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ABSTRACT

This document is an instructional module package prepared in objective form for use by an instructor familiar with the operation of an ion exchange softening system. It includes objectives, an instructor guide, student handouts, and transparency masters. This is the second level of a three module series. The module considers operation and maintenance, trouble shooting process problems, and ion exchange softener design. (Author/RH)

INTERMEDIATE ION EXCHANGE SOFTENING

Training Module 2.211.3.77

Prepared for the

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by

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September, 1977

INSTRUCTOR GUIDE

for

Training Module II3AAWS

TABLE OF CONTENTS

Module No: II3AAWS	Module Title: Intermediate Ion Exchange Softening
	Submodule Title:
Approx. Time: 11 hours	Topic: Summary

Objectives: Upon completion of this module, the participant will be able to:

1. Describe the operation of a basic ion exchange softener.
2. Describe the maintenance of a basic ion exchange softener.
3. Identify process problems.
4. Design an ion exchange softener.

Instructional Aids:

1. Handout
2. Transparencies #1-#28

Instructional Approach:
Discussion and Class Problems

References:

1. Manual of Instruction for Water Treatment Plant Operators, Health Education Service
2. Manual of Water Utility Operators, Texas Water Utility Assoc.
3. Elements of Ion Exchange, Kunin
4. Ion Exchange Resins, Kunin
5. Recommended Standards for Water Works, 1976, Health Education Service

Class Assignments:

1. The participant will read Handout
2. The participant will work Problems #1

Module No: II3AAWS	Topic: Summary

Instructor Notes:	Instructor Outline:
1. Distribute Handout	1. Discuss the operation, maintenance, design and process problem identification of an ion exchange softener.
2. Present Transparencies	2. Give evaluation of 30 questions.

Module No: II3AAWS	Module Title: Intermediate Ion Exchange Softening
	Submodule Title:
Approx. Time: 1 hour	Topic: Introduction

Objectives: Upon completion of this topic, the participant will be able to:

1. Describe the principles of Ion Exchange Softening.
2. Describe the preventative maintenance of a basic ion exchange softener.
3. Describe the laboratory control necessary for ion exchange.
4. Describe the safety requirements for ion exchange softener.

Instructional Aids:

1. Handout - Introduction
2. Transparency #1 - Softening Reactions
3. Transparency #2 - Regeneration Reactions
4. Transparency #3 - Preventative Maintenance
5. Transparency #4 - Laboratory Control
6. Transparency #5 - Safety

Instructional Approach:

Discussion

References:

1. Manual of Instruction for Water Treatment Plant Operators, Health Education Service
2. Manual of Water Utility Operators, Texas Water Utility Assoc.
3. Elements of Ion Exchange, Kunin
4. Ion Exchange Resins, Kunin

Class Assignments:

1. The participant will read Handout - Introduction

Module No:	Topic:
II3AAWS	Introduction

Instructor Notes:	Instructor Outline:
1. Present Transparency #1	1. Review the principles of ion exchange softening.
2. Present Transparency #2	2. Review the principles of regeneration of ion exchange softening.
3. Present Transparency #3	3. Review the preventative maintenance program for an ion exchange softener.
4. Present Transparency #4	4. Review the laboratory control for an ion exchange softener.
5. Present Transparency #5	5. Review the safety requirements for an ion exchange softener.

Module No: II3AAWS	Module Title: Intermediate Ion Exchange Softening
	Submodule Title:
Approx. Time: 3 hours	Topic: Design Evaluation

Objectives: Upon completion of this topic, the participant will be able to:

1. Evaluate the design of an existing ion exchange softener
2. Calculate the economics of an ion exchange softener

Instructional Aids:

1. Handout - Design Evaluation
2. Transparency #6 - Components of Softener
3. Transparency #7-9 - Ten States Standards for Softeners
4. Transparency #10 - Components of Brine Tank
5. Transparency #11 - Ten States Standards for Brine Tank
6. Transparency #12 - Trouble Shooting

Instructional Approach:

Discussion and Class Problem

References:

1. Manual of Instruction for Water Treatment Plant Operators, Health Education Service
2. Manual of Water Utility Operators, Texas Water Utility Assoc.
3. Elements of Ion Exchange, Kunin
4. Ion Exchange Resins, Kunin
5. Recommended Standards for Water Works, 1976, Health Education Service

Class Assignments:

1. The participant will read Handout - Design.
2. The participant will work class Problem #1 - Design Evaluation and Economics of Operation.

Module No.:	Topic:
II3AAWS	Design Evaluation

Instructor Notes:

1. Present Transparency #6
2. Present Transparency #7-9
3. Present Transparency #10
4. Present Transparency #11
5. Present Class Problem #1. Work problem with class participation.

Instructor Outline:

1. Review the components of the softener
2. Discuss the Ten States Standards in relation to softener design evaluation.
3. Review the components of the brine tank.
4. Discuss the Ten States Standards in relation to brine tank design evalution.
5. Discuss cost of softener operation and economy of operation.
6. Check Exchange Capacity

   Total Capacity = OK -20,000 grains/ft^3

   20,000 x 90 = 1,800,000 grains/gal

   ∴ total gallons treated will be:

   $$\frac{1,800,000}{(12.25 + 7.65)} = 90,000 \text{ gals OK}$$

   Check flow rate

   Cross sectional area = 19.6 ft^2

   $$\text{Average flow} = \frac{80,000}{(60)(24)} = 56 \text{ gpm}$$

   $$\therefore \text{downflow rate} = \frac{56}{19.6} = 2.9 \text{ gpm/ft}^2 \quad \text{OK}$$

   Peak flow:

   $$\frac{157}{19.6} = 8.01 \text{ gpm/ft}^2 \quad \text{high}$$

   Backwash:

   $$\frac{96}{19.6} = 5 \text{ gpm/ft}^2 \quad \text{low}$$

Module No:	Topic:
II3AAWS	Design Evalution

Instructor Notes:	Instructor Outline:
	Check Brinetank

salt needed

.3 lbs/1000 grains removed

∴ (80,000)(19.9) = 1,592,000 grains removed

∴ 1,592 x .3 = 477 lbs salt

50 to 60 lbs/ft^3 salt

∴ $477/_{50}$ = 9.54 ft^3 salt

Tank size is 3.14 x 2ft^2 x 4 ft = 50 ft^3
OK

Economics

at 20,000 grains/ft^3 it is operated at 2/3 maximum capacity.

∴ need 477 lbs of salt

∴ cost will be $(477/_{80})$ (\$1.45) = \$8.65/day

or $8.65/_{80}$ ≐ \$ .11/1000 gals

Therefore, the conclusion is:

The softener is hydraulically over loaded during peak flows which may result in poor water quality. Otherwise, the design is adequate.

Module No:	Module Title:
II3AAWS	Intermediate Ion Exchange Softening
	Submodule Title:
Approx. Time:	Topic:
2 Hours	Advanced Operation (Trouble Shooting)

Objectives: Upon completion of this topic, the participant will be able to

1. Diagnose and describe solutions to reduced flow problems.
2. Diagnose and describe solutions to loss of capacity problems.
3. Diagnose and describe solutions to slow regeneration problems.
4. Diagnose and describe solutions to blown bed problems.

Instructional Aids:

1. Handout - Advanced Operation (Trouble Shooting)
2. Transparency #12 - Reduced Flow Problem
3. Transparency #13-14 - Reduced Capacity Problem
4. Transparency #15 - Slow Regeneration Problem
5. Transparency #16 - Blown Bed Problem

Instructional Approach:

Same

References:

Same

Class Assignments:

Same

Module No: IISAAWS	Topic: Advanced Operation (Trouble Shooting)
Instructor Notes:	**Instructor Outline:**
1. Present Transparency #12	1. Discuss the problem of reduced flow through the softener and the solutions to the problem
2. Present Transparencies #13-#14	2. Discuss the problem of lost capacity and the solutions to the problem.
3. Present Transparency #15	3. Discuss the problem of slow regeneration and the solutions to the problem.
4. Present Transparency #16	4. Discuss the problem of blown bed and the solutions to the problem.

Module No:	Module Title:
II3AAWS	Intermediate Ion Exchange Softening
	Submodule Title:
Approx. Time:	Topic:
4 hour	Equipment Maintenance and Repair.

Objectives: Upon completion of this topic, the participant will be able to:

1. Describe auxillary equipment used in ion exchange.
2. Discuss advantages and disadvantages of auxillary equipment

Instructional Aids:

1. Handout - Equipment Maintenance and Repair
2. Transparency #17 - Sensors
3. Transparency #18-19 - Valves
4. Transparency #20-28 - Automatic controls.

Instructional Approach:

Discussion

References:

1. Manual of Instruction for Water Treatment Plant Operators, Health Education Service
2. Manual of Water Utility Operators, Texas Water Utility Assoc.
3. Elements of Ion Exchange, Kunin
4. Ion Exchange Resins, Kunin

Class Assignments:

1. The participant will read Handout - Equipment Maintenance and Repair

Module No: II3AAWS	Topic: Equipment Maintenance and Repair
Instructor Notes:	**Instructor Outline:**
1. Present Transparency #17	1. Discuss the different types of continuous monitors. Discuss problems, calibration and the lack of real need for the sensors.
2. Present Transparency #18	2. Discuss the different types of valves used to control softeners. Discuss the advantage and disadvantages of each. Stress the fact that the most common valve used is the water operated.
3. Present Transparency #19	3. Discuss in detail the workings of the water operated valve. Discuss the maintenance and repair of the valve.
4. Present Transparency #20	4. Discuss in general the two major types of controls used in ion exchange softening.
5. Present Transparency #21	5. Discuss the typical solo control installation. Review the various valves and their purpose.
6. Present Transparency #22	6. Discuss the operation of the solo control. Discuss how it works and what is going on with the control in each position.
7. Present Transparency #23	7. Discuss in detail the workings of the solo control. Discuss the maintenance and repair of the control.
8. Present Transparency #24	8. Discuss the typical stager installation. Discuss what is happening with the stager and the various valves during different operations.
9. Present Transparency #25	9. Discuss the interaction between the stager and the water operated valve both to open and close.
10. Present Transparency #26	10. Discuss in detail the workings of a typical stager control. Discuss the maintenance and repair of the control.

Module No: I13AAWS	Topic: Equipment Maintenance and Repair

Instructor Notes:	Instructor Outline:
11. Present Transparency #27	11. Discuss the operation of a multivalve assembly. Discuss what is happening with the various valves during different operations.
12. Present Transparency #28	12. Discuss in detail the workings of a typical multi-valve assembly. Discuss the maintenance and repair of the unit.

Module No: II3AAWS	Module Title: Intermediate Ion Exchange Softener
	Submodule Title:
Approx. Time:	Topic: Evaluation

Objectives:

The participant should be able to answer correctly 25 of the 30 questions asked.

Instructional Aids:

None

Instructional Approach:

Examination

References:

None

Class Assignments:

None

Module No:	Topic:
II3AAWS	Evaluation

Instructor Notes:	Instructor Outline:
1. Distribute exam. Each participant is to complete the exam independently and with no books or notes. Collect after 1 hour.	

TRANSPARENCIES

for

Training Module II3AAWS

SOFTENING REACTIONS

HARD WATER		SODIUM EXCHANGE RESIN		SOFT WATER		EXHAUSTED EXCHANGE BED

$$\left\{\begin{matrix} Ca \\ Mg \end{matrix}\right\} \left\{\begin{matrix} (HCO_3)_2 \\ SO_4 \\ Cl_2 \end{matrix}\right\} + Na_2R \longrightarrow Na_2 \left\{\begin{matrix} (HCO_3)_2 \\ SO_4 \\ Cl_2 \end{matrix}\right\} + \left\{\begin{matrix} Ca \\ Mg \end{matrix}\right\} R$$

REGENERATION REACTIONS

EXHAUTED EXCHANGE BED		SODIUM CHLORIDE (SALT) SOLUTION		SODIUM EXCHANGE BED		WASTE BRINE

$$\left\{\begin{matrix} CA \\ MG \end{matrix}\right\} R + 2\,NA\,CL \longrightarrow NA_2\,R + \left\{\begin{matrix} CA \\ MG \end{matrix}\right\} CL_2$$

PREVENTATIVE MAINTENANCE

A. ACCURATE RECORD OF PERFORMANCE
   1. PERIODIC CAPACITY CHECKS
   2. PERIODIC BRINE FLOW CHECKS

B. KEEP ALL PARTS WELL PAINTED TO PREVENT CORROSION

C. PROPERLY TREAT UNITS WHEN ~~THEY~~ ARE LAID UP
   1. FOR ABOVE FREEZING TEMPERATURES
      A) BACKWASH AND REGENERATE
      B) LEAVE A VALVE OPEN TO RELEASE ANY PRESSURE BUILDUP
   2. FOR BELOW FREEZING TEMPERATURES
      A) BACKWASH
      B) FILL TANK WITH STRONG BRINE
      C) LEAVE A VALVE OPEN TO RELEASE ANY PRESSURE BUILDUP

LABORATORY CONTROL

A. PHYSICAL
   1. TEMPERATURE - FINAL
   2. PRESSURE LOSS THROUGH SOFTENER

B. CHEMICAL
   1. ALKALINITY - FINAL
   2. TOTAL AND CALCIUM HARDNESS - RAW AND FINAL
   3. TOTAL DISSOLVED SOLIDS - FINAL
   4. pH - FINAL
   5. SOAP TEST - FINAL

SAFETY

A. Electrical Safety

1. Always use grounded or double insulated electrical tools when working on softeners.
2. If softener has automatic controls always connect to an appropriately grounded outlet. Replace any worn or frayed power cords.

B. Lifting Heavy Salt Bags

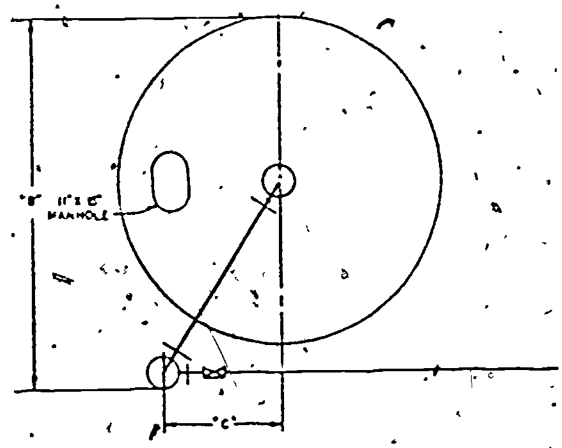
1. Always lift from the knees to prevent personal injury.

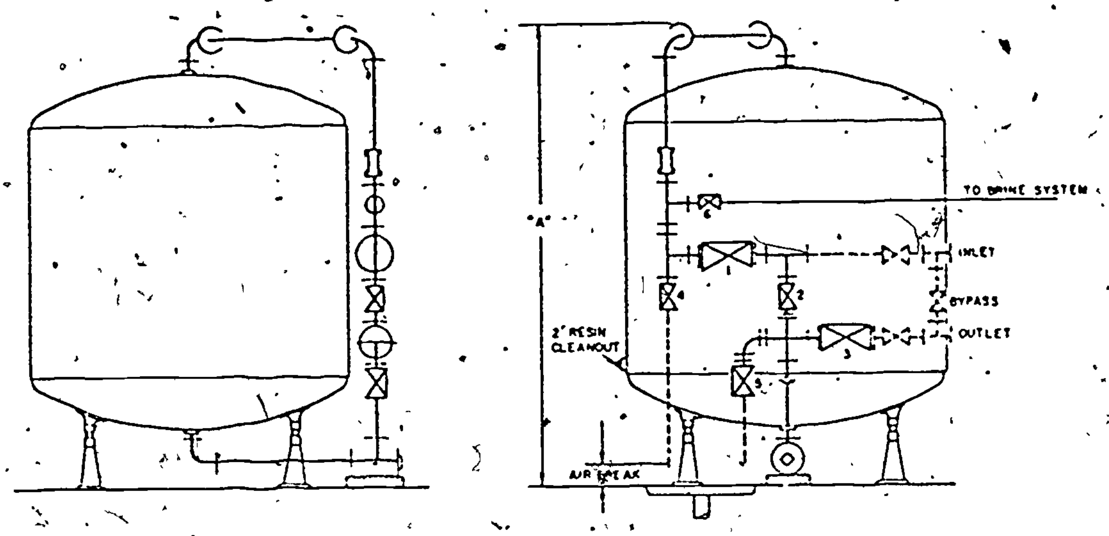
C. Eye Protection

1. Always wear eye protection when handling salt or working around the brine tank.
2. If salt gets into your eye, flush with a large quantity of fresh water.

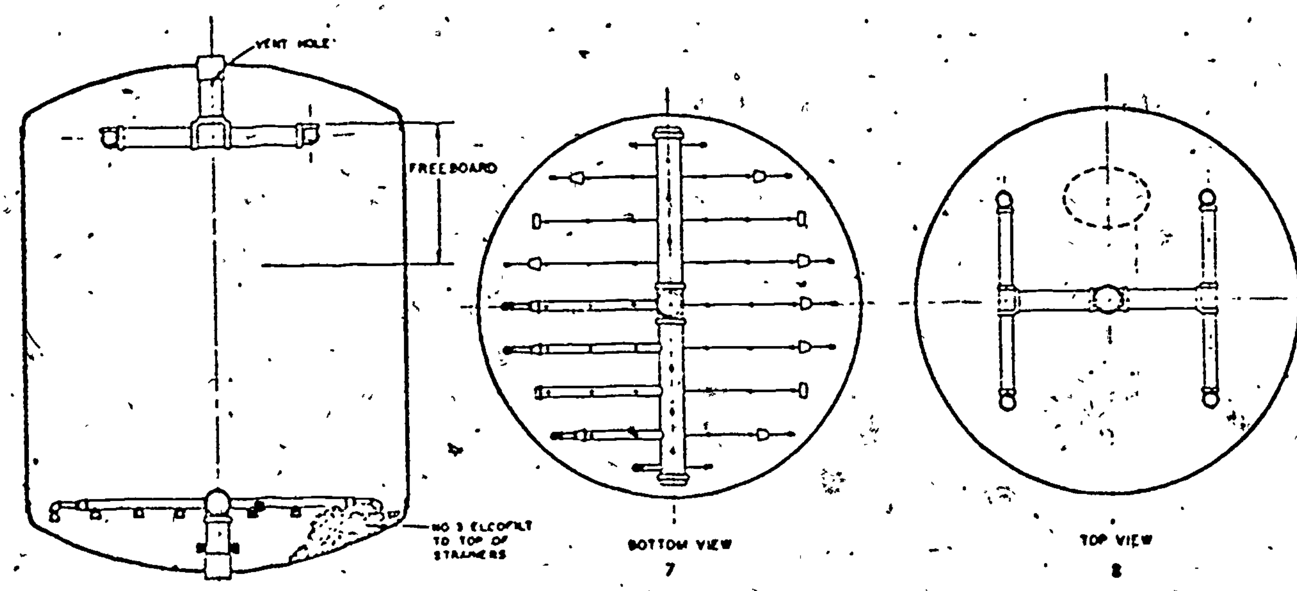
BASIC COMPONENTS OF A SOFTENER

1. Inlet valve
2. Backwash control valve
3. Outlet valve
4. Backwash outlet valve
5. Brine to waste valve
6. Brine control valve
7. Bottom manifold
8. Top manifold





SOFTENER EXTERNAL VIEW



SOFTENER INTERNAL VIEW

TRANSPARENCY II3AAWS - #6

4.4.2 Cation exchange process

Alternative methods of hardness reduction should be investigated when the sodium content and dissolved solids concentration is of concern. Iron, manganese, or a combination of the two, should not exceed 0.3 milligrams per liter in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron, manganese, or a combination of the two, is one milligram per liter or more.

4.4.2.1 Design

The units may be of pressure or gravity type, of either an upflow or downflow design. Automatic regeneration based on volume of water softened should be used unless manual regeneration is justified and is approved by the reviewing authority. A manual override shall be provided on all automatic controls.

4.4.2.2 Exchange capacity

The design capacity for hardness removal should not exceed 20,000 grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilograin of hardness removed.

4.4.2.3 Depth of resin

The depth of the exchange resin should not be less than three feet.

4.4.2.4 Flow rates

The rate of softening should not exceed seven gallons per minute per square foot of bed area and the backwash rate should be six to eight gallons per minute per square foot of bed area.

4.4.2.5 Freeboard

The freeboard will depend upon the specific gravity of the resin and the direction of water flow.

4.4.2.6 Underdrains and supporting gravel

The bottoms, strainer systems and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters. (see Sections 4.2.1.6 and 4.2.1.7).

TEN STATES STANDARDS FOR SOFTENERS

4.4.2.7 Brine distribution

Facilities should be included for even distribution of the brine over the entire surface of both upflow and downflow units.

4.4.2.8 Cross connection control

Backwash, rinse and air relief discharge pipes should be installed in such a manner as to prevent any possibility of back-siphonage.

4.4.2.9 Bypass

A bypass must be provided around softening units to produce a blended water of desirable hardness. Totalizing meters must be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shut-off valve should be provided on the bypass line. In some installations it may be necessary to treat the bypassed water to obtain acceptable levels of iron and/or manganese in the finished water.

4.4.2.10 Additional limitations

Waters having five units or more turbidity should not be applied directly to the cation exchange softener. Silica gel resins should not be used for waters having a pH above 8.4 or containing less than six milligrams per liter silica and should not be used when iron is present. When the applied water contains a chlorine residual the cation exchange resin shall be a type that is not damaged by residual chlorine. Phenolic resin should not be used.

4.4.2.11 Sampling taps

Smooth-nose sampling taps must be provided for the collection of representative samples. The taps shall be located to provide for sampling of the softener influent, effluent and blended water. The sampling taps for the blended water shall be at least 20 feet downstream from the point of blending. Petcocks are not acceptable as sampling taps.

4.4.2.14 Stabilization

Stabilization for corrosion control shall be provided. (see Section 4.8.5).

4.4.2.15 Waste disposal

Suitable disposal must be provided for brine waste. (see Section 4.11).

4.4.2.16 Construction material

Pipes and contact materials must be resistant to the aggressiveness of salt.

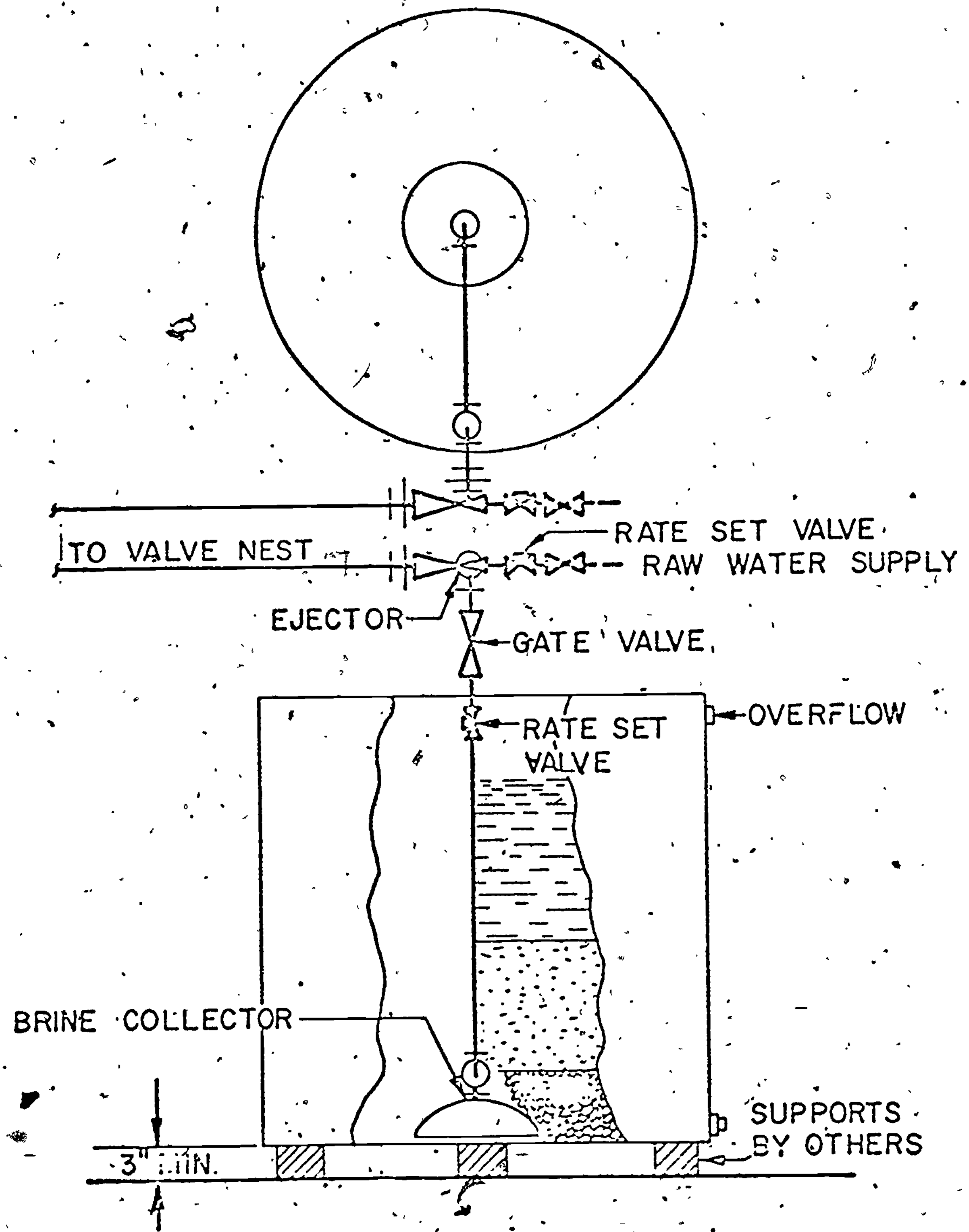
4.4.2.17 Housing

Salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

4.11.2 Brine waste

The waste from ion exchange plants, demineralization plants, etc. may be disposed of by controlled discharge to a stream if adequate dilution flow is available. Stream requirements of the regulatory agency will control the rate of discharge. Except when discharging to large waterways, a holding tank of suffucient size should be provided to allow the brine to be discharged over a twenty-four hour period. Where discharging to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer and/or interference with the waste treatment processes. The effect of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons.

BASIC COMPONENTS OF A BRINE TANK



TRANSPARENCY 113AWS - #10

TEN STATES STANDARDS FOR BRINE TANK

4.4.2.12 Brine and salt storage tanks.

Brine measuring or salt dissolving tanks and wet salt storage facilities must be covered and must be constructed of corrosion-resistant material. The make-up water inlet must have a free-fall discharge of two pipe diameters above the maximum liquid level of the unit or be otherwise protected from back-siphonage. Water for filling the tank should be distributed over the entire surface by pipes above the maximum brine level in the tank. The salt shall be supported on graduated layers of gravel under which is a suitable means of collecting the brine. Wet salt storage basins must be equipped with manhole or hatchway openings having raised curbs and watertight covers having overhanging edges similar to those required for finished water reservoirs. Overflow, where provided, must be turned down, have a proper free fall discharge, and be protected with corrosion-resistent screens or self-closing flap valves.

4.4.2.13 Salt storage capacity

Salt storage should have sufficient capacity to store in excess of 1½ carloads or truckloads of salt, and provide for at least 30 days of operation.

TROUBLE SHOOTING

PROBLEM (1) - REDUCED FLOW THROUGH SOFTENER

PROBABLE CAUSE (1) - LACK OF PRESSURE AT SOFTENER INLET.
REMEDY - INSTALL BOOSTER PUMP OR INCREASE PIPE SIZE SUPPLING SOFTENER.

PROBABLY CAUSE (2) - CLOGGED SCREEN
REMEDY - CLEAN OR REPLACE ALL WYE SCREENS AND/OR SCREENS LOCATED IN THE METER.

PROBABLY CAUSE (3) - CLOGGED MANIFOLD
REMEDY - BACKFLOW AND CLEAN WITH SODIUM HYDROSULFIDE.

PROBABLY CAUSE (4) - INSUFFICIENT BACKWASH
REMEDY - WHEN A SOFTENER HAS NOT BEEN BACKWASHED SUFFICIENTLY THE ZEOLITE BED BECOMES PACKED AND DIRTY. TO CLEAN THE ZEOLITE CLOSE ALL VALVES AND REMOVE MANHOLE OR HANDHOLE IN THE TOP OF THE SOFTENER. GRADUALLY OPEN BACKWASH VALVE, LETTING WATER FLOW OUT THE MANHOLE OR HANDHOLE UNTIL THE TOP OF THE ZEOLITE BED IS NEARLY LEVEL WITH THE MANHOLE. WITH WATER FLOWING OUT OF THE MANHOLE, PROBE THE ENTIRE ZEOLITE BED ABOVE THE GRAVEL LAYER WITH A ROD. STIR ANY PACKED SECTIONS UNTIL THEY ARE FREE. CONTINUE TO LET THE WATER FLOW FROM THE MANHOLE UNTIL IT COMES CLEAN.

CAUTION: TAKE CARE NOT TO WASH OUT ANY ZEOLITE.

TROUBLE SHOOTING

PROBLEM (2) - LOSS OF CAPACITY

PROBABLE CAUSE (1) - LOSS OF RESIN
REMEDY - ADD MORE ZEOLITE

PROBABLE CAUSE (2) - NOT ENOUGH SALT IN BRINE SATURATOR
REMEDY - ADD MORE SALT TO BRINE SATURATOR. THE HEIGHT OF SALT IN THE BRINE SATURATOR MUST BE KEPT ABOVE THE MINIMUM LEVEL RECOMMENDED BY THE SOFTENER MANUFACTURER.

PROBABLE CAUSE (3) - INSUFFICIENT BRINE USED IN REGENERATION
REMEDY - THE FULL AMOUNT OF BRINE CALLED FOR BY THE MANUFACTURER SHOULD BE APPLIED EACH REGENERATION. MAKE SURE THE BRINE CONCENTRATOR IS FULL. IF NOT ADJUST FILL VALVE. ALSO, CHECK TO MAKE SURE THE FULL AMOUNT OF BRINE IS DRAWN DOWN DURING REGENERATION. IF NOT CHECK THE EDUCTOR AND THE PRESENCE OF SALT BRIDGING.

PROBABLE CAUSE (4) - INSUFFICIENT BACKWASHING
REMEDY SEE PROBLEM (1)-PROBABLE CAUSE (4)

PROBABLE CAUSE (5) - INCREASE IN HARDNESS OF RAW WATER
REMEDY - ANY CHANGE IN THE HARDNESS OF THE RAW WATER AFFECTS THE NORMAL GALLONAGE. WHENEVER THE HARDNESS OF THE RAW WATER CHANGES, THE NORMAL GALLONAGE OF SOFTENED WATER THE SOFTENER WILL DELIVER BETWEEN REGENERATIONS SHOULD BE CORRECTED.

PROBABLE CAUSE (6) - IRON FOULING
REMEDY - FIF THE RAW WATER CONTAINS MORE THAN .3 MG/L OF IRON, THE SOFTENER WILL BECOME IRON FOULED. TO ALLEVIATE THIS PROBLEM, REGENERATE WITH SODIUM HYDROSULFIDE. FOLLOW THE DIRECTIONS OF THE SODIUM HYDROSULFIDE MANUFACTURER.

TROUBLE SHOOTING

PROBLEM (2) CONTINUED -

PROBABLE CAUSE (7) - BACTERIAL FOULING
REMEDY - IF THE RAW WATER IS NOT CHLORINDATED, THE POSSIBILITY OF BACTERIAL FOULING EXISTS. TO ALLEVIATE THIS PROBLEM, PROVIDE CONTINUOUS CHLORINATION AND BACKWASH LONGER.

PROBABLE CAUSE (8) - ORGANIC FOULING
REMEDY - IF THE RAW WATER IS DERIVED FROM A SURFACE WATER SOURCE THE POSSIBILITY OF ORGANIC FOULING EXISTS. THERE APPEARS TO BE NO WAY TO SOLVE THIS PROBLEM OTHER THAN TO REPLACE THE RESIN.

TROUBLE SHOOTING

PROBLEM (3) - SLOW REGENERATION OR DIFFICULTY IN DRAWING BRINE

PROBABLE CAUSE (1) - INSUFFICIENT GRADING OF THE ZEOLITE IF THE TROUBLE IS EXPERIENCED WHEN THE SOFTENER IS NEW.

REMEDY - BACKWASH SOFTENER TO REMOVE FINES. IF BACKWASH RATE IS INADEQUATE TO REMOVE FINES, OPEN MANHOLE AND MANUALLY SCRAPE EXCESS FINES OFF THE TOP OF THE ZEOLITE BED.

PROBABLE CAUSE (2) - PACKED SALT IN THE BRINE SATURATOR.

REMEDY - BREAK UP THE SALT CAKE AND STIR WITH A ROD.

PROBABLE CAUSE (3) - DIRTY AND CLOGGED GRAVEL BED IN THE BRINE SATURATOR.

REMEDY - REMOVE SALT AND GRAVEL BED FROM THE BRINE SATURATOR AND CLEAN TANK. ADD NEW GRAVEL BED AND SALT.

PROBABLE CAUSE (4) - INSUFFICIENT BACKWASH

REMEDY - SEE PROBLEM (1) - PROBABLE CAUSE (4)

PROBABLE CAUSE (5) - OBSTRUCTION IN BRINE LINE.

REMEDY - REMOVE ALL BRINE PIPING AND CHECK FOR OBSTRUCTION. ALSO CHECK EDUCTOR FOR AN OBSTRUCTION.

PROBABLE CAUSE (6) - LOW OPERATING PRESSURE

REMEDY - INSTALL BOOSTER PUMP.

TRANSPARENCY II3AWS - #15

TROUBLE SHOOTING

PROBLEM (4) - BLOWN BED

PROBABLE CAUSE (1) - EXCESSIVELY HIGH BACKWASH RATES OR A SUDDEN SURGE OF WATER THROUGH THE SOFTENER DURING BACKWASH.

REMEDY - DRAIN THE SOFTENER BY REMOVING THE DRAIN PLUG; REMOVE THE ZEOLITE, KEEPING IT SEPARATE AND REMOVE THE UNDER BEDING. INSPECT THE LOWER MANIFOLD FOR CORRODED OR DAMAGED PARTS AND REPLACE ALL FOUND DEFECTIVE. RELAY THE UNDERBEDING, USING NEW MATERIAL. REPLACE THE OLD ZEOLITE IN THE SOFTENER AND ADD SUFFICIENT NEW ZEOLITE TO BRING THE LEVEL OF THE ZEOLITE UP TO THE PROPER POINT.

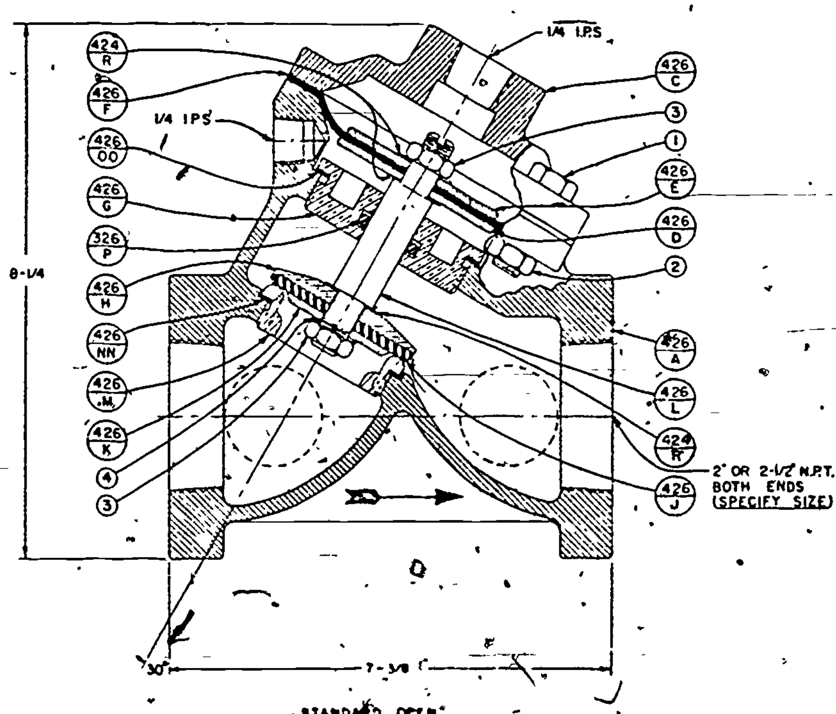
SENSORS:

1. IN TANK PROBES
2. DOWNSTREAM PROBES
3. AUTOMATIC TITRATORS

VALVES

1. ELECTRIC SOLENOID
2. MOTER DRIVEN
3. WATER OPERATED

WATER OPERATED VALVE

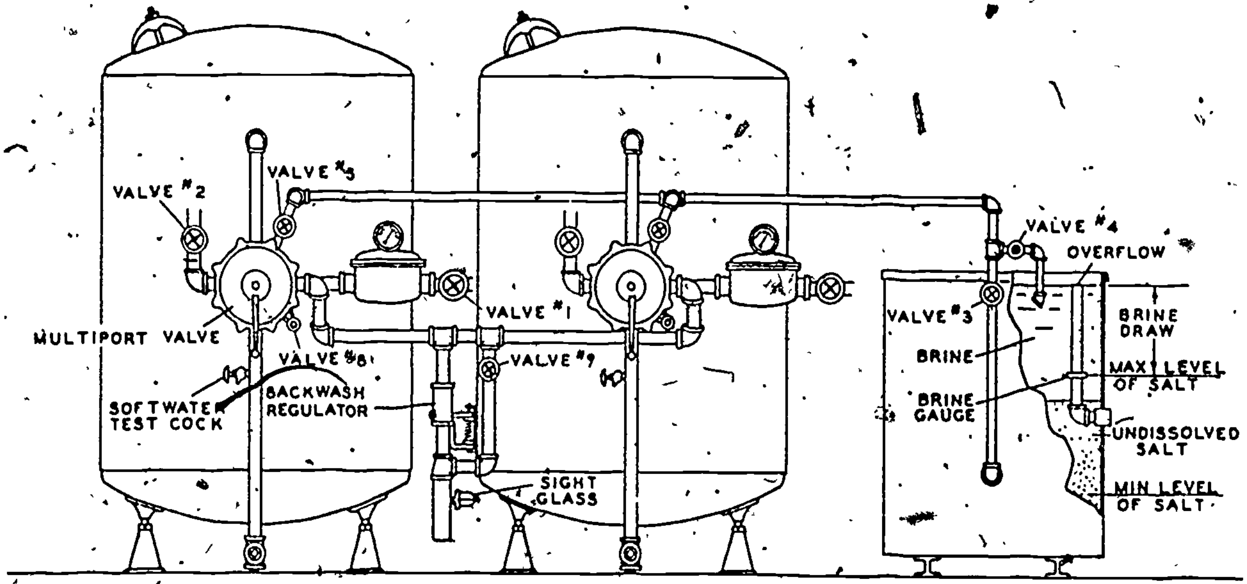


TRANSPARENCY 113AAWS - #19

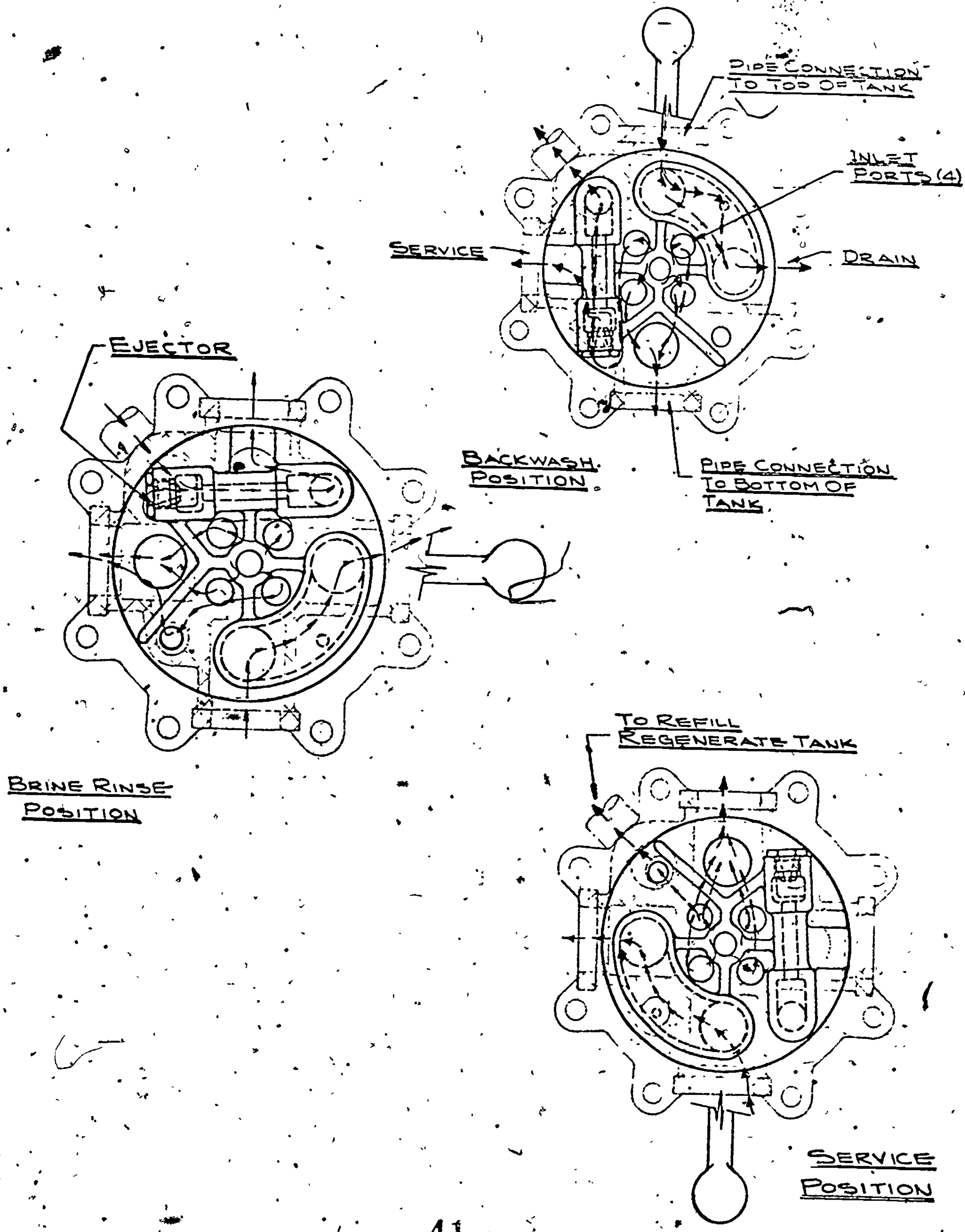
CONTROLS

1. Solo Control
2. Stager Control

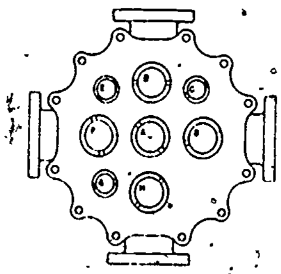
TYPICAL SOLO INSTALLATION



SOLO CONTROL OPERATION

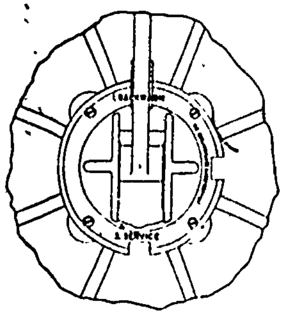


SOLO CONTROL

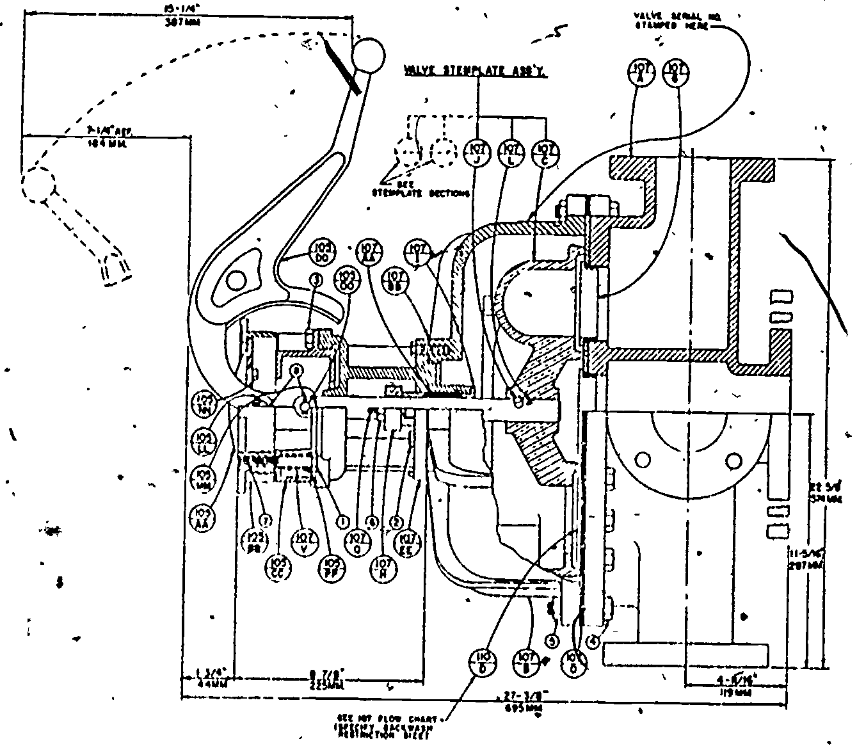


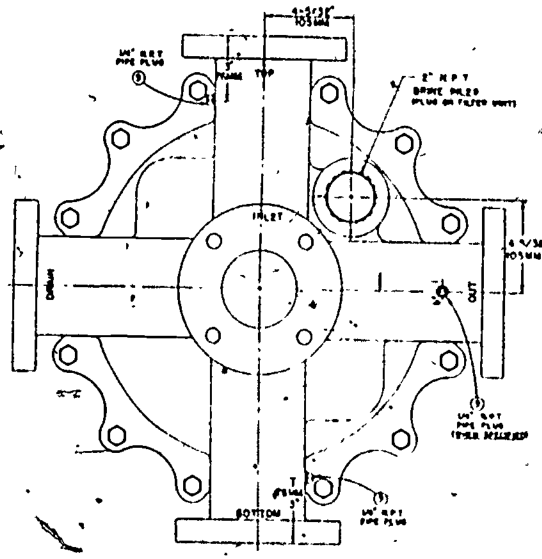
PORT IDENTIFICATION

A - INLET PORT
B - DRAIN PORT
C - BRINE TO TOP OF TANK PORT
D - TOP OF TANK PORT
E - BRINE INLET PORT
F - OUTLET PORT
G - BY-PASS PORT
H - BOTTOM OF TANK PORT

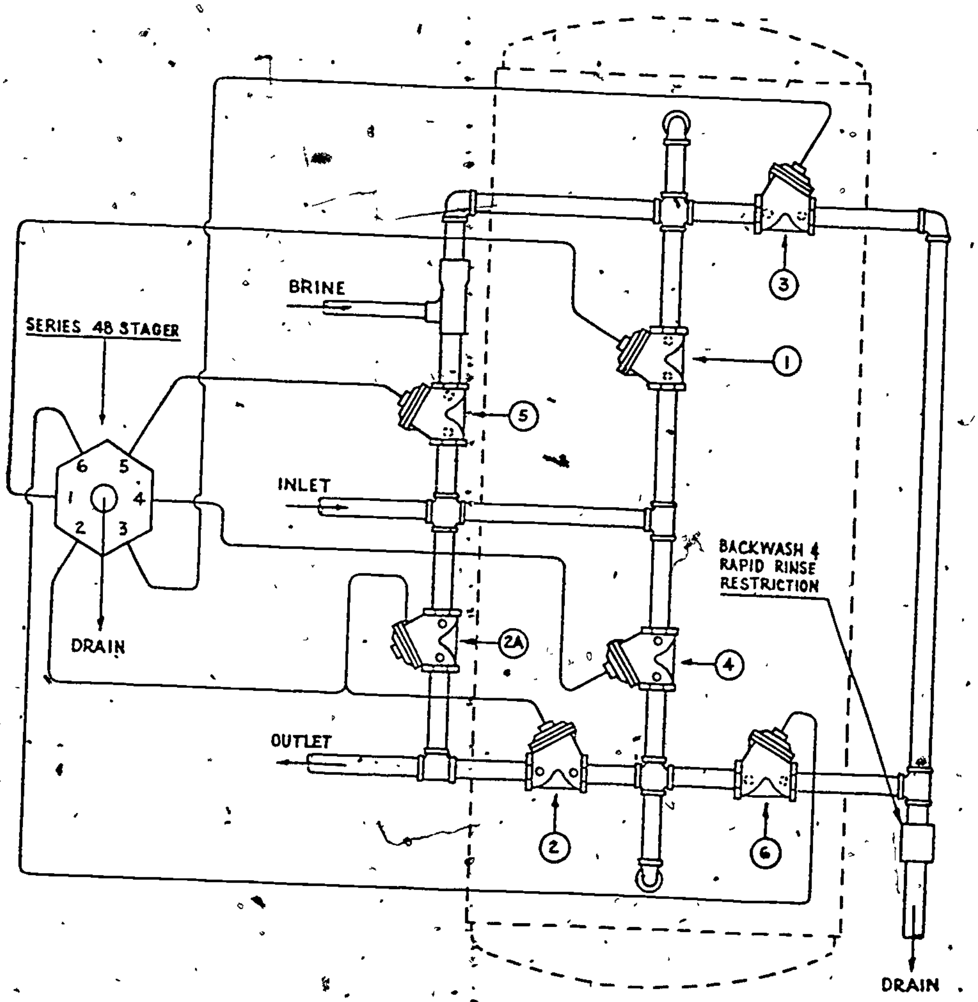


3-POSITION SOFTENER UNIT



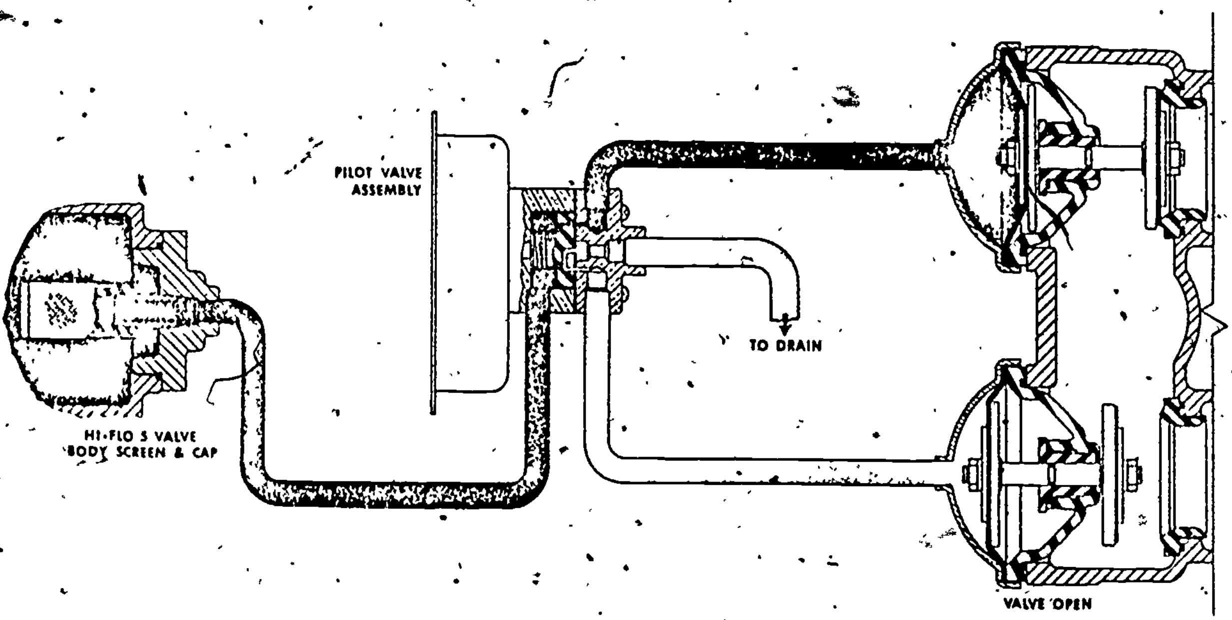


TYPICAL STAGER INSTALLATION



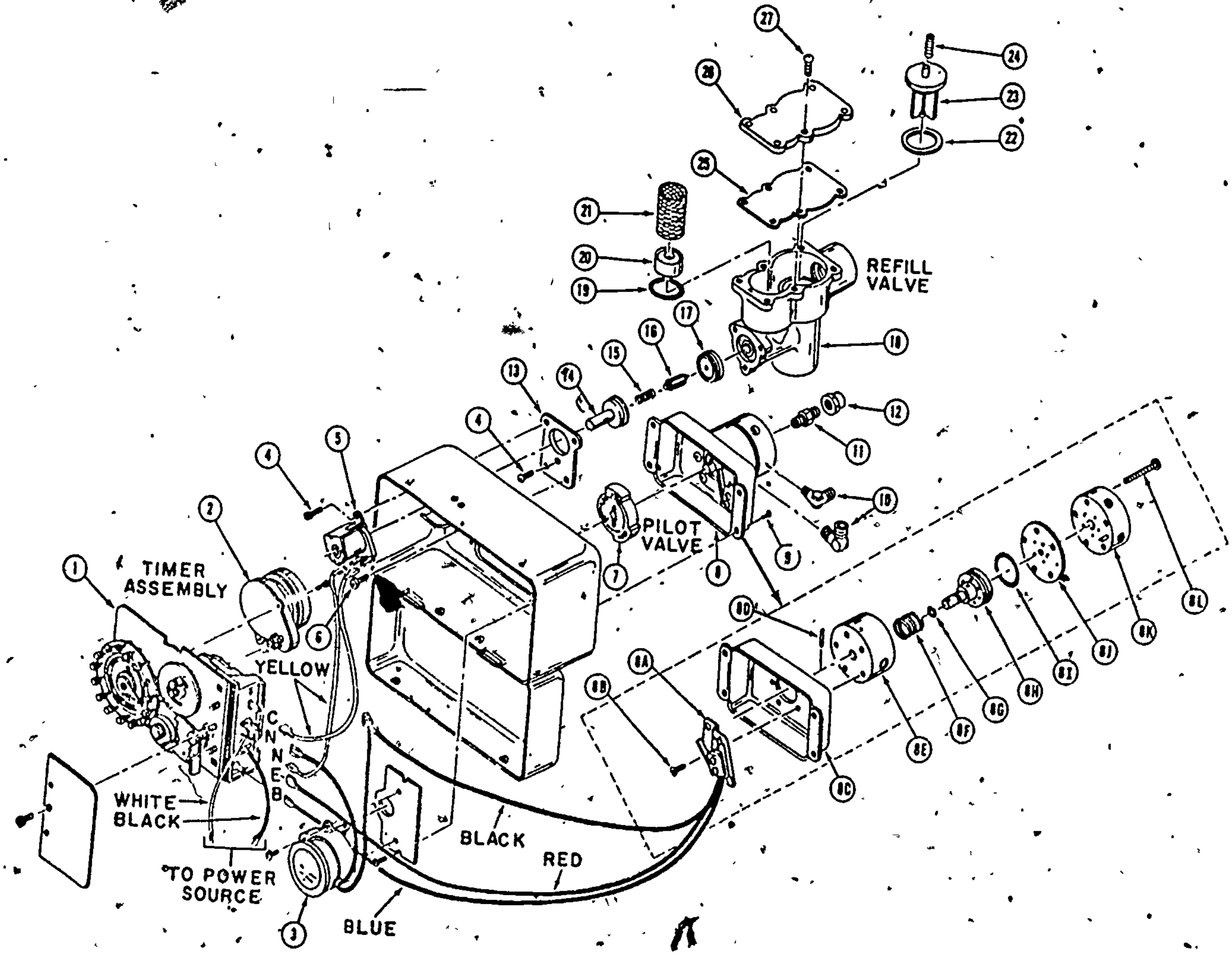
STAGER POSITION	SOFTENER FUNCTION	VALVES OPEN
4	SERVICE	1 & 2
	OFF	2 & 3
1	BACKWASH	3 & 4
	OFF	4 & 5
2	BRINE	5 & 6
3	RAPID RINSE	6 & 1

STAGER OPERATION



TRANSPARENCY 113MWS - #25

STAGER CONTROL

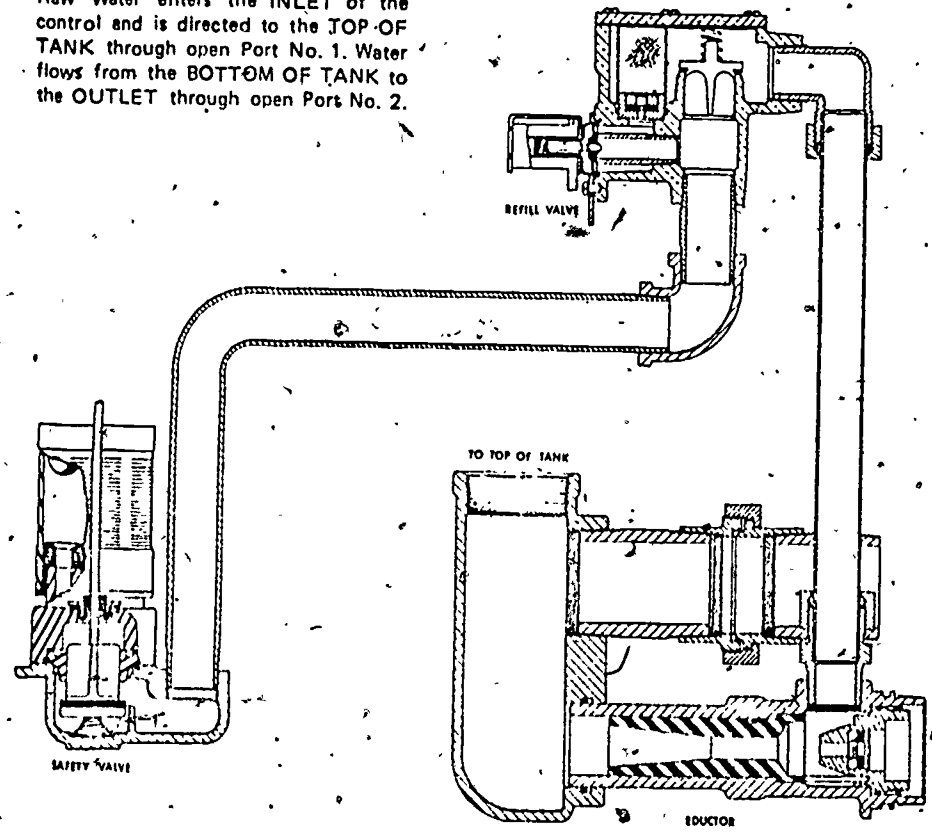


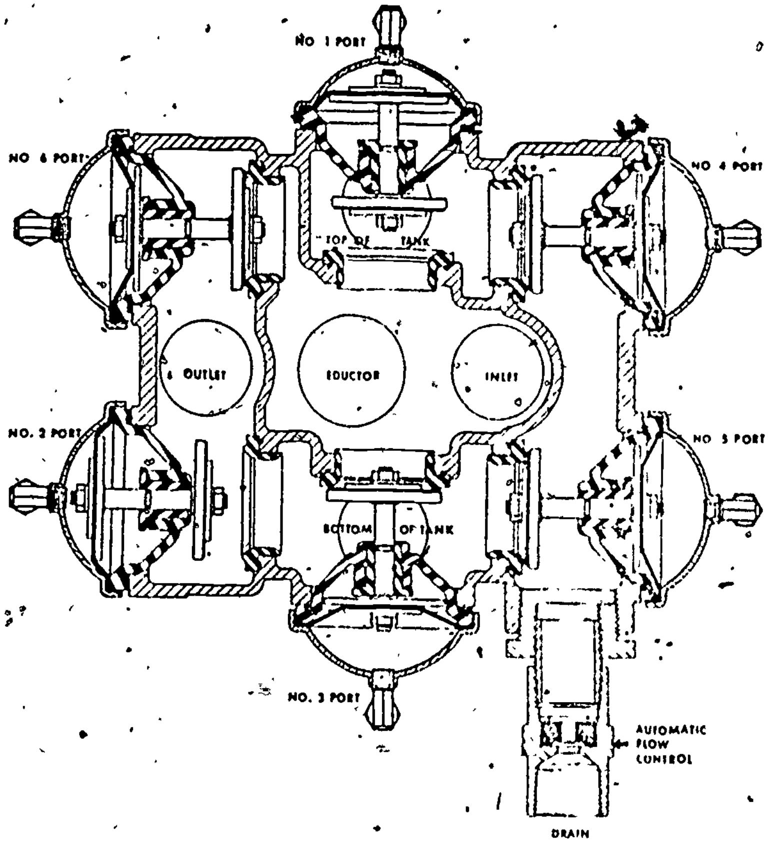
TRANSPARENCY II3MWS - #26

MULTI-VALVE ASSEMBLY OPERATION

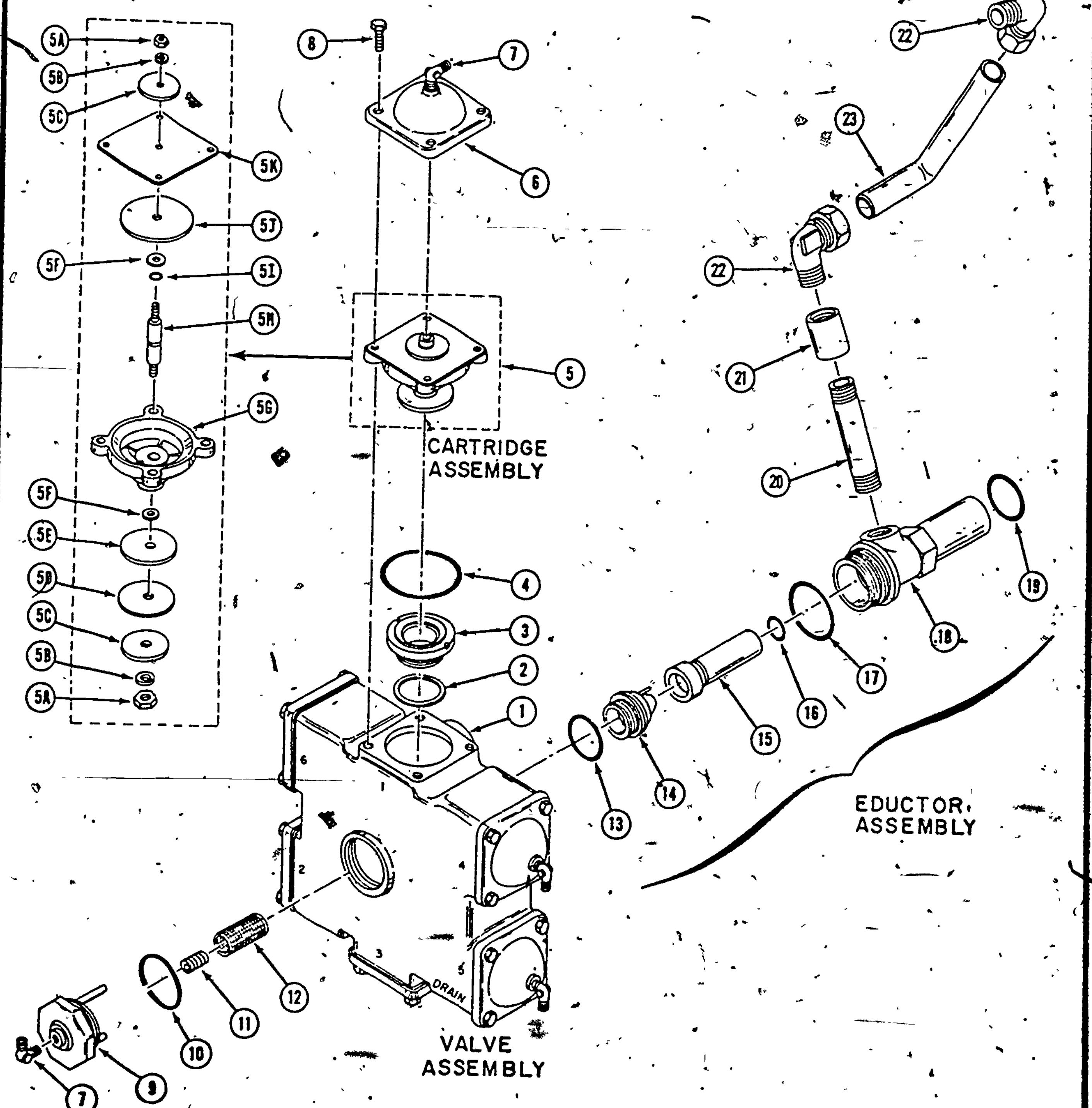
Service

Raw water enters the INLET of the control and is directed to the TOP OF TANK through open Port No. 1. Water flows from the BOTTOM OF TANK to the OUTLET through open Port No. 2.





MULTI VALVE ASSEMBLY



TRANSPARENCY 113AAWS - #28

CLASS PROBLEM #1

1. The following softener has been in operation for a number of years with varying water quality. One possible reason for failure is inadequate design. Evaluate the existing softener to determine whether the design is adequate.

Raw Water

Calcium - 12.25 grains/gallon
Magnesium - 7.65 grains/gallon
Flow - 80,000 gallon per day
Max. Flow - 157 gallons per minute

Softener

Size - 60 inch diameter; 72 inch shell height
Resin - Rese x 5, capacity 20,000 grains/ft^3, 90 ft^3
Backwash rate - 96 gallons per minute

Brine Tank

Size - 48 inch diameter; 48 inch shell height

2. What will be the cost per day to soften the water with the above softener with rock salt cost of $1.45/80 lbs.

CLASS HANDOUT

for

Training Module II3AAWS

Handout for II3AAWS - Intermediate Ion Exchange Softening

I. Introduction
   A. Principles of ion exchange softening
   B. Preventative maintenance for ion exchange softener
   C. Laboratory control for ion exchange softener
   D. Safety for ion exchange softener

II. Design Evaluation of an Ion Exchange Softener
   A. Softener
      1. Ten States Standards

4.4.2 Cation exchange process

Alternative methods of hardness reduction should be investigated when the sodium content and dissolved solids concentration is of concern. Iron, manganese, or a combination of the two, should not exceed 0.3 milligrams per liter in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron, manganese, or a combination of the two, is one milligram per liter or more.

4.4.2.1 Design

The units may be of pressure or gravity type, of either an upflow or downflow design. Automatic regeneration based on volume of water softened should be used unless manual regeneration is justified and is approved by the reviewing authority. A manual override shall be provided on all automatic controls.

4.4.2.2 Exchange capacity

The design capacity for hardness removal should not exceed 20,000 grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilograin of hardness removed.

4.4.2.3 Depth of resin

The depth of the exchange resin should not be less than three feet.

4.4.2.4 Flow rates

The rate of softening should not exceed seven gallons per minute per square foot of bed area and the backwash rate should be six to eight gallons per minute per square foot of bed area.

4.4.2.5 Freeboard

The freeboard will depend upon the specific gravity of the resin and the direction of water flow.

4.4.2.6 Underdrains and supporting gravel

The bottoms, strainer systems and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters. (see Sections 4.2.1.6 and 4.2.1.7).

4.4.2.7 Brine distribution

Facilities should be included for even distribution of the brine over the entire surface of both upflow and downflow units.

4.4.2.8 Cross connection control

Backwash, rinse and air relief discharge pipes should be installed in such a manner as to prevent any possibility of back-siphonage.

4.4.2.9 Bypass

A bypass must be provided around softening units to produce a blended water of desirable hardness. Totalizing meters must be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shut-off valve should be provided on the bypass line. In some installations it may be necessary to treat the bypassed water to obtain acceptable levels of iron and/or manganese in the finished water.

4.4.2.10 Additional limitations

Waters having five units or more turbidity should not be applied directly to the cation exchange softener. Silica gel resins should not be used for waters having a pH above 8.4 or containing less than six milligrams per liter silica and should not be used when iron is present. When the applied water contains a chlorine residual the cation exchange resin shall be a type that is not damaged by residual chlorine. Phenolic resin should not be used.

4.4.2.11 Sampling taps

Smooth-nose sampling taps must be provided for the collection of representative samples. The taps shall be located to provide for sampling of the softener influent, effluent and blended water. The sampling taps for the blended water shall be at least 20 feet downstream from the point of blending. Petcocks are not acceptable as sampling taps.

4.4.2.14 Stabilization

Stabilization for corrosion control shall be provided. (see Section 4.8.5).

4.4.2.15 Waste disposal

Suitable disposal must be provided for brine waste. (see Section 4.11).

4.4.2.16 Construction material

Pipes and contact materials must be resistant to the aggressiveness of salt.

4.4.2.17 Housing

Salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

4.11.2 Brine waste

The waste from ion exchange plants, demineralization plants, etc. may be disposed of by controlled discharge to a stream if adequate dilution flow is available. Stream requirements of the regulatory agency will control the rate of discharge. Except when discharging to large waterways, a holding tank of suffucient size should be provided to allow the brine to be discharged over a twenty-four hour period. Where discharging to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer and/or interference with the waste treatment processes. The effect of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons.

B. Brine Tank

4.4.2.12 Brine and salt storage tanks

Brine measuring or salt dissolving tanks and wet salt storage facilities must be covered and must be constructed of corrosion-resistant material. The make-up water inlet must have a free fall discharge of two pipe diameters above the maximum liquid level of the unit or be otherwise protected from back-siphonage. Water for filling the tank should be distributed over the entire surface by pipes above the maximum brine level in the tank. The salt shall be supported on graduated layers of gravel under which is a suitable means of collecting the brine. Wet salt storage basins must be equipped with manhole or hatchway openings having raised curbs and watertight covers having overhanging edges similar to those required for finished water reservoirs. Overflow, where provided, must be turned down, have a proper free fall discharge and be protected with corrosion-resistent screens or self-closing flap valves.

4.4.2.13 Salt storage capacity

Salt storage should have sufficient capacity to store in excess of 1½ carloads or truckloads of salt, and provide for at least 30 days of operation.

III. Advanced Operation (Trouble Shooting)

A. PROBLEM (1) - Reduced Flow Through Softener

Probable Cause (1) - Lack of pressure at softener inlet.
Remedy - Install booster pump or increase pipe size supplying softener.

Probable Cause (2) - Clogged screen
Remedy - Clean or replace all wye screens and/or screens located in the meter.

Probable Cause (3) - Clogged manifold
Remedy - Backflow and clean with sodium hydrosulfide.

Probable Cause (4) - Insufficient backwash
Remedy - When a softener has not been backwashed sufficiently the zeolite bed becomes packed and dirty. To clean the zeolite close all valves and remove manhole or handhole in the top of the softener. Gradually open backwash valve, letting water flow out the manhole or handhole until the top of the zeolite bed is nearly level with the manhole. With water flowing out of the manhole, probe the entire zeolite bed above the gravel layer with a rod. Stir any packed sections until they are free. Continue to let the water flow from the manhole until it comes clean.
CAUTION: Take care not to wash out any zeolite.

B. PROBLEM (2) - Loss of Capacity

Probable Cause (1) - Loss of Resin
Remedy - Add more zeolite

Probable Cause (2) - Not enough salt in brine saturator
Remedy - Add more salt to brine saturator. The height of salt in the brine saturator must be kept above the minimum level recommended by the softener manufacter.

Probable Cause (3) - Insufficient brine used in regeneration.
Remedy - The full amount of brine called for by the manufacturer should be applied each regeneration. Make sure the brine concentrator is full. If not, adjust fill valve. Also check to make sure the full amount of brine is drawn down during regeneration. If not check the eductor and the presence of salt bridging.

Probable Cause (4) - Insufficient backwashing
Remedy - See PROBLEM (1) Probable Cause (4)

Probable Cause (5) - Increase in hardness of raw water
Remedy - Any change in the hardness of the raw water affects the normal gallonage. Whenever the hardness of the raw water changes, the normal gallonage of softened water the softener will deliver between regenerations should be corrected.

Probable Cause (6) - Iron Fouling
Remedy - If the raw water contains more than .3 mg/l of iron, the softener will become iron fouled. To alleviate this problem, regenerate with sodium hydrosulfide. Follow the directions of the sodium hydrosulfide manufacturer.

Probable Cause (7) - Bacterial Fouling
Remedy - If the raw water is not chlorinated, the possibility of bacterial fouling exists. To alleviate this problem, provide continuous chlorination and backwash longer.

Probable Cause (8) - Organic Fouling
Remedy - If the raw water is derived from a surface water source, the possibility of organic fouling exists. There appears to be no way to solve this problem other than to replace the resin.

C. PROBLEM (3) - Slow Regeneration or Difficulty in Drawing Brine

Probable Cause (1) - Insufficient grading of the zeolite if the trouble is experienced when the softener is new.
Remedy - Backwash softener to remove fines. If backwash rate is inadequate to remove fines, open manhole and manually scrap excess fines off the top of the zeolite bed.

Probable Cause (2) - Packed salt in the brine saturator.
Remedy - Break up the salt cake and stir with a rod.

Probable Cause (3) - Dirty and clogged gravel bed in the brine saturator.
Remedy - Remove salt and gravel bed from the brine saturator and clean tank. Add new gravel bed and salt.

Probable Cause (4) - Insufficient backwash
Remedy - See Problem (1) - Probable cause (4)

Probable Cause (5) - Obstruction in brine line.
Remedy - Remove all brine piping and check for obstruction. Also check eductor for an obstruction.

Probable Cause (6) - Low operating pressure.
Remedy - Install booster pump.

D. PROBLEM (4) - Blown Bed

Probable Cause (1) - Excessively high backwash rates or a sudden surge of water through the softener during backwash.
Remedy - Drain the softener by removing the drain plug; remove the zeolite, keeping it separate and remove the underbedding. Inspect the lower manifold for corroded or damaged parts and replace all found defective. Relay the underbedding, using new material. Replace the old zeolite in the softener and add sufficient new zeolite to bring the level of the zeolite up to the proper point.

IV. Equipment Maintenance and Repair
   A. Sensors
      1. Intank probes
      2. Downstream probes
      3. Automatic Titrators
   B. Valves
      1. Electric solenoid
      2. Motor driven
      3. Water operated
   C. Controls
      1. Solo control
      2. Stager

EXAMINATION

for

Training Module II3AAWS

Examination for II3AAWS - Intermediate Ion Exchange Softening

1. For each mg/l of calcium removed ______ mg/l of sodium are released into the water in ion exchange softening.

2. List four periodic checks necessary for a good preventative maintenance program on an ion exchange softener.

   a.
   b.
   c.
   d.

3. List the five factors affecting water stabilization.

   a.
   b.
   c.
   d.
   e.

4. A blown bed is usually caused by ______________________________.

5. List two types of control commonly used on ion exchange softeners.

   a.
   b.

6. Salt storage should be adequate to handle ______ days of salt usage.

7. List six causes of lost capacity in ion exchange softening.

   a.
   b.
   c.
   d.
   e.
   f.

TRUE OR FALSE - CIRCLE THE CORRECT ANSWER

T or F 8. Softeners should be operated at 2/3 capacity and regenerated at .3 lb salt/1000 grains removed.

T or F 9. Softeners in Iowa are designed under the "Ten States Standards".

T or F 10. Water activated valves would work well in all types of waters.

T or F 11. Reduced flow through a softener can always be solved by increasing the length of backwash.

T or F 12. Organically fouled resins can be cleaned by using a solution of sodium hydrosulfide.

T or F 13. Most softeners need continuous online monitoring for adequate control of the softener.

T or F 14. Ion exchange softened water has all the clacium and magnesium removed and therefore is not a corrosive water.

T or F 15. A packed ion exchange bed can be corrected by backwashing longer.

T or F 16. If the support gravel bed for the softener becomes disturbed, it can be corrected by increasing the backwash rate.

T or F 17. Ion exchange softeners can soften water containing 1.0 mg/l of iron with no adverse affect on the softener.