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Installation, Operation, and Maintenance Manual

For the **AQUACHLOR** On-site Sodium Hypochlorite Generator

Models AC-25, AC-50, AC-100 and AC-200

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System Overview

The Aquachlor system provides a 0.6% solution of sodium hypochlorite. This is an effective water disinfectant that eliminates waterborne diseases like cholera, typhoid fever, hepatitis, amoebic dysentery, bacterial gastroenteritis, and others. The relatively low concentration of equivalent chlorine has been chosen to be friendly to the environment and safe to the operator while maintaining a high disinfecting power.

The system consists of a Generating Cell, a source of electricity for the Generating Cell, and a brine tank. The Generating Cell electrolyzes the brine into a solution of sodium hypochlorite. The Generating Cell is enclosed in a PVC housing. Depending on the application, the source of electricity may be municipal altern current (AC) or direct current (DC) from solar panels

Technical Specifications

Electrode	***AC-25***	***AC-50***	***AC-100***	***AC-200***
Production Cycle	24 hours	24 hours	24 hours	24 hours
Production per hour	30 grams	55 grams	110 grams	210 grams
Equivalent Chlorine per cycle	720 grams	1,320 grams	2,640 grams	5,040 grams
Concentration	6 grams / lit	6 grams / lit	6 grams / lit	6 grams / lit
Consumption per Cycle				
SALT	3.5 kg	7.0 kg	14 kg	28 kg
Electricity	5.0 Kwh.	8.25 Kwh.	18 Kwh.	36 Kwh.
Water	90 lit	165 lit	330 lit	630 lit
Dimensions				
Electrode	66 cm	81 cm	112 cm	145 cm
Cable Length	213 cm	309 cm	295 cm	29.5 cm
Weight	2.5 kg	4.0 kg	7.70 kg	10.0 kg
Power Supply				
Type (Fixed Current - Floating Voltage)	Switching	Switching	Switching	Switching
Timer/Switch Electromechanical	24 hours, variable	24 hours, variable	24 hours, variable	24 hours, variable
Input	120/240VAC, 50/60 Hz	120/240VAC, 50/60 Hz	120/240VAC, 50/60 Hz	120/240VAC, 50/60 Hz
Output	~12VDC, 15A	~12VDC, 26A	~12VDC, 55A	2 x ~12VDC, 55A
Additional Equipment				
Reactor Tank (Not supplied)	20 - 100 lit	100 - 200 lit	200 lit +	300 lit +

Theory of operation

The Sodium Hypochlorite is generated in the cell by the following final reaction:

$$ClNa + H_2O + e^{(-)} = NaOCl + H_2$$

Precautions

All instructions should be read and understood before attempting to install, wire, operate, and maintain the equipment.

First Aid

- **Eye Burns** (due to contact with sodium hypochlorite, acid, or vinegar) wash the eyes with running water for 10 minutes. Seek professional treatment.
- **Skin Burns** (due to contact with sodium hypochlorite or acid.) Wash the affected area with running water for 10 minutes. Seek professional treatment.
- **Oral Ingestion of sodium hypochlorite.** Do not induce vomiting. Give milk, ice cream, or an antacid. Seek professional treatment immediately.
- **Oral Ingestion of acid or vinegar**. Do not induce vomiting. Seek professional treatment immediately.
- **Electric Shock.** Do not touch the person until the electrical source has been disconnected. Disconnect the source of electricity and assist the person. If required, seek professional assistance.

Installation

Equipment Description

The main components of the Aquachlor sodium hypochlorite generating system consist of the Generating Cell, a source of direct current for the cell (Power Supply), several recipients resistant to brine and sodium hypochlorite, and possibly adequate laboratory equipment for verification of the sodium hypochlorite concentration.

ESE provides the Power Supply and the Generating Cell. Additional water recipients resistant to sodium hypochlorite and brine are necessary for proper operation. These recipients are not included since their size depends on the particular application and since

they're readily availability makes it more economical to obtain locally. Tanks constructed of polypropylene or polyethylene is adequate. Metallic tanks or fiberglass containers are not adequate.

Installation Precautions

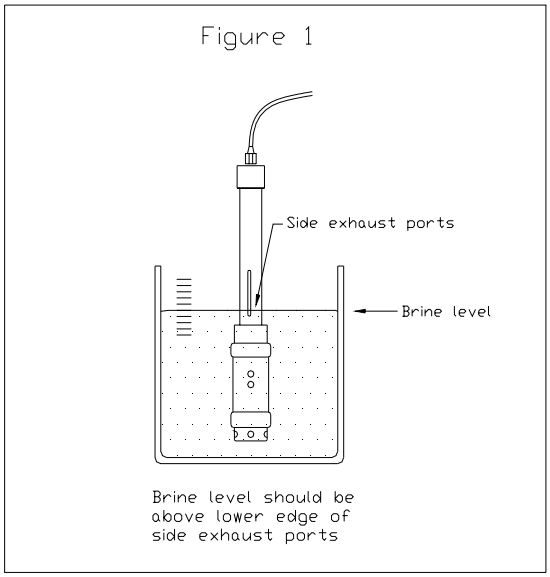
- Locate the power supply away from the vapors that escape from the process container (opposite direction of the predominant wind.)
- Observe the necessary precautions with the electrical equipment. This system operates on 110/220 volts and 50 to 60 Hz.
- Make sure the available electrical supply conforms to the requirements of the Power Supply.
- Make sure the Generating Cell is properly connected. Reversing the polarity of the cell will permanently damage the electrode.
- Locate the power supply away from the possibility of liquid spills.
- Hydrogen and chlorine gas are byproducts of hypochlorite generation. Install the system in a well-ventilated area, preferably with crossed ventilation for proper evacuation of hydrogen.
- Tighten the nuts/screws that connect the electrode to the power supply snugly with the proper tool.

The Aquachlor Generating Cell consists of a series of highly specialized electrodes encased in a protective PVC capsule. When the appropriate current is applied, the electrodes incite an electrolytic reaction whereby the brine solution is converted into a solution of sodium hypochlorite. The cell has been designed to operate using a direct current. It is important to energize the cell with the correct current and polarity. Excessive current, incorrect polarity, and improper maintenance will damage the cell.

The Power Supply converts the AC electrical source to a mode and level useable by the Generating Cell. The Power Supply supplied will require either 110 or 220 VAC, 50/60 Hz and will supply 9 to 13 Volts DC. The voltage and frequency are set at the factory and cannot be changed. The Power Supply was calibrated at the factory and will work properly only with Generating Cells of a specific capacity. That is, a Power Supply supplied with an AC-25 will only work properly with AC-25 Generating Cells. The

switching-type Power Supply contains solid-state electronic components that provide higher accuracy over a wider operating range with less bulk and weight than traditional rectifiers based on transformer wire coils.

The electrolysis tank In this tank that the brine is converted into sodium hypochlorite. Efficient operation of the hypochlorite generating system depends on proper selection of this tank. It should be made of a material resistant to sodium hypochlorite and salt, such as PVC or Polypropylene. The tank should contain the brine batch and have a **well-ventilated cover** to prevent debris from entering. This cover may have a 6" hole in the center for the electrode (See **figure 1**). In addition, the water level should be in or above the side exhaust ports of the generating electrode when this is immersed in the brine (See **figure 2**). Proper placement of the water level is necessary for adequate flow of brine through the electrode.



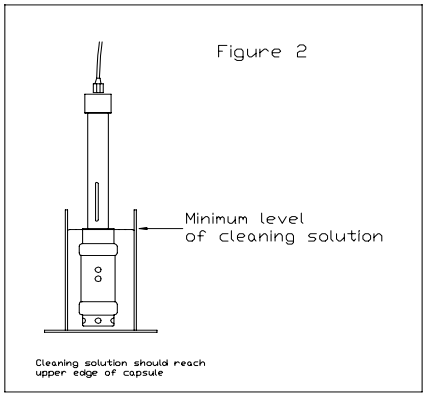
The brine preparation tank is desirable but not necessary. The salt is dissolved in it in a small quantity of water prior to making the brine batch. Usually a two-gallon pail is adequate to pre-dilute the salt.

The salt measuring container is used in lieu of a scale to weigh the salt for brine preparation. It should have permanent volumetric graduations corresponding to the weight of the salt in the container. Since the bulk density of the salt will depend on the locally available salt, each container should be calibrated individually.

The electrode cleaning-container stores and cleans the generating electrode while it is not in use. This container is filled with pure white vinegar or with a 5% solution of hydrochloric acid (muriatic acid).

IMPORTANT: USE OF ACID CONCENTRAITON HIGHER THAN 5% WILL PERMANENTLY DAMAGE THE GENERATING ELECTRODE AND WILL VOID THE WARRANTY. COMMERCIALLY AVAILABLE HYDROCHLORIC ACID TYPICALLY HAS A CONCENTRATION SEVERAL TIMES HIGHER THAN 5%, AND MUST BE PROPERLY DILUTED TO BE USED FOR ELECTRODE CLEANING PURPOSES.

The container should be filled to a level that when the electrode is immersed, the capsule of the electrode is below the liquid surface.



Installation Overview

The Aquachlor Generating System has been designed for permanent installation. Proper care must be exercised for portable use of the system. Only

qualified personnel should perform only after reading and understanding the installation manual, and installation.

Installation consists of obtaining the additional necessary equipment, selection of an adequate site, and connection of the Power Supply from municipal power to the Generating Electrode.

Site Selection

The permanent site for the sodium hypochlorite generating system should be selected considering the requirements, the operating parameters and safety.

The Power Supply will require a compatible source of electricity as indicated on the Power Supply label. Depending on the model, the Power Supply will require a source of 110 or 220 Volts, 50 to 60 Hertz of alternating current (AC). The voltage and frequency are set at the factory and cannot be changed. Choose a site with permanent and safe electrical installation.

The Power Supply is an electronic device and susceptible to damage from moisture, drastic hikes or drops of voltage and lighting. The connecting outlet should be protected by a GFI circuit breaker. In addition, the generating process produces a small amount hydrogen and chlorine gas, which must be vented to the atmosphere. These gases must be kept away from the power supply. Select a site that will protect the Power Supply from rain and moisture. The site should have adequate ventilation to ensure rapid evacuation of the hydrogen and chlorine gases. The equipment should not be located in an area where open flames or sparks are present.

The presence of electricity and of sodium hypochlorite produces inherent hazards in the generating process. Access to the equipment must be restricted to personnel properly trained and aware of these hazards. Choose a site that can be secured from access by those not trained to use the equipment. In particular, ensure that those unaware of the hazards, such as children and animals, have no access to the equipment.

Layout

The placement of the Power Supply is very important to ensure the longevity and safety of the system. It should be located on a sturdy shelf or table as far away as possible from the electrode and on a higher level than the electrode. The chlorine gas is heavier than the air and shall not be sucked by the power supply cooling fans. Under no circumstances should it be located above any liquid recipient, where it may fall and create a shock hazard. In addition, the Power Supply produces heat that must be dissipated by its

cooling fan. Make sure the vents on the sides at the back of the Power Supply are not obstructed.

Wiring

In addition to conforming to the input requirements of the Power Supply, the wiring for the Power Supply should meet local standards of safety. In essence, the line should be

110 to 120 volts 50 to 60 hertz alternating current with a ground wire. Grounding is very important. In-line with the Power Supply, install a suitable GFI circuit breaker and a weatherproof power switch.

Operation

Operating Precautions

- Do not smoke or have open flames close to the equipment.
- Avoid contact of the solution with eyes or skin.
- Avoid the solution contacting clothes.
- Do not activate the Power Supply until the electrode is properly immersed in the brine solution.
- Do not remove the electrode from the brine tank until the Power Supply has been deactivated.
- Do not operate the electrode longer than recommended. Doing so is wasteful and will eventually decrease the concentration of sodium hypochlorite in the solution.
- The water used for the brine solution should be free of visible particles and solids. If necessary, this water should be strained with a coarse-cloth filter.

Modes of operation/ Overview

Your Aquachlor sodium hypochlorite generating cell relies, for a proper operation, on the rapid flow of the liquid solution created by the of hydrogen gas. The electrode was designed to function under this flow condition.
To operate the system, first select the formula to use, dissolve the predetermined amount of salt in a specific volume of water. Water volume and salt amount will be determined shortly. The generating electrode is then immersed in the brine and the timer switch of the power supply is activated. After a predetermined amount of time, the brine solution will have been converted into a solution of sodium hypochlorite.

Materials

The generation of sodium hypochlorite requires very little in terms of raw materials. All that is needed is water, salt and electricity. The water for the electrolysis tank should be as particle-free as possible Likewise; the salt should be as clean as possible. Salt impurities increase the rate of minerals build-up on the cathode, requiring more frequent cleaning.

1. Brine preparation

Table 1

Total Chlorine (Grams)	Water Volume (Liters)	Salt (Kg)	Time (Hours)			
			AC-25	AC-50	AC-100	AC-200
50	8.3	.3	2	1		
100	16.7	.6	4	2	1	
200	33.3	1.2	8	4	2	
400	66.7	2.3	16	8	4	
500	83.3	2.9	20	10	5	
600	100.0	3.50	24	12	6	
1000	166.7	5.0		20	10	
1200	200.0	7.0		24	12	6
2000	333.4	10.0			20	10
2400	400.0	14.0			24	12
4000	666.8	17.2				20
4800	800.0	28.0				24

Select the formula to use. For instance, to generate 600 grams of chlorine using an AC-50. Measure 3.5 kg of common salt and pour it into the tank. Fill the tank with 100 lit of water. Agitate continuously until all of the salt has been dissolved. This will make about a 3% brine solution. Rotate the timer switch clockwise to 12 hours. In 12 hours it will turns itself off and the brine is converted into sodium hypochlorite. On occasion it is helpful to pre-dissolve the salt in a separate container. Refer to table 1.

2. Cell activation

Before introducing the cell in the brine solution, make sure the power to the Power Supply is interrupted by an in-line switch or by the timer switch on the front panel of the power supply.

Once the brine has been prepared, introduce the Generating Cell into the electrolysis tank. If there is a switch on the front panel of the power supply, make sure it is on. Turn the timer switch clockwise to set the electrolysis time. The timer dial is located on the

front panel of the power supply. The electrolysis time depends on the volume of water in the electrolysis tank, and is tabulated on table 1 above.

WARNING: INTRODUCING THE ELECTRODE INTO THE BRINE SOLUTION WHILE THE POWER TO THE POWER SUPPLY IS ON SUBJECTS THE POWER SUPPLY AND THE ELECTRODE TO AN UNDUE LOAD. THIS WILL EVENTUALLY DAMAGE BOTH COMPONENTS.

The Generating Cell should be producing hydrogen, which is visible bubbling and white foam that exits through the cell exhaust ports. The Power Supply should indicate on its LCD the voltage and current supplied to the Generating Cell.

3. End of Generating Cycle

The timer will automatically interrupt the power to the Generating Cell once the predetermined time has elapsed. Should the electricity to the Power Supply be interrupted, the timer will also stop. It will resume operation for the remaining time upon the return of the electricity. Thus, there is no need to reset the timer in the event of a power outage.

Once the time has expired, the concentration of equivalent chlorine in the electrolysis tank should be at least 6 grams per liter or 0.6%. This solution is used for water or general disinfections. The amount of disinfectant to use depends on many factors and should be determined by a person knowledgeable in the field and familiar with the application.

The cell should be removed from the electrolysis tank immediately after the time has expired. Before removing the cell, be sure the power supply is off.

WARNING: REMOVING THE GENERATING CELL FROM THE ELECTROLYSIS TANK WHILE THE POWER TO THE POWER SUPPLY IS ON SUBJECTS THE POWER SUPPLY AND THE ELECTRODE TO AN UNDUE LOAD. THIS WILL EVENTUALLY DAMAGE BOTH COMPONENTS.

Maintenance

MAINTENANCE PRECAUTIONS

- Power to the generating electrode must be off while the electrode is in the cleaning solution.
- Rinse the generating electrode thoroughly with water after removal from the storage container and prior to immersion in the electrolysis tank.
- Never combine the cleaning solution with the sodium hypochlorite solution.

Overview

Impurities both in the salt and in the water used in the brine in accumulate on the cathode within the generating cell. This accumulation must be cleaned periodically using a solution of acetic acid (white vinegar) or hydrochloric (muriatic) acid. If this accumulation is not removed, it will eventually short-circuit the Generating Cell, rendering it inoperable and will overload the Power Supply damaging it irreparably.

The Generating Cell should be cleaned **every other day** in the following manner:

1. Thoroughly rinse the Generating Cell with water.
2. Submerge the capsule of the Generating Cell into pure white vinegar, or into a 5% solution of hydrochloric acid. See figure 2.
3. After at least 20 minutes, remove the cell from the acid and rinse thoroughly with running water.

IMPORTANT: NEVER MIX THE CLEANING SOLUTION WITH SODIUM HYPOCHLORITE. NEVER USE UNDILUTED ACID TO CLEAN THE ELECTRODE. THIS WILL DAMAGE COMPONENTS INSIDE THE CELL.

Dosing

Table 2

Tank Capacity		Dosage of the Solution of NaOCl at 0.6% concentration								
		2 PPM			3 PPM			4 PPM		
Gals.	Ltrs.	Ltrs.	Gals.	Grams of Cl_2	Ltrs.	Gals	Grams of Cl_2	Ltrs.	Gals.	Grams of Cl_2
1000	3785	1.3	0.33	7.57	1.9	0.50	11.36	2.5	0.67	15.14
5000	18927	6.3	1.67	37.85	9.5	2.50	56.78	12.6	3.33	75.71
6000	22712	7.6	2.00	45.42	11.4	3.00	68.14	15.1	4.00	90.85
7000	26498	8.8	2.33	53.00	13.2	3.50	79.49	17.7	4.67	105.99
8000	30283	10.1	2.67	60.57	15.1	4.00	90.85	20.2	5.33	121.13
9000	34069	11.4	3.00	68.14	17.0	4.50	102.21	22.7	6.00	136.27
10000	37854	12.6	3.33	75.71	18.9	5.00	113.56	25.2	6.67	151.42
16000	60567	20.2	5.33	121.13	30.3	8.00	181.70	40.4	10.67	242.27

One liter of 0.6% sodium hypochlorite solution dosed into 6000 liters of water will produce a 1-PPM (milligram per liter) of chlorine in the water. Likewise, to dose a 2-PPM of chlorine, add 2 liters of the sodium hypochlorite solution to 6000 liters of water.

Verification

The concentration of the sodium hypochlorite solution produced needs to be verified periodically to ensure its effectiveness. There are several methods whereby this may be achieved although only the Iodometric and the Drop-Dilution methods are described here. The Iodometric method is the more accurate of the two, although it requires more laboratory equipment. The Drop-Dilution method provides a good estimate of the free chlorine, and requires less equipment.

Iodometric Method

Equipment

1. .01N $Na_2S_2O_3$ solution
2. 10% KI solution
3. 50% H_2SO_4 solution
4. Starch indicator
5. 125 ml flask
6. 5ml graduated pipette
7. 10ml graduated pipette
8. 25ml burette
9. Glass dropper

Procedure

1. Using a 10ml pipette, add 20 ml of 10% KI solution to 125-ml flask.
2. Using dropper, add 6 drops of 50% H_2SO_4 solution (0.3 ml).
3. Using 5ml pipette, quickly add 3-ml of sample. Solution should turn color.
4. Using burette, titrate immediately with .01N $Na_2S_2O_3$ solution to a light yellow color.
5. Add three drops of starch indicator solution.
6. Finish titration with .01N $Na_2S_2O_3$ solution until colorless.

Calculation of available chlorine concentration from titration results:

Concentration of available chlorine in grams per liter = (ml of thiosulfate used) x (normality of thiosulfate solution) x (1000) x (35.5) / (ml of NaOCl sample)

Drop-Dilution method

Equipment

1. 5ml graduated pipette
2. 10 ml test tubes (2)
3. DPD colorimetric method chlorine test kit (common test kit for swimming pools).
4. Distilled water.

Procedure

1. In a 10ml test tube, add 1ml of sample to 9 ml of distilled water.
2. To second 10ml test tube, add 0.1 ml of the solution above to 9.9 ml of distilled water.
3. Test this solution with DPD colorimetric test kit according to its instructions.

Alternate procedure

1. Measure exactly 200 ml of distilled water.
2. Mix 4 drops of solution into the water.
3. Test this solution with DPD colorimetric test kit according to its instructions.

Calculations

No calculations are required. The scale of the test kit, which is graduated in PPM, may be interpreted directly as grams per liter.

Summary of operating instructions