OPERATING INSTRUCTIONS

OPERATORS COPY

Bldg 670

PERMUTIT
SYBRON CORPORATION

THE PERMUTIT COMPANY, DIVISION OF SYBRON CORPORATION, E49 MIDLAND AVENUE, PARAMUS, NEW JERSEY 07652

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OPERATING INSTRUCTIONS

for WATER CONDITIONING EQUIPMENT

Date October, 1971

Job No. A173E48112

Prepared for Camp LeJeune
North Carolina

PERMUTIT GRAVITY SPIRACTOR

THE PERMUTIT COMPANY, E 49 MIDLAND AVENUE, PARAMUS, NEW JERSEY 07652
a division of SYBRON CORPORATION

3054-965-3C

PERMUTIT GRAVITY SPIRACTOR

SPECIFICATIONS AND DATA

Number of Units:	Two (2)
Size:	12-S
Principal Dimensions:	
Top Diameter:	10'-0"
Bottom Diameter:	2'-6"
Vertical Height:	23'-3"
Flow Rate:	1400 GPM (Total Plant) 700 GPM (each unit)
Flow Operating Range:	50% to 100% capacity. Do not operate below 50% capacity.
Operating Weight:	88,000 lbs. (each)
Chemical Dosages:	
Quick Lime (90% CaO): Trisodium Phosphate:	) Determined in the field)
Chemical Feed System:	By Purchaser
Catalyst Material Type:	Hydro No. 80 sand, as furnished by Standard Sand & Silica Company
Volume of Catalyst:	120 cu.ft. (each unit)
Catalyst Removal:	Excess removal of catalyst manually controlled by opening flushout valve to drain pit. Removal determined by carryover at No. 7 sample port.

Sample Connections
Locations -

No.	Location
1	4'-0" above the bottom straight of Spiractor
2	8'-3" above the bottom straight of Spiractor
3	10'-0" above the bottom straight of Spiractor
4	11'-3" above the bottom straight of Spiractor
5	12'-0" above the bottom straight of Spiractor
6	15'-4" above the bottom straight of Spiractor
7	16'-9" above the bottom straight of Spiractor
8	18'-0" above the bottom straight of Spiractor
9	18'-9" above the bottom straight of Spiractor
10	Effluent Pocket

NOTE: Of these sample connections, five (5) are plugged and four (4) are valved for chain operation from ground level.
Samples No. 9, 8, 6, 4 and 1 are plugged.
Samples No. 7, 5, 3 and 2 are valved for chain operation.

Chemical Tests: (See Instructions for Chemical Tests)

Test Set No. 12 - Alaklinity
Test Set No. 73 - Total hardness, calcium hardness, and magnesium hardness.

Catalyst Charging Hopper

Number of Units: Two (2)

Dimensions:
Top Diameter: 2'-6"
Bottom Diameter: 9"
Height: 24"

Eductor: (2) Two Schutte & Koerting Size 1½" Water Jet Sand Eductor

Reference Drawings:

Layout and Assembly of Spiractor 185-14984
Assembly of Catalyst Hopper 101-08796

SPIRACTOR

1. Capacity

The Spiractor will give a constant flow of 700 gpm.

2. Principle of Operation

The plant is operated for the purpose of reducing the hardness of the raw water. The softening is accomplished by the addition of lime.

Raw water is admitted at a constant flow rate at the bottom of the Spiractor and passes through a catalyst bed in a tangential upward flow.

Lime and if required, trisodium phosphate, are added just at the point of entry.

Reaction of the chemical with the raw water causes precipitates to form, which deposit on the particles of catalyst, causing the particles to "grow".

This reaction may be written as:

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$CA(OH)_2 + CA(HCO_3)^2 \longrightarrow 2CaCO_3 + 2H_2O$$

The addition of trisodium phosphate is useful in treating certain waters. The action of this chemical is to slow down the reaction between the lime and alkalinity resulting in the formation of more dense grains of "grown catalyst", and also prevents the formation of small particles which would tend to carry over.

The treated water then leaves the Spiractor and is passed to filters.

In operation, it is necessary to periodically remove a portion of the "grown" catalyst from the catalyst bed, to prevent the catalyst bed from building up to a point where catalyst will carry over from the Spiractor. A certain amount of fresh catalyst must also be added to prevent the average size of the catalyst particles from increasing excessively.

3. Rate of Flow

The flow to the Spiractor is controlled by a Simplex No. 82BFH Controller. The Spiractor must operate at a constant rate of flow. It will operate effectively at any rate between about 50% and 100% of its maximum rate, but must be held constant at the rate selected.

4. Sampling Connections

Ten (10) possible sample connections are provided to take samples from five points at various levels. The upper sampling point No. 9 is 18'-9" above the base straight of the tank with the next lower point No. 8, 18'-0" above the base straight of the tank.

For convenience in designation, the top sampling poing is referred to as Sampling Point No. 9. The next lower point is called No. 8, and so forth down to sample point No. 1. The presence of catalyst grains in sample No. 7 indicates that the top of the catalyst bed is riding too high, either as a result of too high a flow rate or excess catalyst in the unit. Sampling point No. 10 is the Effluent Pocket.

5. Starting Plant in Operation

Be sure that inside of tank is clean of debris. Install the catalyst supplied.
Add catalyst until the bed level is between Sampling points No. 2 and No. 3. This should require about 120 cu. ft. of catalyst. With the rated flow of 700 gpm flowing through the unit, the bed should be washed to waste for a few minutes to remove excessively fine grains.

Stop flow and check bed level.
If level of catalyst is above sampling point No. 3, remove excess catalyst.

Place the chemical feeds in operation.

Place the trisodium phosphate feed in operation (if required).

6. Control of Catalyst Bed

When operating at the designed flow rate of 700 gpm, the top of the expanded bed should be held between sampling point No. 5 and sampling point No. 7. The velocity of flow through the top of the expanded bed should be approximately 15 gallons per minute per sq. ft. of bed area. If a lower flow rate is used, the bed should be lowered so that the velocity of flow through the surface of the bed (expressed as gpm per sq.ft.) is about the same as above: The chemical feeds should, of course, be correspondingly reduced.

Operation of the unit should be such that a sample taken from point No. 5 shows some carryover of catalyst material, while a sample from point No. 7 is clear.

If the sample from point No. 5 is clear, the flow rate may not be high enough or the quantity of catalyst may not have grown enough to show at this point.

If the sample from point No. 7 contains carried-over material, the flow rate may be too high, or there is an excess of catalyst in the unit and some catalyst must be blown out of the unit.

Make adjustments as necessary.

IMPORTANT: NEVER ALLOW CATALYST TO CARRY OVER INTO EFFLUENT WATER.

It is estimated that the individual catalyst grains will grow from 3 to 4 times their original diameters. The amount of replacement catalyst needed will vary from about 1/25th to about 1/50th of the grown catalyst removed.

When operating at lower flow rates, as described above, the amount of grown catalyst to be removed will, of course, be reduced. At lower flow rates it will also be necessary to increase the ratio of replacement catalyst to grown catalyst removed so that the average catalyst grain size will be smaller than when operating at full rate of flow.

7. Chemical Results and Control

It is now possible that changes will occur in the composition of the raw water. Changes in the chemical dosages will have to be made to meet the changes in the composition of the raw water.

Chemical Tests

As a matter of routine control, the following tests should be made several times a day on both the raw and treated water and the results recorded:

Total Hardness
Methyl Orange Alkalinity (Alk.A)
Phenolphthalein Alkalinity (Alk.B)

To calculate the total hardness of the treated water use the following formula:

$$\text{T.H. in ppm as } CaCO_3 = \text{T.H. in grains per gal.} \times 17.1$$

Substitute the ppm values of ALK.A and ALK.B obtained for the treated water in the following equation:

$$(2 \times \text{ALK.B}) - \text{ALK.A} = \text{ALK.C}$$

If the result of the above equation is between -5 and +5 the operation is satisfactory. If the result is less than -5 the lime feed should be increased. If the result is greater than +5 the lime feed should be decreased.

After making any change in the chemical dosage, allow 20 to 30 minutes to elapse so that the new conditions will become stabilized through the Spiractor before taking a sample for new tests.

EDUCTOR

1. Purpose - The eductor carries the fresh catalyst from the hopper up into the Spiractor.

2. Operating Procedure -
The inlet valve to the eductor should be opened. The dilution water line should then be opened, and the catalyst fed into the hopper. It will be carried from there up into the Spiractor.

When sufficient catalyst has been withdrawn from the hopper by the eductor to fill the Spiractor up to the level between sample connections No. 2 and No.3 the dilution line should be closed, followed by the eductor inlet valve, in that order. If too much time is allowed to elapse between the closing of the discharge and the inlet valves, the hopper will overflow.

LIME FEED

The most satisfactory results will be obtained by feeding quick lime.

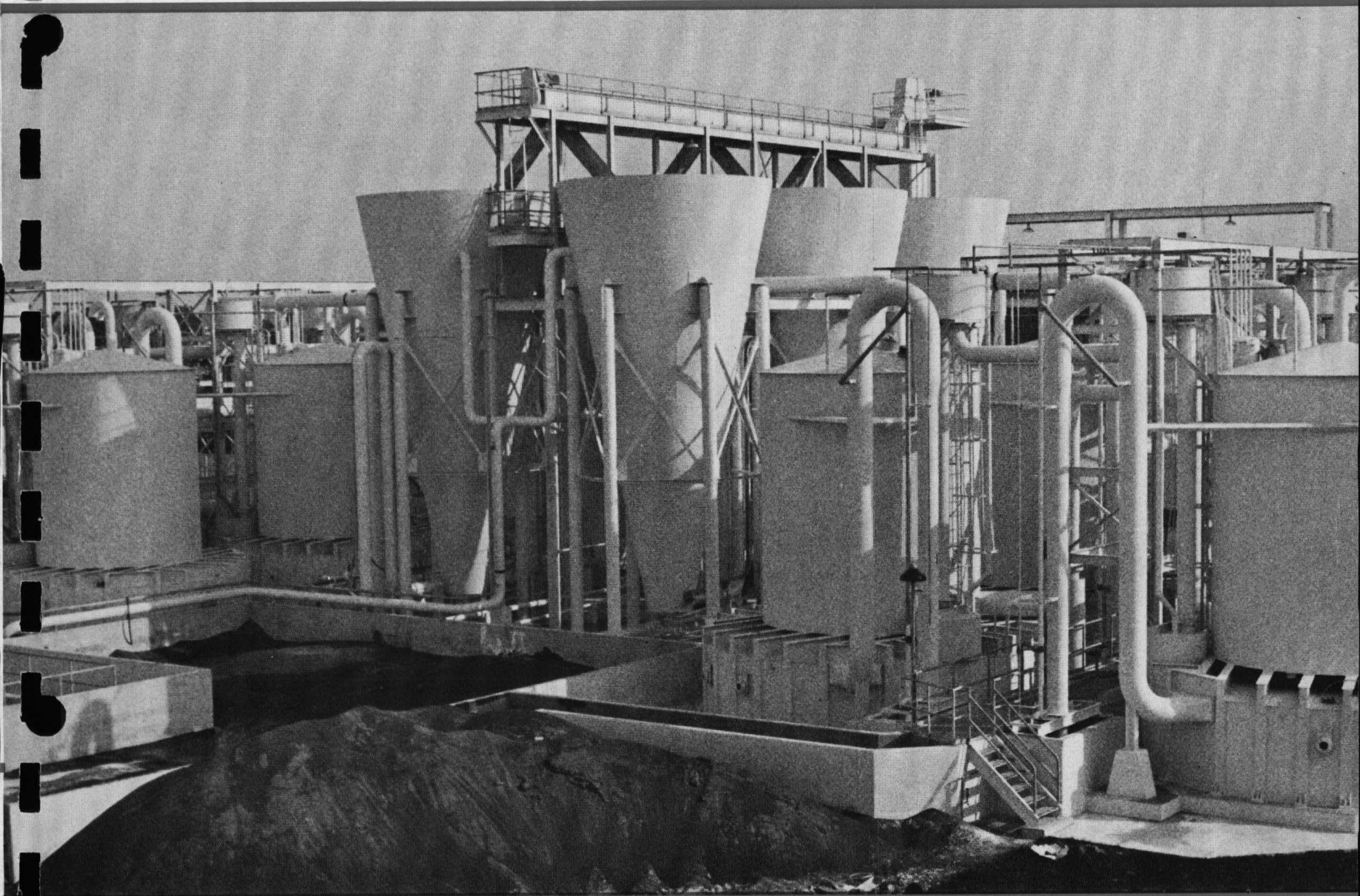
TRI-SODIUM PHOSPHATE FEED (If Required)

Tri-Sodium phosphate solution should be made up in a separate feed tank and pumped by an adjustable stroke, diaphragm type positive displacement pump. The phosphate solution is introduced into the raw water entering the Spiractor.

A weighted quantity of chemical is placed in the feed tank and water is slowly admitted, thus dissolving the charge. Agitate if necessary to dissolve all the phosphate.

The pump described above will deliver a measured volume at a constant rate. The amount of chemical fed may be varied by varying the strength of the mixture. However, if the pump runs at a constant number of strokes per minute, the volume of solution delivered can also be varied by adjusting the length of the stroke.

Bulletin 2384D



PERMUTIT® SPIRACTOR®

high-rate cold lime water softener

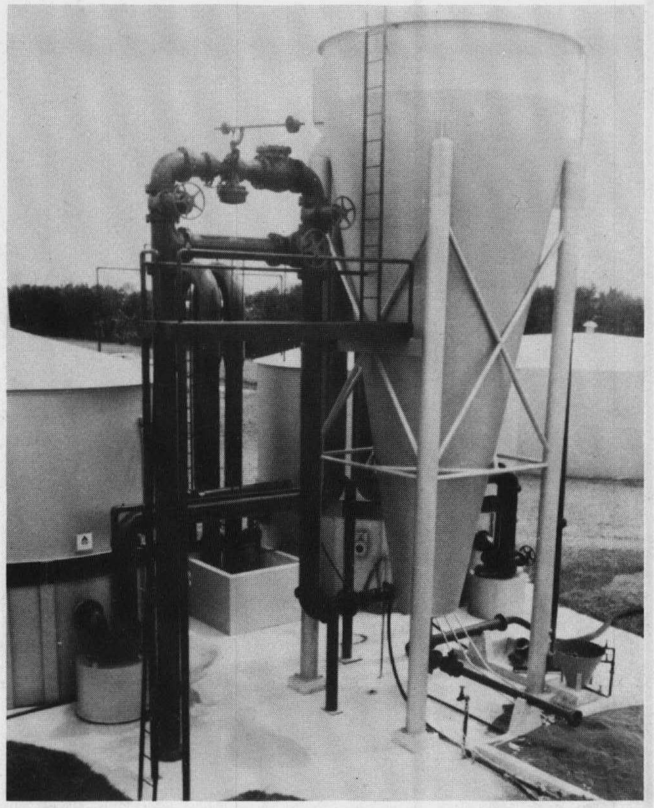
Ideal for treating waters that require softening primarily, the Permutit Spiractor offers very high flow rates in relation to the space it occupies. Treatment period (detention time) is only 8 to 10 minutes. No messy sludge waste or brine disposal problems to cope with; Spiractor's waste product is hard pebbles, easily disposable as desirable land fill.

WATER & WASTE TREATMENT PERMUTIT SYBRON CORPORATION

The Permutit SPIRACTOR For S

The Permutit Spiractor is a high-rate, cold lime-soda water softener embodying a unique softening principle—catalytic precipitation. Besides hastening the softening process, which takes less than 8 minutes, a charge of catalyst granules serve as nuclei around which the precipitated hardness compounds build up. These enlarged granules are dense crystalline pebbles, much like coarse sand.

Thus the voluminous wet sludge (containing 85 to 95% water by weight), characteristic of all other lime-water softening processes, is eliminated. Such wet sludge has presented problems in disposal because it usually must first be lagooned or otherwise dried. The Spiractor produces a waste product consisting of enlarged catalyst granules that, after drainage, has a moisture content essentially of damp sand. This solves the sludge dewatering problem and avoids the use of large land areas for lagooning.



1,040 gpm capacity gravity type Permutit Spiractor with Permutit Automatic Valveless Gravity Filters serving a Florida municipality.

APPLICATIONS

The Permutit Spiractor is particularly well suited to certain requirements.

Municipal Especially where space is limited, where sludge disposal is a problem and where state agencies will not permit the use of brine to regenerate softeners.

Cooling Water Treatment Since the Spiractor is a specific for calcium removal and alkalinity reduction, it is an ideal treatment process for cooling water containing high calcium bicarbonate.

A 300 gpm gravity type Spiractor and two Automatic Valveless Gravity Filters provide complete treatment facilities for a Southern community.

ADVANTAGES

Saves Real Estate Space requirement is approximately 1/6 to 1/8 the size of plot required by conventional sludge blanket units.

No Sludge Handling Yields reaction product which can be disposed of easily.

No Moving Parts All the agitation required is accomplished by the upward flow of water through catalyst bed.

Flexibility Readily adjustable to changes in character of water.

No Re-pumping By using a pressure cone, repumping may be eliminated when desired.

Low Operating Cost Uses no costly coagulants or coagulant aids.

Low Installed Cost Approximately ¼ to ⅓ that of conventional sludge blanket units.

Of Dissolved Iron And Color

COLOR REMOVAL BY SPIRACTOR

The Spiractor has been used on a variety of raw water supplies primarily to reduce hardness. However, it has also proved highly effective for achieving color reduction as well as hardness removal. Waters 1 and 2 reflect the two extremes of condition that existed with one raw well water supply. In both cases, color was reduced to an acceptable level by catalytic precipitation using lime but without the addition of chlorine or other oxidizing agents.

	No. 1 Raw	No. 1 Spiractor Effluent	No. 2 Raw	No. 2 Spiractor Effluent
Color	19	9	45	8
Total Hardness	330	44	312	32
Calcium Hardness	320	34	290	20
Magnesium Hardness	10	10	22	12
Alkalinity, M.O.	284	52	290	44
Alkalinity Phenolphthalein	0	40	0	24

Since color in water is often caused by different materials, pilot testing of individual supplies may be recommended, if our past experience cannot be applied.

IRON REMOVAL BY SPIRACTOR

The catalytic precipitation technique used in the Spiractor can also effectively reduce dissolved iron, in addition to removing hardness and color.

Water (A) was being treated largely for iron removal with only sufficient hardness reduction to fix the iron on the Spiractor catalyst. Note iron reduction from 1.7 to 0.2 ppm.

	WATER A RAW	WATER A SOFTENED AND FILTERED
Iron (Fe)	1.7	0.1
Carbon Dioxide (CO_2)	45	0
Total Hardness ($CaCO_3$)	250	175
pH	7.2	8.5
Calcium (Ca)	242	167
Magnesium (Mg)	8	8
Sodium (Na)	14	14
Total Cations	264	189
Alkalinity (HCO_3)	228	147
Alkalinity (CO_3)	0	6
Sulfate (SO_4)	10	10
Chloride (Cl)	26	26
Total Anions	264	189

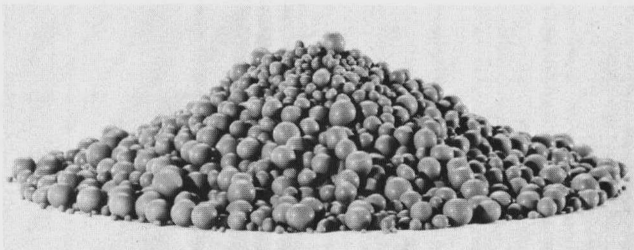
Water (B) is a combination iron, hardness and alkalinity reductions.

	WATER B RAW	WATER B SOFTENED AND FILTERED
Iron (Fe)	1.13	0.02
Carbon Dioxide (CO_2)	6	0
Total Hardness	180	80
pH	7.7	8.4
Calcium (Ca)	152	56
Magnesium (Mg)	28	24
Sodium (Na)	66	68
Total Cations	246	148
Alkalinity (HCO_3)	162	54
Alkalinity (CO_3)	0	4
Sulphate (SO_4)	4	4
Chloride (Cl)	80	86
Total Anions	246	148

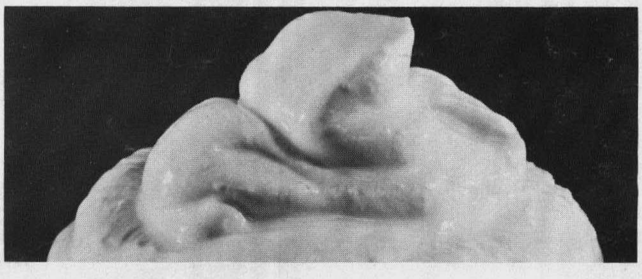
Spiractor Reaction Product Eliminates Liquid Pollution

Calcium and iron from the water deposits upon the Spiractor catalyst. Building up gradually, it forms larger and larger granules or beads around the catalyst core in the same fashion a cultured pearl grows. The largest and heaviest beads sink to the bottom of the Spiractor where they are drawn off periodically. The dense crystaline material which is the reaction product, is spherical in shape and ranges in size from that of coarse sand up to 1/16" beads.

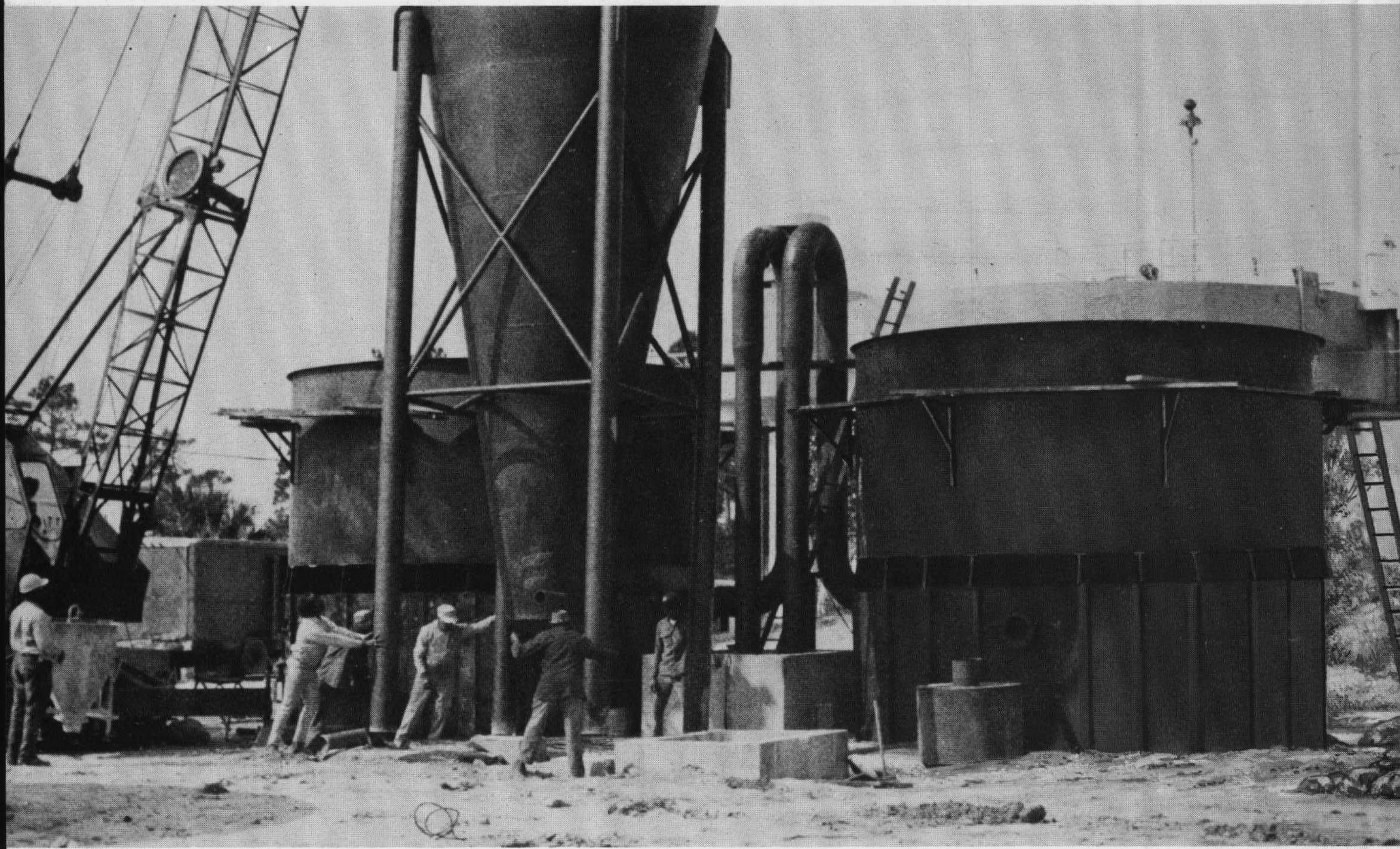
Spiractor reaction product is insoluble and drains free of water rapidly and easily. It is not a waste but has a variety of uses including land fill, garden soil conditioner, fine gravel, filler around well points and grit for sand blasting. It handles as simply as sand or gravel.



Spiractor waste, above, is a clean bead-like product. Compare it with the settled sludge from a conventional lime softening plant, below. Both photographs are unretouched.



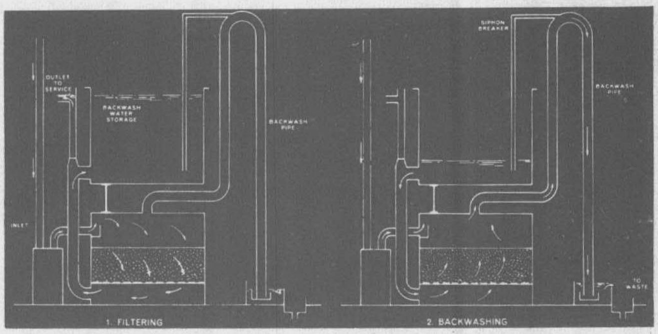
The SPIRACTOR/AVGF Water Treatment Plant



A highly efficient, complete water treatment plant is available to many municipalities and industries thru the combination of the Permutit Spiractor and Automatic Valveless Gravity Filter. This unique modular system delivers a low hardness water, virtually free of suspended solids, that meets highest quality standards for potable water.

Auxiliary components are confined to a chemical feed system serving the Spiractor. These are the only moving parts and the only electric power consuming components except the well pumps and high service pumps. The control system is a simple, direct-acting Simplex Type "S" Rate of Flow Controller. It is self contained, needs no power and, since it is based on a Venturi Tube design, it can also serve as the primary for a meter.

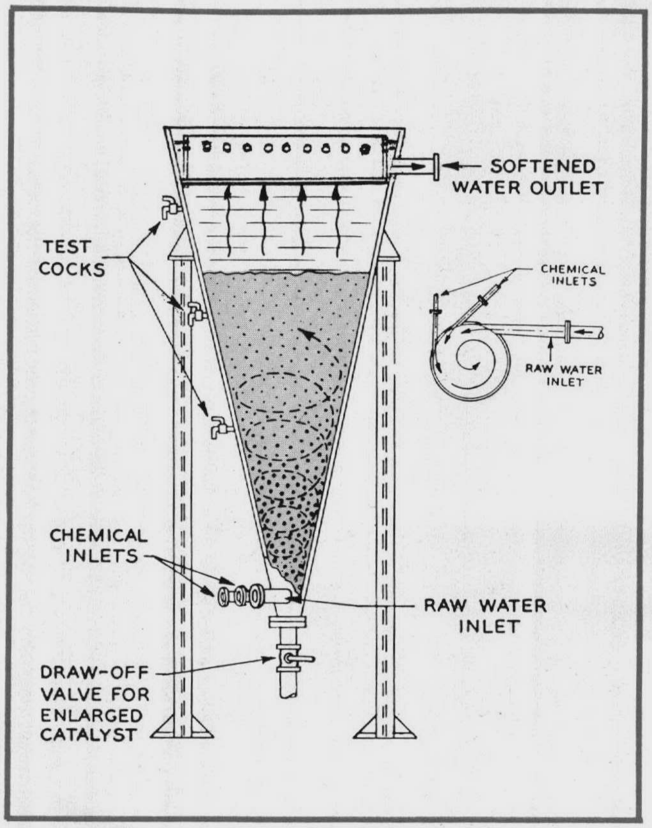
The Permutit Spiractor/AVGF system is designed and built for the purpose of treating water profitably. It is a plant virtually without moving parts and therefore is practically maintenance free. This automatic plant needs a minimum of supervision. Its reaction products are easy to handle and present no disposal problems. Compact and above ground, it occupies a minimum of space and it can be expanded easily using economical, prefabricated modules.



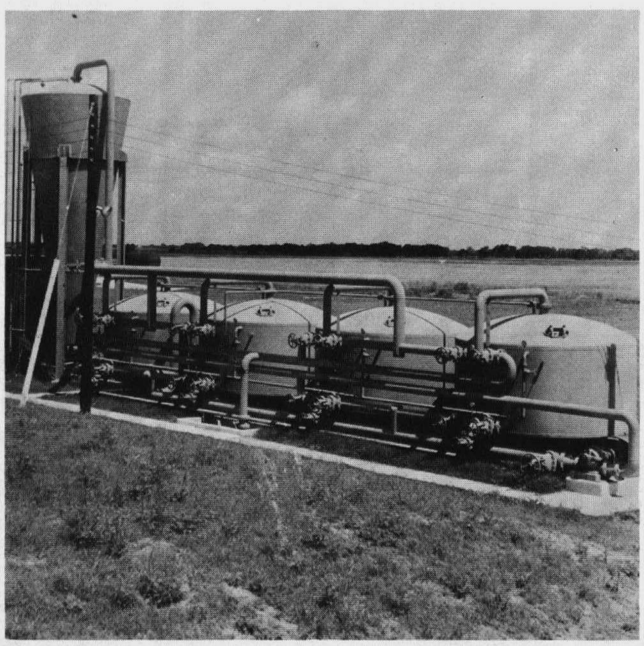
AUTOMATIC VALVELESS GRAVITY FILTER

An exclusive Permutit development, the AVGF filter operates automatically without a single valve, backwash pump, flow controller or other instruments. The AVGF is the closest thing to perpetual motion yet devised. The only power it needs is provided by the water you bring to it. It does the rest. It filters, backwashes, rinses and returns to service automatically. Nothing moves but the water. The filter adapts itself to varying loads without adjustment or supervision. Whenever the suspended matter removed by the filter bed causes the pressure loss to reach a predetermined level, backwash starts automatically. Flow reverses automatically at the end of backwash, the backwash tank refills and the filter returns to service.

ftening Hard Water And Remova



Cross-sectional view of Permutit Spiractor showing flow. Insert gives detail of arrangement of raw water and chemical inlets.



Pressure type Permutit Spiractor of 700 gpm capacity in combination with four pressure filters, serving a Naval Air Station in Texas.

OPERATION

The Spiractor's conical steel shell is partially filled with a granular catalyst of proper grain size. Raw water and the usual chemicals are introduced at the bottom of the cone through separate inlets. The tangential direction of these inlets, plus the conical shape of the shell, imparts a turbulent spiral motion to the incoming water and chemicals; thus, intimate mixing of the water and chemicals with the granules of catalyst is assured. As the water rises in the Spiractor cone, its velocity is gradually reduced by the increasing cross-sectional area. Since suspension of the granules of catalyst requires a certain upward velocity of flow, a point is reached where the velocity is no longer sufficient to suspend the catalyst.

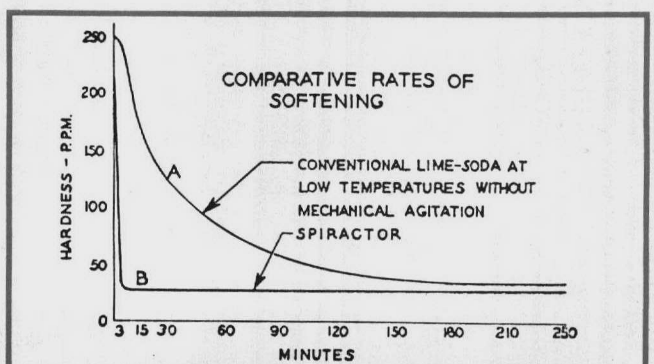
By design, when this point of low velocity is reached, the time of contact between the water, chemicals, and catalyst has been sufficient to carry the softening reactions to completion. Also the water has lost almost all of its turbulent motion and rises to the outlet soft and clarified.

As the Spiractor continues in operation, the hardness compounds, precipitated by the chemicals, build up on the catalyst granules as hard crystalline shells and enlarge them. These larger, heavier particles gravitate towards the bottom of the Spiractor. Periodically, the enlarged granules are drawn off by opening a drain valve at the bottom of the cone. Fresh catalyst is introduced into the Spiractor at the top.

PERFORMANCE

Analyses of two water supplies are given both before and after treatment. Water (A) was treated to leave about 5 gr./gal. residual hardness as is typical of municipal practice. The treatment indicated for water (B) is typical of that required for reducing the high bicarbonate content of such a water in order to render it satisfactory for cooling purposes or the like. Results of the Permutit Spiractor operation are indicated in the following table (ppm as $CaCO_3$):

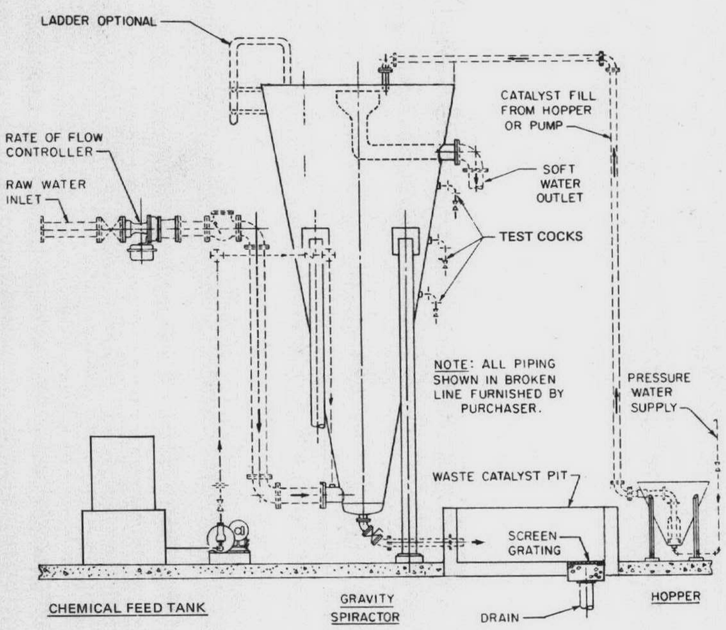
	WATER A		WATER B	
	Raw	Softened and Filtered	Raw	Softened and Filtered
Total Hardness	400	85	250	80
Calcium Hardness	320	35	220	60
Magnesium Hardness	80	50	30	20
Alkalinity, M.O.	350	50	200	30
Alkalinity Phenol.	0	27	0	15
Turbidity	5	2	0	2



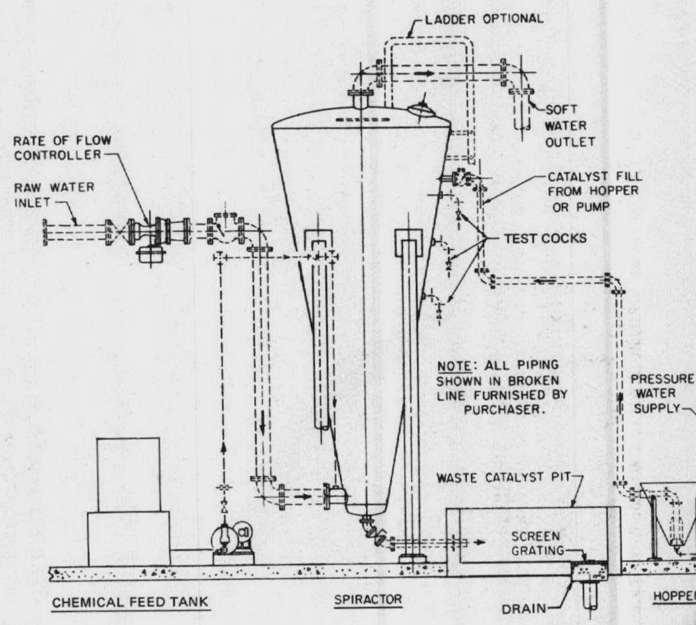
Curves show clearly the greatly increased rate of softening obtainable with Permutit Spiractor (B) over conventional type cold lime-soda softener (A).

PERMUTIT SPIRACTOR SPECIFICATIONS

GRAVITY SPIRACTOR



PRESSURE SPIRACTOR



SPIRACTOR CAPACITIES AND WEIGHTS

Size	CAPACITY		WEIGHTS lbs.								
			Catalyst (102 lbs/ft)	Gravity		Pressure 50 lbs PSIG		Pressure 75 lbs PSIG		Pressure 100 lbs PSIG	
	GPM	MGD	Shipping	Shipping	Operating	Shipping	Operating	Shipping	Operating	Shipping	Operating
1 S	50	0.07	900	1,500	8,000	1,500	8,000	1,500	8,000	1,500	8,000
2 S	75	0.11	1,350	1,800	11,000	1,800	11,000	1,800	11,000	2,000	11,200
3 S	100	0.14	1,788	2,100	14,000	2,100	14,000	2,100	14,100	2,500	14,400
4 S	150	0.22	2,700	2,600	22,000	2,700	22,000	3,000	22,400	3,600	23,000
5 S	200	0.29	3,600	3,100	28,000	3,300	28,000	4,300	29,200	4,900	29,800
6 S	250	0.36	4,572	3,500	34,000	3,800	34,400	4,900	35,400	6,100	36,600
7 S	300	0.43	5,400	4,100	40,000	4,900	42,000	6,200	43,400	7,400	44,400
8 S	350	0.50	6,312	5,100	48,000	6,000	50,000	7,500	51,400	9,400	53,400
9 S	400	0.58	7,170	5,300	54,000	6,800	56,000	8,400	57,600	10,600	59,800
10 S	500	0.72	9,000	6,800	66,000	7,700	70,000	10,100	72,400	12,000	75,000
11 S	600	0.86	10,800	7,500	76,000						
12 S	700	1.01	12,732	8,700	88,000						
13 S	870	1.25	15,720	9,700	106,000						
14 S	1,040	1.50	18,720	10,800	126,000						
15 S*	1,400	2.02	30,000	16,000	170,000						
16 S*	2,650	3.82	81,000	35,000	515,900						

*Units 15S and 16S shipped K.D. for field erection.

PERMUTIT
SYBRON CORPORATION

THE PERMUTIT COMPANY, DIVISION OF SYBRON CORPORATION, E49 MIDLAND AVENUE, PARAMUS, NEW JERSEY 07652

Printed in U.S.A.

2384D—1/70—5M

NOTE TO OPERATOR ON PROCEDURE:

TOTAL ALKALINITY MAY ALSO BE DETERMINED USING METHYL PURPLE INDICATOR. ADD 1 OR 2 DROPS. SAMPLE WILL TURN GREEN. AS ACID IS ADDED, COLOR CHANGES THRU GRAY TO FAINT PURPLE WHICH IS THE END POINT.

TEST PROCEDURE

for CHEMICAL ANALYSIS

TEST SET #12

B/M 5922

METHYL ORANGE ALKALINITY AND PHENOLPHTHALEIN ALKALINITY

Apparatus

1 - 10 ml automatic burette Q-5713
1 - 100 ml graduated cylinder Q-5750
1 - Porcelain dish, 5" diameter Q-5756
3 - Glass stirring rods Q-6072
Instruction Sheet, Form 4570

Reagents

1 qt. N/50 H_2SO_4 Spec.212, Bottle Q-2861
2 oz. 0.05% methyl orange indicator (dropper bottle) Spec.234, Q-5729
2 oz. phenolphthalein indicator (dropper bottle) Spec.235, Q-5729

PROCEDURE

DETERMINATION OF METHYL ORANGE ALKALINITY ("ALKALINITY A")

1. Place a 100 ml sample of water, measured in the glass cylinder, into a clean porcelain evaporating dish.

2. Add two to three drops of the methyl orange indicator.

3. Fill the burette with N/50 sulfuric acid solution to the zero mark.

4. Add this solution cautiously from the burette, with constant stirring, until the color changes from yellow to the faintest pink discernible.

5. Every one-tenth of a ml of the sulfuric acid solution added is equivalent to one ppm of Methyl Orange Alkalinity expressed as $CaCO_3$ or:

M.O. Alk = ppm Methyl Orange Alkalinity expressed as $CaCO_3$
M.O. Alk = 10 x (ml of sulfuric acid solution added)

DETERMINATION OF PHENOLPHTHALEIN ALKALINITY ("ALKALINITY B")

1. Place a 100 ml sample lf water, measured in a glass cylinder, into a clean porcelain evaporating dish.

2. Add two to three drops of the Phenolphthalein Indicator.

3. Fill the burette with the N/50 sulfuric acid solution to the zero mark.

4. Add this solution cautiously from the burette with constant stirring until the faint red color entrely disappears. When nearing the end point, add two drops from the burette at a time. Wait 30 seconds after each addition until the end point is reached.

5. Each ml of the sulfuric acid added is equivalent to 10 ppm of Phenolphthalein Alkalinity (Alk B) as $CaCO_3$, or:

ppm Alk B = 10 x (ml of N/50 sulfuric acid used)

HYDROXIDE ALKALINITY ("ALKALINITY C") BY DIFFERENCE

The hydroxide Alkalinity (Alk C) in raw or treated waters can be determined from the equation:

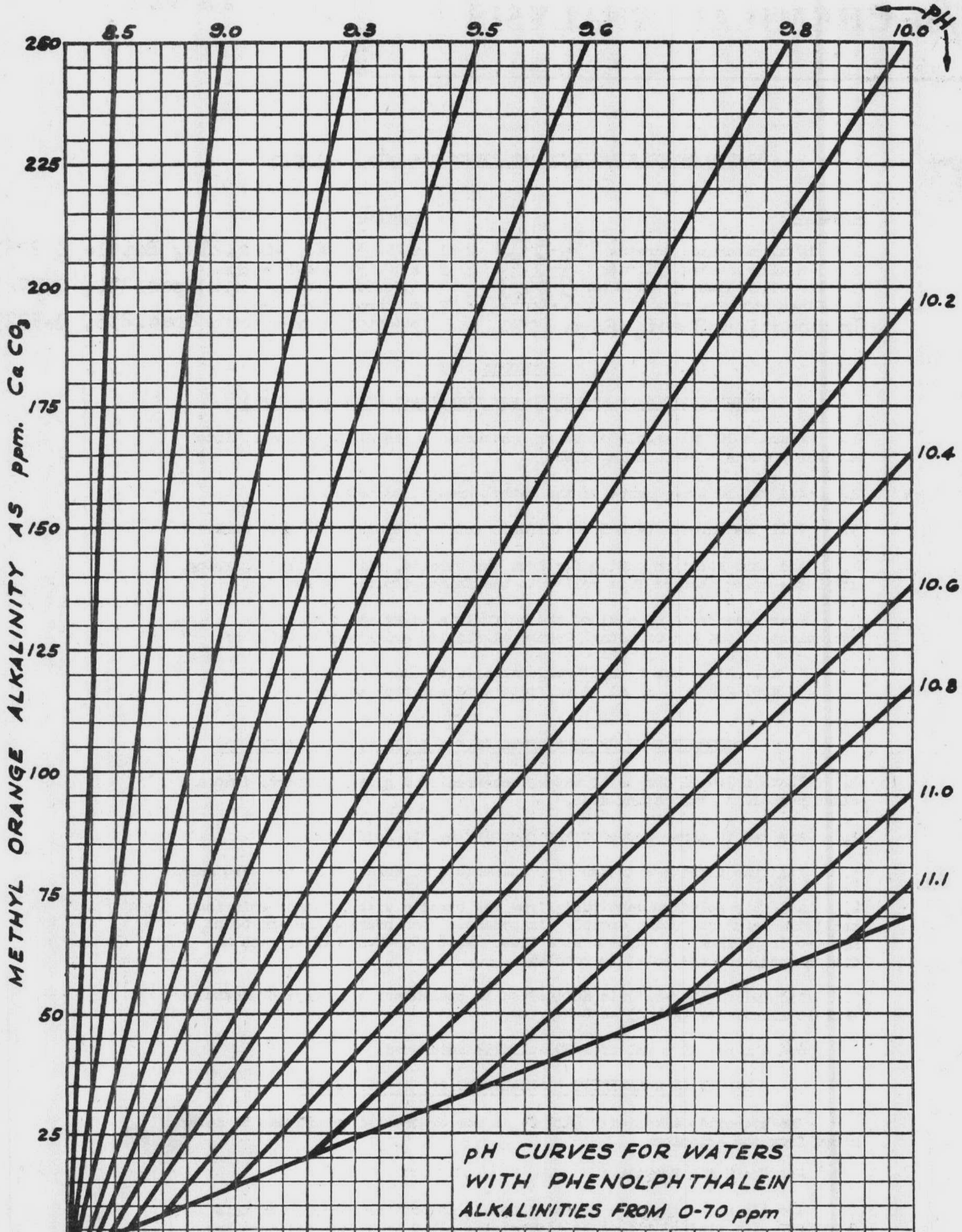
Alk C = 2 Alk B - Alk A

The Alk C is zero if a negative result is obtained when using this equation. For special method of determining Alk C in boiler salines, see Test Set #14.

pH (GRAPHICALLY)

Refer to accompanying chart which shows the relationship of Phenolphthalein Alkalinity (Alk B) and Methyl Orange Alkalinity (Alk A) to pH.

References: Test Sets #8 and #9.



pH Curves for Waters Containing Phenolphthalein Alkalinity

TEST PROCEDURE

for CHEMICAL ANALYSIS

TEST SET # 73
B/M 7290

TOTAL HARDNESS BY THE AZO DYE METHOD

CALCIUM HARDNESS BY THE CHELATE DYE METHOD

MAGNESIUM HARDNESS BY DIFFERENCE

Apparatus

1 - Set Instructions 4580
1 - 10 ml Automatic Burette, Q-5713
1 - 50 ml Graduated Cylinder, Q-5749
1 - Porcelain Dish 5" diameter, Q-5756
3 - Glass Stirring Rods, Q-6072
1 - Square Amber 1 oz. bottle (#102) with dropper calibrated 0.5, Q-1241
1 - Square Amber 2 oz. bottle (#103) with dropper calibrated 0.5 ml and 1.0 ml, Q-5726
2 - 0.2 ml. Brass dipper, Q-5754

Reagents

1 qt. N/50 Sequestering Solution Spec. 275 (Q-5737 Poly Bottle)
100 grams granular Azo Dye Indicator Spec. 280 (Bottle Q-5718)
1/2 pt. Sulfide-Borate Solution Spec. 269 (Bottle Q-5723)
1 pt. 1.0 N sodium Hydroxide, Spec. 285 (Bottle Q-5736)
50 grams Calcium Indicator Q-6326 (Bottle Q-5717)

PROCEDURE FOR TOTAL HARDNESS

1. Measure 50 ml. of the sample to be tested in the graduated cylinder, and pour it into the procelain dish. While gently stirring, add 0.5 ml of the Sulfide-Borate Solution, by means of the 0.5 ml calibrated dropper.

2. Allow the sample in the dish to stand for two minutes.

3. Add one level dipper of the granular Azo Dye Indicator using the 0.2 ml brass dipper, and stir until the indicator is in solution. If hardness is present, the sample will turn red.

4. Fill the burette with the N/50 Sequestering Solution to the zero mark.

5. Add this solution slowly from the burette with constant stirring, until the last trace of reddish color just disappears. When approaching the endpoint, a bluish color will become apparent.

   Note: At the end of the titration, the sample will be blue. In a few cases, the sample may not be blue, but the disappearance of the red color is always the endpoint.

6. Calculate total hardness:

   Total Hardness in ppm as $CaCO_3$ = 20 x (ml of N/50 Sequestering Solution used).

NOTES:

1. With water containing over about 50 ppm (as $CaCO_3$) of Free Mineral Acidity such as might be obtained from a Cation Exchange Unit operating on the hydrogen cycle, it is necessary to neutralize the acidity before following the procedure given here for the determination of hardness.

2. If after a few months the Sulfide-Borate Solution no longer has the odor of Hydrogen Sulfide (rotten eggs) it will not be effective in eliminating the interference of heavy metals such as iron, copper, and manganese. However, with most waters the amount of heavy metals in the water will not be large enough to change greatly the accuracy of the determination, although the endpoint of the titration will be less distinct. If desired, the Sulfide content of the solution can be restored by adding about 5 g/l of Sodium Sulfide.

PROCEDURE FOR CALCIUM HARDNESS

1. Measure 50 ml of sample to be tested in the graduated cylinder and pour it into the porcelain dish. While gently stirring, add 2.0 ml of the 1.0 N Sodium Hydroxide by means of the 1.0 ml calibrated dropper.

2. Add one level 0.2 ml dipper of Calcium Indicator, using the other dipper and mix. If calcium is present, the sample will turn salmon pink.

3. Fill the burette to the zero mark with N/50 Sequestering Solution and titrate immediately as follows:

4. Add this solution slowly from the burette with constant stirring. As the endpoint of the titration is approached, a purple tinge will become apparent. The endpoint is the final color change from salmon pink to orchid purple. Further addition of N/50 Sequestering Solution will produce no additional color change.

5. Calculate calcium hardness:

Calcium Hardness as $CaCO_3$ = 20 x (ml of N/50 Sequestering Solution used)

MAGNESIUM HARDNESS

Magnesium Hardness can be calculated:

(Total Hardness as $CaCO_3$) - (Calcium Hardness as $CaCO_3$) = Magnesium Hardness as $CaCO_3$.