It should be big enough to hold at least a seven-day supply.

To assist in mixing the stock solution, make 20 litre (5 gallon) marks as graduations on the side of the container.

A corrosion resistant and tight fitting cover is needed for the solution tank.

8.2 The Suction Pipe

This pipe is usually made of translucent polyethylene.

A weight is usually provided at the end of the suction pipe to keep the pipe at the bottom of the solution tank.

The suction pipe should just be long enough to reach the bottom of the solution tank with no excess length lying on the bottom of the tank.

8.3 Weighted Strainer and Foot Valve

The weight at the end of the suction pipe includes a strainer. This prevents any solid particles from entering the suction pipe. These particles could damage the pump.

A one-way suction or foot valve is incorporated into the strainer.

There are usually three one-way check valves in the hypochlorination set-up, to keep the hypochlorite solution moving in the direction desired. The valves are arranged as follows:

- 1) a one-way valve at the strainer on the suction pipe;
- 2) a one-way valve on the suction pipe just before the pump; and
- 3) a one-way valve just after the pump.

The main purpose of all the valves is to prevent any back-flow and loss of prime.

The valves must be kept in an upright or vertical position if they are to work properly.

8.4 Discharge Valve and Pipe

The pump sucks the hypochlorite up the suction pipe and forces it into the discharge pipe. The valves keep the liquid moving in the right direction.

8.5 Point of Application

The discharge pipe carries the hypochlorite solution to the application point. In water supply systems where chlorination is the only treatment, this point is usually on the discharge side of the water pump. In wastewater disinfection the application point is immediately before the chlorine contact chamber.

8.6 The Pump

The pump most commonly used in hypochlorination is a positive displacement diaphragm type of pump. These are available in various sizes. The smallest can handle only a few litres each day, the largest over 2,000 litres (440 gallons).

The basic parts of a diaphragm hypochlorinator are:

- a. The pumphead is where the actual pumping takes place. The diaphragm causes a pumping action to take place in the pumphead and both the suction and discharge valves are attached to the pumphead. To make sure the valves work properly, the pumphead always has to be vertical, with the discharge valve at the top.
- b. The diaphragm is a circular piece of rubber or plastic. It fits inside the pumphead. An electric motor inside the pump makes this diaphragm move back and forth. This reduces the pressure inside the pumphead causing suction. Solution is sucked into the pumphead, then forced into the discharge pipe. The valves keep the liquid moving in the right direction. How much solution will be pumped depends on how far the diaphragm moves back and forth.
- c. The feed rate control knob controls how far the diaphragm moves back and forth, and in turn the amount of solution pumped. The feed rate control knob has to be adjusted by hand to change the amount of solution being pumped. Accordingly, the operator must keep a close eye on the amount of solution being pumped and the amount that should be pumped. This task is made easier if the hypochlorinator is connected electrically with the pumping system to start and stop at the same time as the main pump.
- d. The valves are described in 8.3.
- e. The electric motor driving the pump can be inside or outside the pump housing.
- f. The pump housing forms protection. Most small hypochlorinators contain the pumphead,

drive mechanism and motor inside one plastic or metal housing. Sometimes there may also be a small fan on the motor shaft to help cool the motor.

9.0 PREPARING A CALCIUM HYPOCHLORITE SOLUTION (HTH - 70% Available Chlorine)

The following points are very important:

- a. Be sure to read and follow your supplier's and manufacturer's instructions.
- b. Be careful to create as little dust as possible when mixing calcium hypochlorite.
- c. NEVER add water to the powder. Water should always be put into the solution-container first, and then the powder added to the water.

How to make a calcium hypochlorite solution:

- a. Use two solution tanks: one for mixing, and one for storage.
- b. Fill the mixing tank to the half-way point with water.
- c. If a mechanical mixer is provided start it and add the required amount of chemical. A mixing paddle or a stick are used for mixing the chemical by hand where mechanical mixers are not provided.
- d. With the mixer still working, add the rest of the water. Allow sufficient mixing time.
- e. Turn the mixer off and allow about 24 hours settling time.

- f. Syphon the clear solution to the second tank for use. (Do NOT use your mouth to start the syphon.)

Never mix the contents a second time or use the mixed solution without first syphoning the clear liquid. If the solids that have settled out get into the piping system, valve and pump damage could occur.

10.0

PREPARING A SODIUM HYPOCHLORITE SOLUTION

Sodium hypochlorite is already in solution form and all the operator has to do is:

- a. add the required amount of sodium hypochlorite to the solution tank;
- b. add the proper amount of water; and
- c. mix the contents briefly with a wooden paddle or stick. (A mechanical mixer could be used.)

It is essential that the proper strength of solution be used. This is a 1% feed solution strength.

Sodium hypochlorite is usually at about 12 or 15% available chlorine. Water is added to bring the strength of the sodium hypochlorite solution down to 1%.

A simple rule of thumb to get a 1% solution is to add 11 litres (gallons) of water to every litre (gallon) of 12 - 15% sodium hypochlorite.

11.0

OPERATION OF THE HYPOCHLORINATOR

The hypochlorination equipment should be examined every day and the operator should conduct the following checks:

- a. The most important thing to check is that there is enough hypochlorite solution being applied to the water or to the wastewater stream to give proper disinfection. This is done by conducting chlorine residual tests. The maximum doses are .2mg/L (ppm) for water and 1mg/L (ppm) for wastewater.
- b. Be sure that there is enough solution in the tank to last until the next visit. Refill the tank if necessary, being sure to replace the cover.
- c. Check for leaks around equipment and pipes. There should not be any, nor should there be any wet areas on the floor. If there is a chlorine smell, a 1% solution will not be strong enough to hurt your eyes, but if the solution is leaking onto the floor, the water will evaporate and the smell of chlorine can be quite strong.
- d. Put your hand on the pump. If any abnormal vibration is noticed or if the pump feels warmer than usual, bearing or gears may need replacement.

The hypochlorite solution is corrosive. Any metal tools used near the solution should be rinsed and dried after use.

12.0 DOSING ADJUSTMENT AND TESTING

12.1 Definition of Chlorine Residual, Chlorine Dosage, and Chlorine Demand

The purpose of disinfection is to kill as many disease-causing organisms as possible. To be sure that all harmful bacteria are destroyed,

enough hypochlorite solution has to be added to leave a slight excess of chlorine in the water or wastewater effluent after a given contact time. This excess chlorine remaining is called the CHLORINE RESIDUAL. It is measured by the chlorine residual test. Your local regulatory agency can tell you what the given chlorine residual is in your area and the necessary contact times. Appendix 1 describes a method for testing the chlorine residual.

The amount of chlorine added for a given volume of water or wastewater, and the amount remaining in the water after disinfection, are measured in milligrams per litre (mg/L) or ppm. The amount of chlorine added to the wastewater is called the CHLORINE DOSAGE.

The difference between the chlorine dosage and the chlorine residual is called the CHLORINE DEMAND.

This means that:

chlorine demand + chlorine residual =
chlorine dosage

12.2 Determining Dosage and Feed Rate

Different waters and wastewaters need different amounts of chlorine, so the dosage rate of chlorine must be varied to get a satisfactory chlorine residual. To make sure that you have a safe water supply and a disinfected wastewater effluent, a chlorine residual must always be present. Frequent checks of the chlorine residual should be made because the amount of chlorine needed to disinfect water or wastewater (the chlorine demand) may vary, or the strength of the chlorine solution may slowly deteriorate.

If the residual is too low, increase the feed rate (the amount of hypochlorite being pumped). If the residual is too high, then reduce the feed rate.

If not enough hypochlorite is being added, proper disinfection may not occur. If too much hypochlorite is being added money is wasted and too much can also be harmful to aquatic life.

Appendix 2 gives some sample calculations for determining dosage and feed rate.

13.0 PREVENTIVE AND CORRECTIVE MAINTENANCE

13.1 Preventive Procedures

Points to remember are:

- a. conduct regular inspections:
 - (1) thoroughly check the operation of the hypochlorination system at least once a month, and
 - (2) check and clear all parts, including the diaphragm, at least once every six months. Replace any worn parts.
- b. The solution tank should be polyethylene or rubber lined. (Plastic garbage pails will not last long).
- c. In regular checks of the system, watch for leaks. Any leaks should be corrected immediately. The hypochlorite is corrosive,

so be sure to wash down areas where leaks did occur. To be on the safe side, put a thin coating of grease on copper or brass fittings in the chlorine room.

- d. The motor should be protected from hypochlorite solution, water, and dust. Lubrication must be strictly in accordance with manufacturer's recommendations.
- e. The only time to change the flow rate adjustment knob is when the pump is running. Do not use force, otherwise the mechanical adjustment mechanism may be damaged.

13.2

Corrective Procedures

There are moving parts involved in the hypochlorinator. As can be expected with any equipment, parts will deteriorate over time.

The only guide that should be used for corrective maintenance is the manufacturer's manual. The service representative can also be very helpful. The name, address and phone number of the service representative should be placed on or near the hypochlorination system.

A trouble shooting checklist is provided in Appendix 3. Some basic instructions are given below:

- a. How to clean and tighten valves and fittings. Every time a valve or fitting is removed, remove old tape, apply new teflon tape, and then tighten finger tight. Do not use wrenches on plastic fittings. Most hypochlorination problems are the result of damage to fittings by too much force or by wrenches. This ruins seats, valves and pumpheads. Forcing a fitting will probably only cause a worse leak.

- b. Suction and discharge valves may have to be removed and cleaned. They can be reused as long as threads are not worn. If they are worn, these parts should be replaced.
- c. Replacing the diaphragm is not very difficult, but be sure to check the equipment manual. To install a diaphragm, the pumphead will have to be removed. Run the pump at its slowest speed and turn it off when the diaphragm is farthest out from the pump housing. This will make it easier to remove the old and install the new diaphragm.

Make sure that the pumphead is replaced with the discharge valve on top, with the head in a vertical position. Tighten the pumphead screws evenly.

It is a good idea to have a spare chlorinator on hand in case of breakdown. If this is not possible, the service representative may be able to lend a unit while yours is being repaired.

14.0

REFERENCES

Water Pollution Control Federation (WPCF).
Chlorination of Wastewater, Manual of Practice
No. 4. Washington, D.C. US.

Water Pollution Control Federation (WPCF).
Wastewater Treatment Skill Training Package,
Chlorination. Washington, D.C. US.

APPENDIX 1

The Chlorine Residual Test (DPD Method)

This test is a simple and reasonably accurate method of finding combined residual chlorine in treated water (DPD is an abbreviation of N. N-diethyl-p-phenylenediamine).

The test equipment relies on comparison of colours between a standard solution and the sample. Three types of equipment are described below. There may be some similar equipment available. Read your instruction book.

Equipment and Reagents

You will need:

- a. DPD tablets - No. 1 and 3 (or No. 4) for total chlorine residual.
- b. Test equipment, such as one of the following:
 - (1) Comparator with Standard Lovibond Discs
 - i) 3/40 A disc for the range 0.1 to 0.0 mg/L chlorine
 - ii) 3/40 B disc for the range 0.2 to 4.0 mg/L chlorine
 - iii) Test tube or 13.5 mm cells and a dulling screen.

- (2) Nesslerizer with Disc covers the range 0.05 to 0.5 mg/L. This disc must be used with a dulling screen and 50 ml tubes
- (3) Hach DR-EL Portable Laboratory Kit covers the range 0 - 3 mg/L for chlorine measurements.

Determining Total Chlorine Residual

1. Rinse 2 cells (test tubes) with clean water.
2. Fill both cells with sample.
3. Put 1 cell in the left hand compartment of the comparator, behind the standard colour code.
4. Take the other cell and drop DPD tablets into the sample.
5. Allow tablets to dissolve, shaking if necessary. Wait for any bubbling to stop (No. 3 tablets do not bubble). The tablets will colour the water.
6. Place this cell in the right hand compartment of the comparator.
7. Wait for two minutes.
8. Hold the comparator up to the light and move the disc on the left hand compartment until the colour matches that of the right hand compartment. A good source of diffused north daylight is best. NEVER LOOK INTO THE SUN. If samples are tested day and night use an artificial light source always for uniformity.
9. The figure shown in the indicator window represents mg/L of total chlorine residual present in the sample.

APPENDIX 2

Sample Calculations For Determining Dosage And Feed Rate

1. How to determine the dosage if you know the
feed rate and the flow:

This is the formula:

$$\text{Dosage (mg/l)} = \frac{\text{Feed rate (litres per day)} \times \text{solution strength} \times 10,000}{\text{flow rate (litres per day)}}$$

(Incidentally, the same formula would apply if you were using gallons).

Here is an example of how this formula works:

You know:

- the flow is 112,500 litres per day; and
- the feed rate is 3 litres per hour, for a 1% solution.

You want to find out what dosage you are getting, so .. use the formula:

$$\begin{aligned} \text{Dosage} &= \frac{(3 \times 24) \times 1 \times 10,000}{112,500} \\ &= \frac{72 \times 1 \times 10,000}{112,500} \\ &= \frac{72}{12} \\ &= 6.4 \text{ mg/l (ppm)} \end{aligned}$$

2. How to determine the feed rate if you know the flow and dosage:

This is the formula:

$$\text{Feed Rate} = \frac{\text{flow rate} \quad \text{dosage}}{10,000 \quad \times \quad \text{solution strength}} \\ \frac{(\text{litres per day} \times (\text{mg/l}))}{(\%)}$$

Here is an example of how this formula works:

You know:

- the flow rate is 80,000 litres per day, and
- the dosage is 6 ppm

You want to find out what the feed rate is, so.. use the formula:

$$\begin{aligned} \text{Feed Rate} &= \frac{800,000 \times 6}{10,000 \times 1} \\ &= 480 \text{ litres per day (or 20 litres per hour)} \end{aligned}$$

3. How to decide what changes to make to the pumping rates to get a desired chlorine residual.

These formulas can help. You are supposed to have a 0.5 ppm chlorine residual. Your present chlorine residual is 0.2 ppm. The flow rate is 600,000 litres per day. The feed rate is 20 litres per hour of a 1% solution.

You want to know what the feed rate should be changed to so that you end up with a 0.5 ppm chlorine residual.

First, use the dosage formula:

$$\begin{aligned} \text{Dosage} &= \frac{20 \times 24 \times 1 \times 10,000}{600,000} \\ &= 8 \text{ ppm} \end{aligned}$$

This tells you that since the residual must be raised by 0.3 ppm, the dosage also has to be raised by 0.3 ppm, to 8.3 ppm.

Now, use the feed rate formula, with the new dosage figure.

$$\text{New feed rate} = \frac{600,000 \times 8.3}{10,000 \times 1}$$

$$= 498 \text{ litres per day (or } 20.7 \text{ litres per hour)}$$

(After making any changes, remember to check the residual after one-half hour. Repeat this procedure if necessary).

4. How to determine feed rate by measuring how long it takes the pump to fill a beaker of known volume.

This is the formula:

$$\text{Feed rate} = \frac{\text{Volume of Beaker (litres)} \times 60}{\text{Times to Fill Beaker (Minutes)}}$$

Here is an example of how this formula works:

You know: - it takes 1 1/2 minutes to fill a 2 litre beaker.

You want to find out what the feed rate is, so.. use the formula:

$$\begin{aligned} \text{Feed rate} &= \frac{2 \times 60}{1.5} \\ &= 80 \text{ litres per hour} \end{aligned}$$

APPENDIX 3

Trouble Shooting Checklist

<u>Problem</u>	<u>Cause</u>	<u>Solution</u>
1. Motor does not run	(1) Power supply is interrupted	Restore power
	(2) If there is one, check liquid-level control. There may be a failure in the low-level cut-off switch.	Repair or replace if necessary
	(3) Motor overheated because overload protector has opened	Motor will start again when it cools
	(4) Motor cool and power on	Replace motor and gear unit
2. Motor runs but diaphragm does not move	(1) Stroke adjustment set at zero	Reset
	(2) Gear train stripped	Have defective parts replaced.
3. Motor runs, diaphragm moves, but no solution pumped	(1) Solution level in tank too low	Refill tank
	(2) Pump not primed	Check manufacturer's manual to find out what to do.
	(3) Air lock in suction line	Remove anti-syphon spring from discharge valve and operate pump until air is removed.
	(4) Suction or discharge fitting not tight enough	Remove, clean, apply new teflon tape and tighten <u>finger</u> tight.

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<u>Problem</u>	<u>Cause</u>	<u>Solution</u>
	(5) Diaphragm is worn out if solution is dripping from the pump housing just behind the pumphead.	Replace diaphragm.
	(6) Discharge line crimped or blocked.	Correct blockage
	(7) Valves dirty or damaged.	Clean valves. Replace O-rings if damaged, pushing them on tightly. Reinstall valves, making sure the liquid is flowing in the right direction.
4. Motor stops and starts	Motor may be overheating. The thermal protection switch may be causing the stop-start action.	Call service representative.
5. Abnormal noise	Hypochlorinator has probably been damaged	Call service representative.
6. Motor runs, diaphragm moves but not pumping to capacity	(1) Diaphragm may be damaged - check for leaks or thinness around the edges	Replace diaphragm if necessary
	(2) Suction tube blocked	Clean suction tube
	(3) Suction fittings not tight enough	Remove, clean, apply new teflon tape and retighten finger tight.

ProblemCauseSolution

- | | |
|--|--|
| (4) Suction or
discharge valves
dirty or damaged | Clean valves.
Replace O-rings
if necessary,
pushing them on
tightly. Reinstall
valves, making sure
the liquid is
flowing in the right
direction. |
|--|--|