ON-SITE GENERATION OF SODIUM HYPOCHLORITE BASIC OPERATING PRINCIPLES AND DESIGN CONSIDERATIONS

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68th Annual Water Industry Engineers and Operators' Conference
Schweppes Centre - Bendigo
7 and 8 September, 2005

ON-SITE GENERATION OF SODIUM HYPOCHLORITE – BASIC OPERATING PRINCIPLES AND DESIGN CONSIDERATIONS

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ABSTRACT:

This paper discusses the technical advances that have been made in the equipment used for generating 0.8% Sodium Hypochlorite on-site (at the point of use) and the benefits & limitations associated with this technology.

1.0 INTRODUCTION

On-Site Generation of Sodium Hypochlorite (on-site at the Water Treatment Plant) has been in commercial use for over 30 years. Power Stations are significant users of on-site generation systems, however the technology has not been as widely utilised in Water

Treatment Plants due to the operating costs compared to that of Bulk Chlorine products. However, recent advances in Electrolyser Cell Technology (namely, Applied Thermodynamic Management of the Cell) have reduced capital, operating and maintenance costs and made this technology much more viable. In addition, Occupational Health and Safety issues have caused Water Utilities and Consultants to specify the technology in place of Chlorine Gas and Commercial Grade Sodium Hypochlorite. There are now a large number of WTP's and commercial swimming pools worldwide utilizing on-site Sodium Hypochlorite generation systems.

2.0 DISINFECTION OPTIONS

Disinfection Technology options include:

1. Chlorine Gas
2. Commercial Grade 12.5% Sodium Hypochlorite
3. Calcium Hypochlorite Tablets (65% available Chlorine)
4. Ultraviolet
5. On-Site Generation of Sodium Hypochlorite (<1% available Chlorine)

3.0 BASIC OPERATING THEORY

Generating Sodium Hypochlorite onsite is a simple and straightforward process that uses three common consumables: salt, water and electricity. On-site generation systems operate by feeding softened water into a brine dissolver. The salt dissolves to form a brine solution, which is further diluted to the desired salt solution.

The salt solution is then passed through the electrolytic cell(s), which apply a low voltage DC current to the brine to produce Sodium Hypochlorite.

The Sodium Hypochlorite is then safely stored in a day tank and when it reaches the low-level set point, the system automatically restarts to replenish its supply. Morton Solar Salt is used in the process. The system is fully automated and has a manual operation feature if needed.

4. 0 KEY COMPONENTS OF AN ELECTROLYTIC CHLORINATION SYSTEM

a) System Control Panel

Mimic Panel of all components
Electrolyser Cell status
System Start / Stop & Reset
Brine Pump Status
Brine Flow Rate
Brine Tank usage to date
Water Softener status
Product Tank level
Metering Pump status
Chlorine Residual
Process Alarms

b) Power Supply / Rectifier

Converts 415 VAC to low voltage DC to power Electrolyser Cell(s)

c) Electrolyser Cell

UV stabilised PVC body containing Titanium Anode and Nichol Alloy Cathode

d) Water Softener

Ion Exchange type Water Softener that removes Scaling Calcium and Magnesium Salts with non-scaling Sodium Salts preventing fouling of the cells. Provides water supply to Brine Tank

e) Brine Tank (Salt Saturator)

Contains Raw Salt and 'soft' feed water. This Saturated Brine Solution is the feed to the Electrolyser Cells

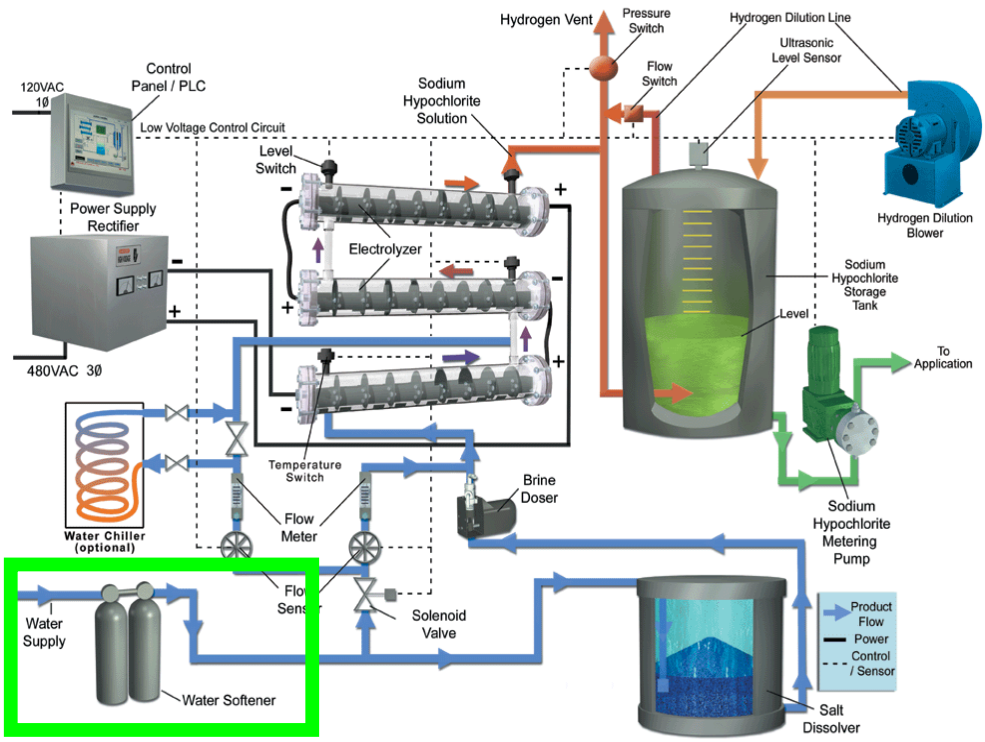
f) Brine Pump

Pumps the Saturated Brine Solution to the Electrolyser Cells

g) Sodium Hypochlorite Storage Tank

Bulk storage of 0.8% Sodium Hypochlorite. Includes Hydrogen Vent and Ultrasonic Level Switch

5.0 TYPICAL SYSTEM CONFIGURATION



6.0 THE PROCESS

NaCl + H20 + 2e ---------- NaOCl + H2

Salt + Water + Energy ---------- Hypo + Hydrogen

7.0 GENERATION COSTS (RAW MATERIALS ONLY)

SALT = 0.62 KG @ $0.34 per kg in 25 kg bags = $0.21
ENERGY = 0.9 KWH @ $0.12 / KWH =$0.11
WATER = 26 LITRES @ $0.40 per kl =$0.03
1.0 KG CHLORINE =$0.35

8.0 SALT AND WATER QUALITY

SALT - Chemical Analysis for Salt required for Electrolytic Cells

Components	**Minimum Values**	**Typical Values**
NaCI	99.00%	99.72%
Calcium as Ca	900 ppm	400 ppm
Magnesium as Mg	120 ppm	120 ppm
Total Sulphate	1700 ppm	1200 ppm
Insoluble matter in H20	300 ppm	200 ppm
Copper as Cu	5 ppm	< 0.5 ppm
Iron as Fe	5 ppm	< 1 ppm
Moisture	<0.2% when packed	

(Note: *The above chemical analysis should be taken as a guide only*)

SALT – Sieving Analysis

Mesh Size (mm):	0.6	0.42	0.21	0.15	-0.15
Typical % Retained:	12	21	31	13	23

PACKAGING:
Laminated woven polypropylene bags 15 kg, 25 kg and 50 kg net when packed.
Also available in 1 tonne polypropylene bulk bags.

STORAGE:
Store in a dry area out of direct sunlight.

WATER
Standard Potable Grade preferably with low Total Hardness. Water Softener option available with Generation System.

9.0 CHARACTERISTICS OF 0.8% SODIUM HYPOCHLORITE

Very Stable due to Low Concentration

Reduced risk of decomposition to form Chlorates due to lower concentration

Minor Total Dissolved Solids (TDS) Impact (3 PPM for every 1 PPM Dosed – equal to 12.5% Sodium Hypochlorite)

pH of 9.0 versus 13.0 for 12.5% NaOCl

More effective Oxidant than commercial Hypochlorite due to Oxidation Reduction Potential (ORP).

Not Classed as Dangerous Goods, (< 1%) therefore storage bunding not required.

10.0 MSDS for 0.8% Sodium Hypochlorite (extract only)

PRODUCT IDENTIFICATION:

PRODUCT NAME:	SODIUM HYPOCHLORITE, 0.8% SOLUTION
FORMULA:	NAOCL
FORMULA WT:	74.44
CAS No:	7681-52-9
NIOSH/RTECS:	NH3486300
COMMON SYNONYMS:	HYPOCHLOROUS ACID, SODIUM SALT; CLOROX
PRODUCT CODE:	9416
EFFECTIVE: 22/5/86	REVISION #0

PRECAUTIONARY LABELLING
BAKER SAF-T-DATA (TM)SYSTEM

HEALTH	-1 SLIGHT
FLAMMABILITY	-0 NONE
REACTIVITY	-1 SLIGHT
CONTACT	-1 SLIGHT

HAZARD RATINGS ARE: 0 to 4 (0 = NO HAZARD; 4 = EXTREME HAZARD)

LABORATORY PROTECTIVE EQUIPMENT:

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS:

WARNING CAUSES BURNS, HARMFUL IF SWALLOWED
AVOID CONTACT WITH EYES, SKIN CLOTHING
AVOID BREATHING VAPOUR, KEEP IN TIGHTLY CLOSED CONTAINER
USE WITH ADEQUATE VENTILATION
WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA (TM)STORAGE COLOUR CODE: ORANGE (GENERAL STORE)

11.0 BYPRODUCTS OF SODIUM HYPOCHLORITE GENERATION PROCESS

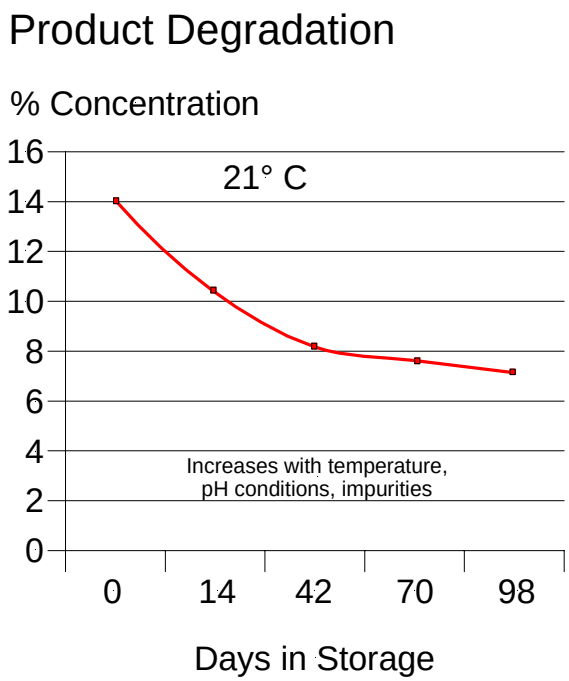
- Hydrogen Gas – Vented to Atmosphere passively or by Air Dilution
- 1.6 g of Hydrogen produced per every kg of Chlorine Equivalent
- Concentration below detectable flame limit
- Brine waste from water softener regeneration
- Chlorates – With Cell Temperature Management, Chlorates will be 3% – 4 % of Dose
- Bromates – Salt contains Bromide. Apx. 50% of Bromide Ion content will be converted to Bromate

12.0 FEATURES OF 0.8% SODIUM HYPOCHLORITE v CHLORINE GAS

- Greatly reduced risk to plant personnel
- No threat to public safety
- Low risk management issues
- No requirement to purchase, handle or transport hazardous chemicals

13.0 FEATURES OF 0.8% SODIUM HYPOCHLORITE v 12.5% COMMERCIAL SODIUM HYPOCHLORITE

- Safety – non hazardous material
- Lower Disinfection Byproducts
- Consistent Solution Strength
- No Gassing-off
- pH 9 v 13
- No requirement to purchase, handle or transport hazardous chemicals.



14.0 FEATURES OF 0.8% SODIUM HYPOCHLORITE v CHLORINE TABLETS

- Safety – non hazardous material
- Better dose rate control
- Lower cost
- pH 9 v 13
- No requirement to purchase, handle or transport hazardous chemicals
- No Calcium deposits

15.0 INDUSTRY DRIVERS FOR THE USE OF ON-SITE SODIUM HYPOCHLORITE GENERATION

- Occupational Health & Safety (OH&S)
- Risk Management associated with proximity to the public
- Transportation of Chemicals
- Handling of Chemicals

16.0 MAINTENANCE & MATERIAL COSTS – CASE STUDY – DAYTONA BEACH WTP – FLORIDA, USA.

After Four (4) years of operation, the System has proven reliable while producing 638,220 kg of 0.8% Sodium Hypochlorite at an average cost of $0.39 per kg. Labour and maintenance for the on-site system has been fairly straightforward, including mostly manufacturer-recommended actions.
Operation & Maintenance of the system consisted of the following:

- De-Scaling (Acid Washing) of the Electrolytic Cell(s) from Calcium deposits (once per year)
- Cleaning the salt tanks (once every four years)
- Cleaning/Changing Water & Brine filters (one per month)
- Hypochlorite Storage & Brine Tank inspection (once per year)
- Electrode replacement every 5 – 10 years depending on use and Salt & Water Quality

17.0 CONCLUSION

Generating Sodium Hypochlorite on-site is a viable, cost effective and safe alternative to 12.5% Commercial Grade Sodium Hypochlorite and Chorine Tablets. It is more expensive per kg than Chlorine Gas, however if safety issues are taken into account, it can still be a viable alternative.

18.0 ACKNOWLEDGEMENTS

Severn Trent Services – ClorTec Division