SODIUM HYPOCHLORITE PRODUCT STEWARDSHIP MANUAL

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Introduction

Sodium hypochlorite, also known as hypochlorite, hypo, bleach or NaOCl, is used in a wide range of industrial settings. Olin has long been regarded as a dependable source of sodium hypochlorite, and our recent innovation in distribution has established Olin as the clear lead supplier of industrial bleach in North America.

Olin's reliable supply of sodium hypochlorite offers you the quality you need in a wide variety of concentrations and is backed by a customer support network that only Olin can provide. Check with your Olin Sales representative for particular solution strengths available in your market.

Product Stewardship

At Olin, our Product Stewardship program is guided by our core values – Act with Integrity, Drive Innovation and Improvement, and Lift Olin People. We are committed to the safe handling and use of our products – and enabling all of our collaborators throughout the value chain to do the same. As a responsible corporate citizen and certified to RC14001®:2015, we assess our products' safety, health, and environmental information and take appropriate steps to protect employees, public health, and the environment.

Ultimately, our product stewardship program's success rests with each individual involved with Olin products – from the initial concept and research to the manufacture, sale, distribution, use, disposal, and recycling of each product.

Manufacturing Locations

Olin has multiple sites throughout North America that manufactures sodium hypochlorite solutions, commonly referred to as "bleach." The capabilities of these sites are similar with slight differences in the grades of product available to meet specific market needs. Olin is uniquely positioned to service your sodium hypochlorite needs as a true integrated North American manufacturer with production facilities and terminals located throughout the United States and eastern Canada. Through our network of manufacturing facilities, shipping equipment, and terminals, we can ship just about anywhere within the United States and North America. For more information regarding your needs, contact an Olin Sales representative.

Manufacturing Processes

Processes

Sodium hypochlorite is produced in batch and continuous processes by the introduction of chlorine into a diluted sodium hydroxide solution. The ratio of chlorine addition to the amount of sodium hydroxide is controlled to ensure adequate excess caustic to stabilize the final product. Automated blending equipment allows for meeting various customer quality and strength requirements depending on the final application. Once chlorination is completed, the product is filtered to remove suspended impurities. By incorporating filtration and cooling steps as integral components at our continuous manufacturing process, customers receiving Olin-produced sodium hypochlorite are provided an inherent advantage, as these two practices play important roles in minimizing product decomposition.

Olin's HyPure® Bleach is manufactured using proprietary technology, which produces a super concentrated, low-salt hypochlorite product. HyPure® Bleach is manufactured at concentrations up to 23 wt.% NaOCl and then undergoes further processing to remove additional trace metals and salt (NaCl). This increased purity means a slight difference in the physical and chemical properties of the product when comparing HyPure® Bleach to standard sodium hypochlorite. This special product has limited availability in North America. Contact your Olin Sales representative for details.

Regulatory and Certifications

Olin's sodium hypochlorite solutions are well-suited for use in a variety of industrial and municipal applications. We offer product certification upon request for various industry and regulatory standards. Contact your Olin Sales representative to discuss specifications, certifications, and product grades (food grade and food chemicals codex (FCC)) available in your particular market.

- American Water Works Association (AWWA B300)
- NSF/ANSI/CAN 60 (Standard 60): Certification by National Sanitation Foundation (NSF) (current locations and grade availability can be found at www.nsf.org)
- Kosher: Certification by Star-K (current locations and grade availability can be found at www.star-k.org)
- U.S. EPA pesticide registration for manufacture use and end use applications. Pesticide labels available upon request.
- Canada Pest Management Regulatory Agency (PMRA) for technical grade/manufacture use and end use applications. Pesticide labels available upon request.

For further regulatory information contact your Olin sales representative.

Regulatory commitments apply to the product as shipped from an Olin location and delivered, in the Olin-arranged original shipping container, or to product as picked up by the customer from an Olin location. Assurances that the product has not been altered or otherwise changed after being removed from the Olin-arranged original shipping container, or after transfer into the customer shipping container, such that it no longer meets the above criteria will have to be obtained from those companies responsible for the subsequent storage, handling, or repackaging of this product.

Physical & Chemical Properties

Chemistry

Sodium hypochlorite solutions are most often produced using an automated continuous process. In early commercial production, hypochlorite was made in a batch process, wherein Chlorine gas or liquid is injected into a dilute caustic solution. To avoid over-chlorination and to maintain the excess alkalinity required to produce a stable hypochlorite solution, chlorine addition must be discontinued prior to complete depletion of the caustic present in the solution. Sodium hypochlorite manufacturing follows the chemical reaction below which combines caustic soda and chlorine to produce one mole of sodium chloride (NaCl) for each mole of sodium hypochlorite (NaOCl). A mole is a measure of the number of molecules of a compound. This one-to-one ratio of production products often garners the name of 'equimolar sodium hypochlorite' as a result.

Equation 1:

$Cl_2 + 2\ NaOH \rightarrow NaOCl + NaCl + H_2O$

Properties

Importance of Density

Density is an analytical tool often used in petroleum and some chemical industries. It allows users to quickly identify contaminations and correlate product quality without expensive laboratory instrumentation or time-intensive "wet chemistry" tests. When determining weight-based calculations, performing an actual density analysis is critical to predicting the most precise concentration value for a freshly collected sample. However, the unique nuances associated with chemical composition and production, as well as the decomposition of sodium hypochlorite over time, can lead to erroneous conclusions when density is incorrectly used to predict hypochlorite concentration. It is important to understand that the correlation between sodium hypochlorite concentration and density is not exact because all bleach solutions are a mixture of several chemical compounds (sodium chloride, sodium hydroxide, etc.). Therefore, a small change in one of these compounds will change the density without changing the sodium hypochlorite concentration. The following examples should be considered due to this effect:

Density Effect on Flow Measurement

- Flow measurement instruments, such as magnetic flow meters that are affected by changes in density, will have to be adjusted for this density difference. Devices that use volume displacement (rotameters, metering pumps, vortex meters, etc.) will not be affected.
-

Level Measurement

- Level instrumentation that relies on pressure (pressure gauges, differential pressure cells, etc.) will need to be re-calibrated based on the new density.
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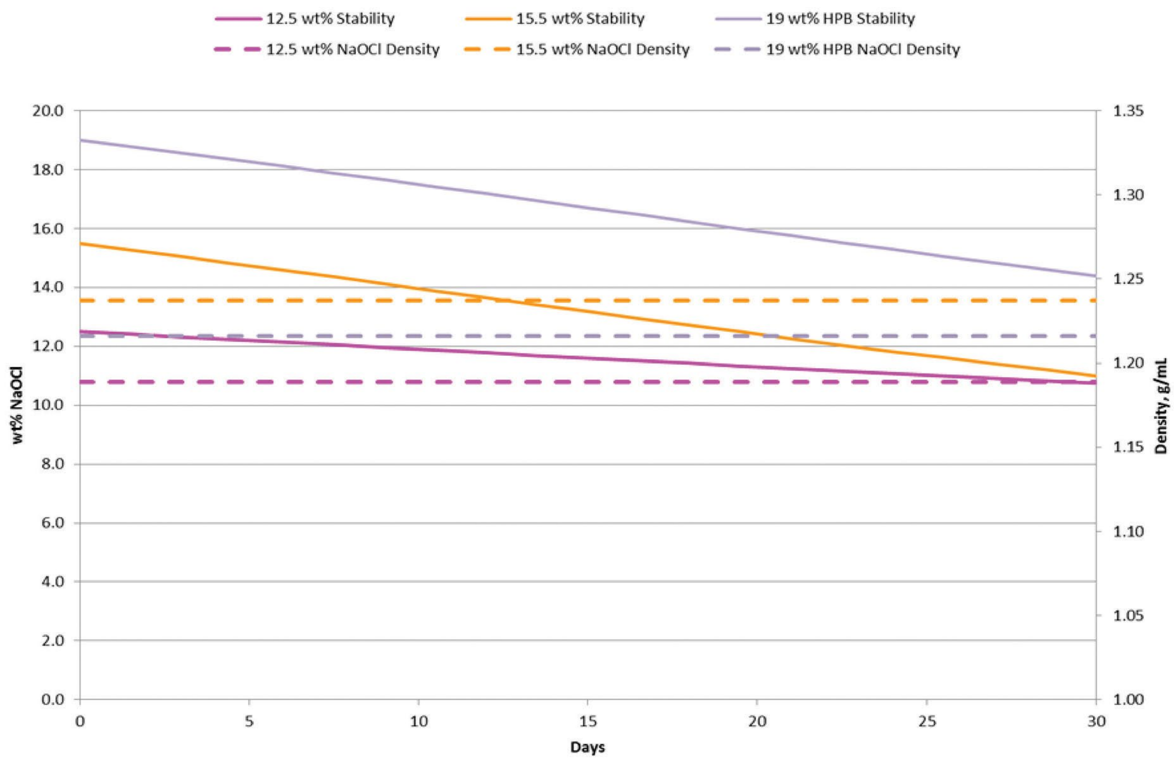
Converting Between Volume and Weight Units

- The density difference must be accounted for when converting between weight and volume such as gallons or liters:
  - Converting shipping container net weight in pounds to a volume in gallons or liters.
  - Filling bottles by volume and then weighing the finished goods.
  - Conversion between weight percent and grams per liter (GPL) or trade percent.

The graph below illustrates how density affects this conversion.

Graph A: Bleach Stability and Density at 70º F



Strength, also known as concentration or assay, of sodium hypochlorite may be expressed in several different ways by manufacturers and suppliers on their invoices, quality documentation, product labels, dosage rates, or bid requirements. As a result, it is always critical to specify the units of concentration when referencing product strength. The table that will follow in the *Concentration of Units* section illustrates the importance of specifying assay units.

Sodium hypochlorite strength is time dependent, with all solutions starting to lose assay immediately after production. Unlike hypochlorite strength, density will remain unchanged over time. For immediately produced product, density will generally correlate with assay. However, the correlation will continue to change as the solution ages and will yield increasingly erroneous conclusions.

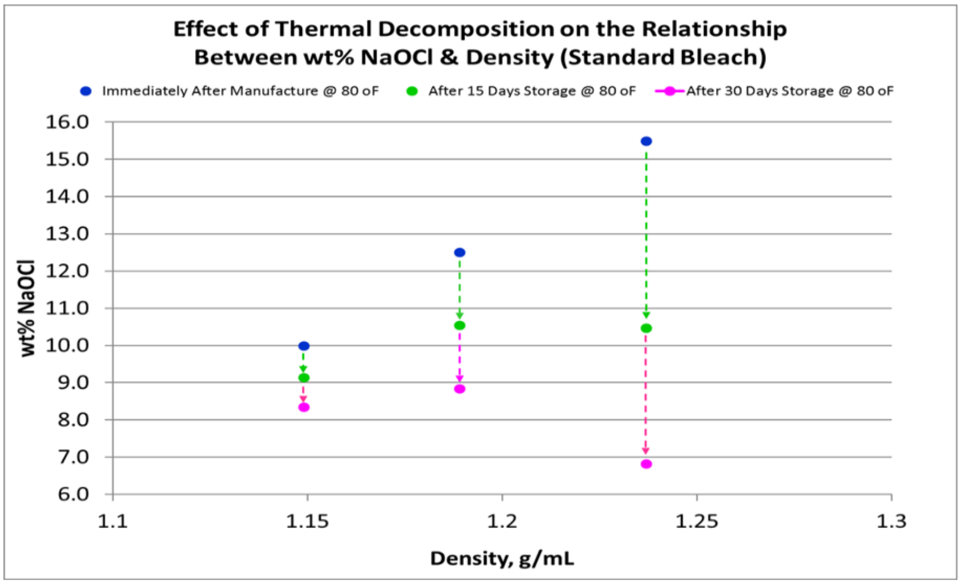
Other factors such as metallic contaminants and exposure to elevated temperature will cause accelerated decomposition and loss of strength. These attributes provide the rationale explaining why an aged hypochlorite solution will have a significantly different assay than a freshly produced one, but density of the solutions will remain unchanged. As a result, hypochlorite solution density (or specific gravity) should not be specified in chemical purchase specifications or acceptance criteria because it is not a reliable predictor of sodium hypochlorite strength. When precision is required for determining strength, assay titration is preferred.

For applications where density must be determined, there are several different test methodologies available, including density meters, hydrometers, or use of a pipette-and-weigh combination. When determining density via meter or hydrometer, the results will need to be temperature-adjusted to yield the most accurate results.

For more information about sodium hypochlorite nomenclature, physical and chemical properties, safe handling systems, analytical procedures, and emergency response – please refer to the following resources: the Olin Sodium Hypochlorite Manual available on request from Olin, and the Chlorine Institute's Pamphlet 96 – Sodium Hypochlorite Manual.

NOTE: The Chlorine Institute (CI) is a technical trade association of companies involved in the safe production, distribution, and use of chlor alkali products.

Graph B: Effect of Thermal Decomposition on the Relationship Between wt.% NaOCl & Density (Standard Bleach)



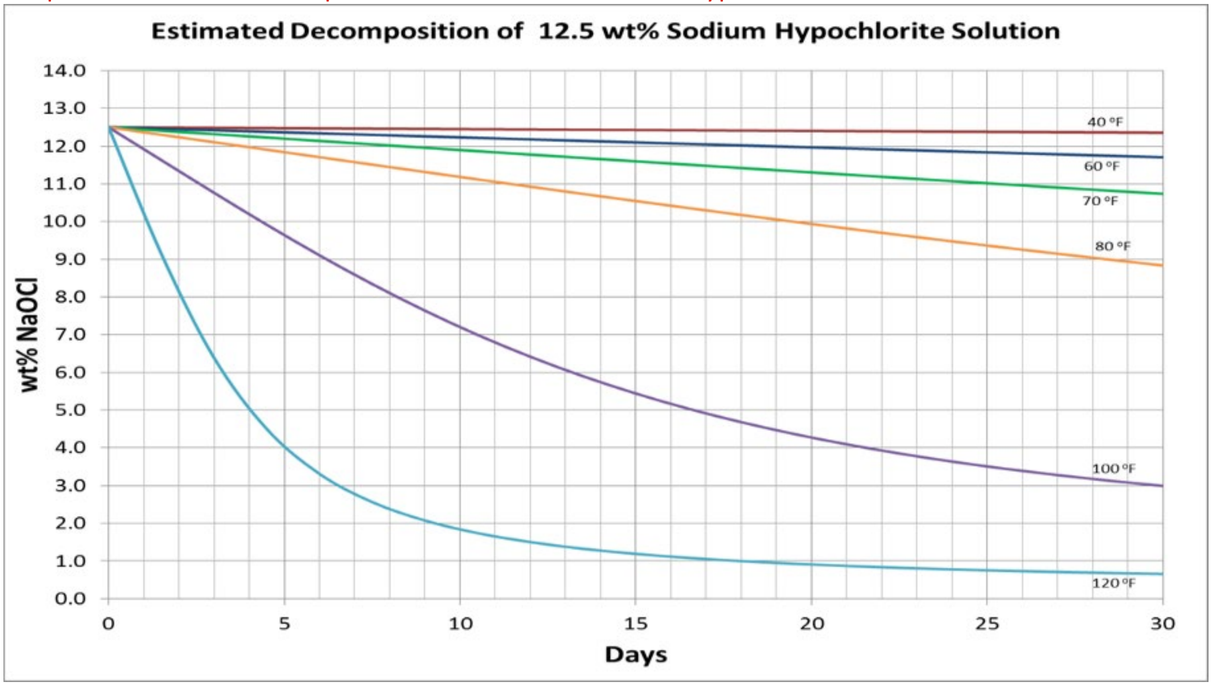
Minimizing Degradation of Sodium Hypochlorite Solutions

The chemical makeup of solutions (NaOCl - often referred to as 'bleach'), is such that they continually decompose immediately after the manufacturing process has occurred. Decomposition cannot be avoided, but the rate of degradation can be slowed. There are many factors which affect the stability of hypochlorite solutions.

These factors include but are not limited to:

- Temperature
- Hypochlorite concentration (strength)
- pH/Alkalinity
- Transition metals contamination
- Other inorganic and organic contaminants
- UV light exposure, and
- Ionic concentration (also called the salt factor includes hypochlorite strength as well as sodium chloride and sodium hydroxide concentration)

Graph C: Estimated Decomposition of 12.5 wt. % Sodium Hypochlorite Solution



Temperature and Concentration:

In most situations, the temperature and hypochlorite concentration at which the hypochlorite solutions are stored have the most impact on their stability because decomposition accelerates as the concentration increases and as temperature increases. Additionally, studies have shown that the decomposition rate increases by a factor of two to four times for every 10 °C (18 °F) temperature increase (Graph C). Here are some tips to reduce degradation:

- Usage rate and storage volume should be managed so that excess inventory is avoided.
- Storage temperature should be minimized, if possible, to reduce degradation.
- Outside storage tanks that are exposed to sunlight should be light colored since darker-colored tanks will absorb more heat when exposed to sunlight.
- In warmer climates, consider insulating the tanks or placing storage tanks indoors or under a covering to provide shade.
- Consider dilution of bleach upon receipt using good-quality softened water.

Alkalinity/pH Management When Diluting Sodium Hypochlorite

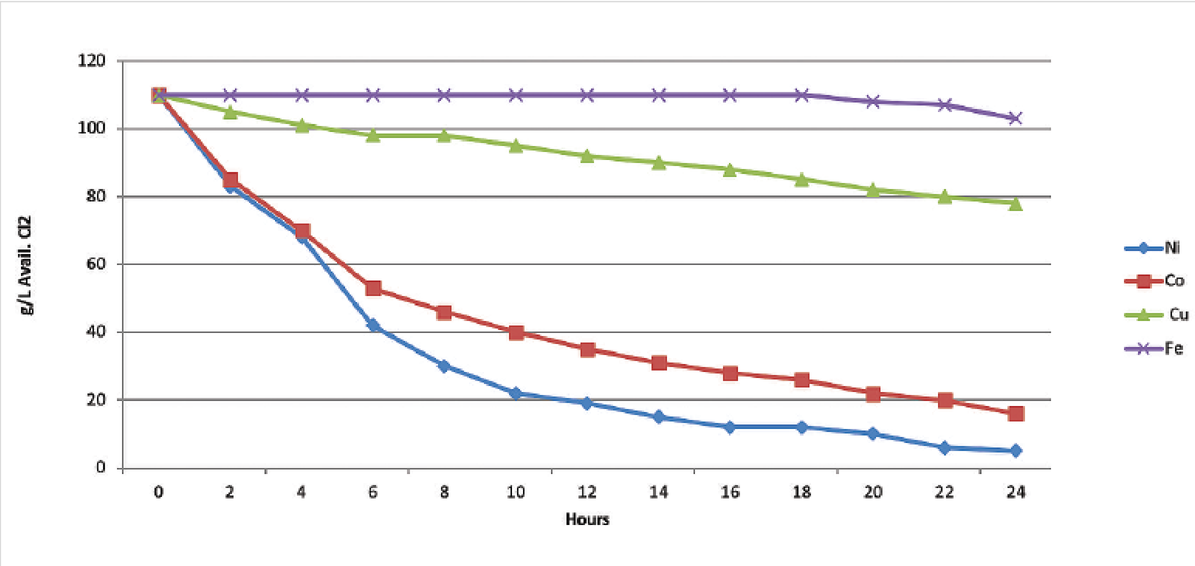
All sodium hypochlorite solutions require residual alkalinity, particularly sodium hydroxide, to ensure product stability and to avoid generation of chlorine gas. For minor dilutions, the excess sodium hydroxide content in the product should be sufficient to maintain the minimum level of about 0.1 wt.% NaOH to ensure product stability. The pH of sodium hypochlorite should be maintained between 11 and 13 even after dilution.

With more significant dilutions, a small addition of caustic soda (sodium hydroxide) may be required to achieve the minimum level necessary for a stable product. Please note that the quality of the caustic soda added can also negatively impact sodium hypochlorite quality, especially higher content of trace metals and salts.

Metals Impact on Stability

Exposure to certain metals can affect the stability of sodium hypochlorite solutions. Nickel, cobalt, copper, and iron have the greatest impact, respectively (Graph D).

Graph D: Metal-Induced Assay Loss (g/L) vs. Time (Hours)



Some corrosion guides indicate that the use of stainless-steel or Hastelloy® connectors or instruments is "acceptable" with sodium hypochlorite solutions. These publications typically focus on the overall rate of component corrosion, but do not consider the negative effects of incompatible metals on the hypochlorite solution's chemical quality. Studies have found that nickel, found in both stainless steel and Hastelloy®, has the highest impact on sodium hypochlorite degradation. Some tips to avoid typical metals exposure sources follow:

Eliminating Metal Exposure

- Unloading connections should be constructed of PVC, CPVC, polypropylene, or PTFE-lined steel. *Stainless-steel connectors or fittings should NOT be used.*
- Dilution water used for bleach should be tested and confirmed to be low in metals.
- Olin manufacturing processes incorporate various types of filtrations to control and/or remove metallic contamination during manufacture. However, for some applications such as product bottling, additional filtration steps may be required to further reduce metallic content.
- Review the entire bleach storage and handling system to ensure all wetted surfaces are metal-free (except for titanium and tantalum). Even a single, incompatible component, such as a pipe elbow, can initiate the decomposition reaction.
- If plant air is used to unload sodium hypochlorite, there should also be a point-of-use filter designed to remove particulates and oil. In addition, the piping, hose, and fittings downstream of the air filter should be constructed of bleach-compatible materials.

Chlorate and Perchlorate Formation in Sodium Hypochlorite

In most cases, as sodium hypochlorite decomposes, sodium chlorate and sodium perchlorate are formed as byproducts. Since these decomposition byproducts are undesirable in many applications, efforts should be taken to slow their formation. The factors listed above that contribute to the formation of these compounds are temperature, hypochlorite concentration (strength), UV light exposure, and ionic concentration.

In order to mitigate the formation of these impurities, the following are recommended:

- Follow the guidelines in the "Temperature and Concentration" section above.
- Reduce or eliminate excess inventories (or heels) in "almost-empty" storage tanks. The residual material can have high levels of chlorates and perchlorates and will contaminate fresh material loaded on top of it.
- Samples of sodium hypochlorite should never be allowed to remain in a warm or sunny location. Exposure to higher temperatures or UV light will skew sample results. If a sample cannot be tested immediately it should be stored in a refrigerator and out of UV light until analysis can be performed.
- For analysis of chlorate/perchlorate (such as that required by ANSI/NSF Standard # 60) the sample of sodium hypochlorite should be quenched per the standard guidelines as soon as possible after sampling. The quenching process reduces hypochlorite degradation and stops formation of chlorate / perchlorates which otherwise continue to form during sample transit and test wait times.

Sodium Hypochlorite Decomposition Byproducts

There are several byproducts that are produced during the decomposition of sodium hypochlorite. The byproducts produced are a function of the primary cause of the degradation and the resulting chemical reaction. Here is a list of the primary decomposition reactions that result from the factors listed above:

- Dominant Decomposition Reaction:
- $_3NaOCl \rightarrow NaClO_3 + {}_2NaCl$
- $NaOCl + NaOCl \rightarrow NaClO_2 + NaCl$ (slow)
- $NaOCl + NaClO_2 \rightarrow NaClO_3 + NaCl$ (fast)
- Factors: Concentration, Temperature, Ionic concentration, UV light
- Perchlorate Formation Reaction:
- $NaClO_3 + NaOCl \rightarrow NaClO_4 + NaCl$
- Factors: Same factors as dominant reaction plus sodium chlorate concentration.
- Secondary/Catalyzed Reaction:
- $_2NaOCl \rightarrow O_2 + {}_2NaCl$
- Factors: Same factors as dominant reaction plus transition metal contamination.
- Low-pH Decomposition Reaction:
- $_2HOCl + OCl- \rightarrow ClO-_3 + Cl_2 + H_2$
- Factors: Same factors as dominant reaction plus pH in the range of 5 to 9.
- Chemical Formula Definitions:
- NaOCl - Sodium Hypochlorite
- NaCl - Sodium Chloride
- $NaClO_3$ - Sodium Chlorate
- $NaClO_2$- Sodium Chlorite
- $NaClO_4$- Sodium Perchlorate
- O_2- Oxygen (gas)
- HOCl - Hypochlorous Acid
- OCl - Hypochlorite ion
- ClO_3 - Chlorate ion
- Cl_2 - Chlorine (gas)
- H_2 - Hydrogen (gas)

Dilution

Dilution of sodium hypochlorite is often chosen by customers to meet assay-specific applications. Although many sources of water can be used for sodium hypochlorite dilution, the most important aspects to consider when choosing a dilution water source are hardness and metals content. Hard water (high calcium and magnesium content) can cause precipitates and scaling to occur in sodium hypochlorite solutions. Exposure of sodium hypochlorite to dissolved metals in dilution water can accelerate product decomposition similar to physical contact with metallic components. It may alter the hypochlorite solution's color. In general, as water quality improves, product scaling and precipitation are reduced, and decomposition rates decrease. For sodium hypochlorite bottling operations, additional water treatment and product filtration may be required.

Another consideration for significant strength dilutions is the excess alkalinity in the diluted product. For minor dilutions, the excess actual sodium hydroxide content in the product should be sufficient to maintain the minimum total alkalinity level of about 0.1 wt.% as NaOH to ensure product stability. With more significant dilutions, a small addition of caustic soda (sodium hydroxide) may be required to achieve the minimum level necessary for a stable product. The quality of the caustic soda addition can also negatively impact sodium hypochlorite quality, especially in trace metals and salts.

Unlike dilution of hypochlorite with water, which is non-exothermic, the addition of significant quantities of caustic soda will result in a temperature gain of the solution. Solution cooling capabilities may be required for large volume alkali additions to minimize temperature-induced product decomposition.

Crystallization Points

The freezing or crystallization temperature for sodium hypochlorite solutions is a function of the hypochlorite concentration. Solutions with higher concentrations of hypochlorite and/ or the other dissolved salts will begin to crystallize at higher ambient temperatures than solutions containing lower concentrations of hypochlorite and/or the other salts.

Since sodium hypochlorite solutions can contain varying amounts of several dissolved salts, the ability to accurately predict the crystallization point of the solution can be difficult. Solutions with higher concentrations of hypochlorite and/ or the other dissolved salts will begin to crystallize at higher ambient temperatures than solutions containing lower concentrations of hypochlorite and/or the other salts.

Crystallization typically first begins on the solution surface or in small diameter piping/tubing subjected to no or low-flow conditions. To prevent the material from freezing, tank cars, tank trucks and piping should be unloaded/drained promptly in cold weather. In extremely cold climates, strong sodium hypochlorite solutions could be diluted to lower the freezing point, which will also increase the stability of the material.

Table 1: Crystallization Points

Weight % NaOCl	Crystallization Point (F°)	Crystallization Point (C°)
20	28	-2.2
15.5	-21.5	-29.6
12	-3	-19.4
6	18.5	-7.5

(Chlorine Institute Data)

Concentration Units

Concentration

Strength or concentration of sodium hypochlorite may be expressed in a number of different ways in supplier certificates of quality, invoices, product labels, dosage rates, or bid requirements. As a result, it is always critical to specify the units of concentration when referencing product strength.

The table below illustrates the importance of specifying assay units. A 12.5 weight percent NaOCl solution (a common industry strength standard) is different from a 12.5 trade percent solution. Additionally, a 12.5 weight percent solution is not the same as a 12.5 solution having units of volume percent. ALWAYS specify units of concentration!

Table 2: Concentration Units

	Wt% NaOCl	Wt% avCl₂	g/l AvCl2	Trade %	Equivalent Cl2	Density (Theoretical)	
	(g NaOCl/100 g soln)	(g AvCl2/100 g soln)	(g/L soln)	(g AvCl2 / 100 mL soln)	(lb. Cl2 / gal soln)	g/ml	lb./gal
Equimolar Bleach	5.25	5.0	53	5.3	0.45	1.067	8.90
	6	5.7	62	6.2	0.51	1.079	9.01
	7	6.7	73	7.3	0.61	1.096	9.14
	8	7.6	85	8.5	0.71	1.112	9.28
	9	8.6	97	9.7	0.81	1.128	9.42
	10	9.5	109	10.9	0.91	1.145	9.55
	11	10.5	122	12.2	1.02	1.161	9.69
	12	11.4	135	13.5	1.12	1.178	9.83
	12.5	11.9	141	14.1	1.18	1.186	9.90
	13	12.4	148	14.8	1.23	1.194	9.97
	13.5	12.9	155	15.5	1.29	1.203	10.04
	14	13.3	161	16.1	1.35	1.211	10.10
	14.5	13.8	168	16.8	1.41	1.219	10.17
	15	14.3	175	17.5	1.46	1.227	10.24
	15.5	14.8	182	18.2	1.52	1.235	10.31
	16	15.2	190	19.0	1.58	1.244	10.38
	16.5	15.7	197	19.7	1.64	1.252	10.45
HyPure® Bleach	17.5	16.7	200	20.0	1.67	1.203	10.04
	18	17.1	207	20.7	1.73	1.209	10.09
	18.5	17.6	214	21.4	1.79	1.216	10.15
	19	18.1	221	22.1	1.85	1.222	10.20
	19.5	18.6	228	22.8	1.90	1.229	10.25
	20	19.1	235	23.5	1.96	1.235	10.31
	20.5	19.5	242	24.2	2.02	1.242	10.36
	21	20.0	250	25.0	2.08	1.248	10.42
	21.5	20.5	257	25.7	2.14	1.255	10.47
	22	21.0	264	26.4	2.21	1.261	10.53
	22.5	21.4	272	27.2	2.27	1.268	10.58
	23	21.9	279	27.9	2.33	1.274	10.63

Note: the conversion between wt.% NaOCl, g/L AvCl2 and Trade % will change depending on the density used in the calculation.

AvCl2 = Available Chlorine; Soln. = Solution; g/L = gram per liter or gpl

One of the complicating factors in converting units involves the role of the density in the calculation. Some units of measure, such as weight percent (wt.%), compare the weight of NaOCl (gram) to the solution weight (100 grams) while other units, such as grams per liter (g/L), compare the weight of the NaOCl (grams) to the solution volume (liter).

When converting between these units, the density of the solution must be used in the calculation. Because there is no direct relationship between density and concentration for sodium hypochlorite solutions, the conversion between weight % and trade % can never be precise unless density is also measured.

Technical Data

Safety & Handling

To prevent injuries to personnel or the environment, follow the safety and handling procedures outlined in this manual. All employees should be instructed in the properties of sodium hypochlorite and safe operating procedures and practices including:

- Safety Data Sheets (SDS)
- Toxicological Properties
- Personal Protection
- Safe Handling
- Safety Shower & Eyewash
- General First Aid
- First Aid Procedures
- Responding to Emergencies
- General Spills

Always review the Safety Data Sheet (SDS) before handling sodium hypochlorite.

Safety Data Sheets (SDS)

The following health and safety information is intended to provide general guidelines only. Sodium hypochlorite is a highly corrosive and reactive compound. To prevent personnel injuries and environmental exposure, this product stewardship manual and the most current SDS should be reviewed and understood. Never handle any sodium hypochlorite solution before you have read and understood the relevant SDS. The SDS may also provide additional information that is not contained in this manual.

The SDS should be readily accessible to all persons where the product is being used. It is your responsibility to ensure that the most up to date SDS, provided by the supplier, is available to and understood by all employees who work with sodium hypochlorite. To obtain an SDS, visit Olin's website at www.olinchloralkali.com or call Olin's Division Headquarters at (423) 336-4850.

Toxicological Properties

Sodium hypochlorite is a strong corrosive solution which will present a serious health hazard if improperly handled. It is corrosive to the skin, eyes, mucous membranes, and the respiratory tract. Accidental skin or eye contact with this material can cause pain, severe burns, tissue, or eye damage. Vapors or mists of sodium hypochlorite represents a hazard to the respiratory tract. If inhaled, may cause irritation, burns or permanent damage of the lungs and the respiratory system. Ingestion may cause damage to the gastrointestinal tract with the potential to cause ulceration or perforation. See the SDS for additional information on potential exposure hazards.

Personal Protection Equipment

A PPE hazard assessment can help a facility determine what PPE will protect individual(s) performing work for process operations. Consult **The Chlorine Institute** *Pamphlet 65, Personal Protective Equipment for Chlor Alkali Chemicals* and a qualified safety or industrial hygiene professional before conducting a job hazard assessment. Hazard assessments should be performed for each job task. The results of the hazard assessment can be used to select the level of PPE to protect individual(s) against the hazards of the task. Hazard assessments should be reviewed on a periodic basis and whenever operating practices, procedures, or conditions change. The PPE recommendations for several common sodium hypochlorite tasks below are based on *The Chlorine Institute Pamphlet 65 guidance.*

Basic PPE required for routine work duties – such as monitoring the process operations – should include a hard hat, safety glasses, and the availability of safety goggles and face shields. It is especially important that the face and eye protection match the potential hazards.

When work duties include performing sampling activities, line breaking such as disconnecting unloading hoses, or maintenance activities, full PPE should be used. Full PPE includes rubber (Neoprene or equivalent) jacket and pants, hard hat, rubber (Neoprene or equivalent) gloves, and boots.

In addition to each person's individual PPE, every sodium hypochlorite handling area should be equipped with the appropriate emergency PPE- including respiratory protection if required for vapor / potential misting situations, chemical resistant suits for emergency response personnel, and safety shower and eyewash stations. This equipment should be kept clean and in good working order and be easily accessible. The storage area for safety equipment should be labeled with a complete listing of its contents.

Safe Handling

- Know the location of the nearest safety shower and eyewash fountain and confirm it is functioning before performing any work in that area.
- Always handle sodium hypochlorite in a way that prevents spillage. Sodium hypochlorite can make floors slippery. Serious falls and injuries may result if sodium hypochlorite is not immediately cleaned from floors, stairs, or other walkways.
- Avoid bodily contact with any form of sodium hypochlorite, and immediately flush exposed area with copious amounts of water.
- Do not mix sodium hypochlorite with other chemicals, especially acids except under the direction of properly and highly trained personnel. This should only be performed in equipment or facilities that have been designed to handle these types of reactions/conditions.
- The neutralization of sodium hypochlorite liberates heat and can be a violent reaction. Application of a water spray to the spill before neutralization occurs is recommended to reduce

the neutralization reaction and the generation of heat. Consult government regulations for proper disposal of sodium hypochlorite and neutralized material residues.

- Make sure that sodium hypochlorite spills, residues, or products of neutralization are not discharged directly into sewers or streams in violation of federal, province, state, and local requirements.
- Vapors given off by sodium hypochlorite solutions may be suffocating and irritating when inhaled. They are also corrosive to most metals and other materials of construction. Therefore, it is important to maintain adequate ventilation at all locations where the bleach is being handled. The choice of appropriate respiratory protection will vary depending upon the expected vapor concentrations in air.

Safety Showers & Eyewash Stations

According to OSHA regulations, safety showers and eyewash units need to be located in areas that have the potential for exposure, such as unloading stations, process pumps, control valves, and spill containment areas. OSHA refers companies to the ANSI Standard Z358.1 which further defines issues such as accessibility and visibility.

According to ANSI, these safety appliances should be located on the same level as the hazard, without access impediments such as steps, curbs, or doors, and be located within 10 seconds of reach. They should also be visible even when someone's vision is impaired. Color-coding, reflective tape, or some similar method should be used to distinguish them from surrounding equipment, handrails, or walls, so that everyone working in the area will know their location.

For more information, consult the most current edition of American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) Z-358.1 for additional information.

General First Aid

Prompt response to bodily exposures is critical to minimize potential injurious consequences. Ensure that medical personnel are aware of the chemical(s) involved if exposure or injury occurs.

Always review the most current Safety Data Sheet (SDS) and provide it to medical personnel administering care to injured persons. To obtain an SDS, visit Olin at (www.olinchloralkali.com) or call Olin's Division Headquarters at (423) 336-4850.

First Aid Procedures

Eye Contact: Immediately flush with water for a minimum of 15 minutes, holding eyelids open and occasionally lifting the upper and lower eyelids to ensure water reaches the affected areas. Remove contact lenses if they can be easily removed. A sensation of heat indicates the water is effectively diluting the sodium hypochlorite – continue rinsing despite the temporary discomfort.
Do not transport the victim unless the recommended flushing period is completed or if flushing can be continued during transport. Do not use soap. Seek medical attention immediately.

Skin Contact: Immediately flush with large quantities of clean water for at least 15 minutes. If there is sodium hypochlorite on the head and face, do not remove goggles until after this area has been thoroughly flushed with water. Remove contaminated clothing and jewelry. Clothing that has come in contact with sodium hypochlorite should not be worn until it has been washed thoroughly. Discard contaminated shoes. Seek medical attention immediately.

Ingestion: DO NOT induce vomiting. Immediately drink large quantities of water. **DO NOT** give anything by mouth if the person is unconscious or having convulsions. Seek medical attention immediately.

Inhalation: Move to fresh air immediately. If breathing is difficult, give oxygen. If breathing stops, provide artificial respiration. Induce artificial respiration with the aid of a pocket mask equipped with a one-way valve. Seek medical attention immediately.
Before work continues, ventilate the work area, and equip personnel with proper respiratory protection.

Responding to Emergencies

Each facility should maintain current procedures for handling emergencies occurring both on-shift and after hours. If your facility meets the requirements of 29 CFR 1910.38 and **external personnel** will be expected to resolve the emergency, then you must have an Emergency Action Plan (EAP) that describes how employees will respond to different emergencies.

Sites with ten or more employees must maintain a written EAP, although a written EAP is desirable for sites of any size. Periodic drills should be conducted to verify employees know the EAP and can carry out the duties identified in the EAP.

Including local emergency response agencies in facility drills can also enhance the effectiveness of drills and communication activities with the community.

In addition to the standard requirements for EAP and ERP for chemical manufacturing and storage facilities, there are requirements specific for sodium hypochlorite.

Emergency Action Plan

In general, an EAP should address:

- Means of reporting fires and other emergencies.
- Evacuation procedures and emergency escape route identification.
- Procedures for operating critical controls prior to evacuation.
- Accounting of all employees.
- Rescue and medical duty assignments.
- Names/job titles to contact in emergencies.

Emergency Response Plan

An Emergency Response Plan (ERP) is to be maintained for sites that meet the requirements of 29 CFR 1920.38 and 29 CFR 1910.120, where **site employees** will also act in a First Responder role.

The ERP has additional detailed procedures that specifically address First Responder roles such as training, emergency recognition and prevention, PPE and emergency equipment, decontamination procedures, and establishing incident command, to name several components.

The ERP should be periodically revised with your Local Emergency Planning Committee (LEPC) to ensure compliance with local, province, state, and federal requirements.

Like EAPs, it is important to conduct frequent Plan drills. Including your LEPC or outside responder in facility drills can provide important insight into Plan strengths and weaknesses and can also strengthen relationships with the community.

General Spills

In general, when encountering a leak or spill, the primary focus should be to always maintain your personal safety as well as those around you.

Consult your EAP or ERP regarding specific actions to take when encountering a spill event and you will be seeking assistance from external personnel. It is important to prevent sodium hypochlorite from spilling onto soil, storm sewers, or into waterways.

Since it is a strong alkaline with a high pH, sodium hypochlorite can threaten the survival of most wildlife, especially in aquatic environments.

Sodium hypochlorite solutions are corrosive with concrete, most metals, and minerals. If sodium hypochlorite was in contact with a building or infrastructure element, the affected area must be thoroughly rinsed, inspected, and repaired.

How to Respond to Spill Events

Step 1: Evacuate and Activate

- Evacuate all personnel from the area and restrict access.
- Maintain safe refuge away from and upwind of the spill area.
- Activate the site's Emergency Plan.
- If external personnel perform response duties, activate the Emergency Action Plan.
- If facility persons perform response duties, activate the Emergency Response Plan.

Step 2: Suit Up and Remediate

THESE STEPS SHOULD BE PERFORMED BY TRAINED,KNOWLEDGEABLE PERSONNEL ONLY!

- Suit up with appropriate PPE per SDS and never respond alone.
- Isolate and contain the spill with the use of inert materials (e.g., sand,dirt, etc.).
- Recover as much chemical as possible for re-use.
- For unusable material, transfer liquids and residues to an approved Hazardous Waste container for proper disposal.
- Manifest and dispose of unusable materials, residues, and their containers consistent with all local, province, state, and federal regulations.
- Neutralize affected area avoiding use of acids and low pH neutralizing agents until all available chlorine has been neutralized. Consult Neutralization section and SDS for additional details.
- Decontaminate all equipment, PPE, and materials.
- Launder any clothing or jewelry prior to re-use.

Step 3 – Report

- Immediately report spills in accordance with local, province, state, and federal regulations.

Consult the SDS to determine the Reportable Quantity (RQ) threshold for this material. Federal law requires that if the spill is greater than the RQ it must be immediately reported to the National Response Center (NRC) at 800-424-8802. **Consult local, province, state, and federal regulatory agencies for specific**

requirements unique to your location. Additional regulatory reporting requirements may vary by jurisdiction.

Special Considerations

Special care must be exercised when attempting to contain, neutralize, and dispose of sodium hypochlorite spills. The strong reactive power dictates that any absorbent material must be chemically inert to sodium hypochlorite. Avoid use of items such as sawdust and rags, which can react with sodium hypochlorite under certain conditions, and materials such as “floor dry,” which typically contain organic components. Spill collection equipment such as shovels or recovery drums, should be verified clean and void of incompatible residues.

Never introduce sodium hypochlorite to local sanitary treatment plants, or bodies of water without proper approvals. Sodium hypochlorite can irreparably disrupt the biological processes of sewage treatment operations and will result in harm to aquatic life. Chlorine gas also might be released at the treatment plant if acidic waters are encountered by hypochlorite. Processing and containment area drains should be periodically reviewed to ensure protective features such as engineering and procedural controls are in place to prevent automatic release.

Neutralization

Neutralization is often favored for larger quantity spills, those which are heavily contaminated and cannot be re-used, or in situations where the resulting neutralized solution will be sent to a wastewater treatment plant. Neutralization methods for spill events described in this publication are not intended to treat bodily exposures. Although the result of neutralization is a less hazardous material, the process itself involves other chemicals, rapid reactions, and in some instances the potential to generate other gases and hazards. When neutralizing hypochlorite solutions, safety must be an integral component throughout the process. Because of the potential for aggressive reactions, only well-trained personnel should attempt neutralization. Completing a hazard analysis before work begins will help identify the critical engineering and procedural controls necessary for safe neutralization.

There are a number of chemical options for neutralizing sodium hypochlorite, including sodium sulfite, sodium bisulfite, sodium thiosulfate, hydrogen peroxide, and sulfur dioxide. Regardless of the method chosen, the sequence of neutralization steps is critical. To prevent generation of chlorine gas, always neutralize the hypochlorite active ingredient before lowering solution pH.

Disposal

Proper clean-up and disposal require that liquids, residues, and neutralized materials are handled, stored, transported, and disposed in accordance with local, province, state, and federal regulations.

Storage Tanks, Piping Systems & Other Equipment

Sodium hypochlorite users are responsible for building and maintaining a properly designed storage and handling system. The initial capital cost should be secondary to these primary objectives.

A properly designed and installed system that meets the objectives of safety and maintenance is generally most economical in the long term. The following items are important considerations when installing a new storage and handling facility or upgrading existing site equipment.

Key factors must be kept in mind when handling sodium hypochlorite:

- Sodium hypochlorite is highly corrosive and can be hazardous to personnel.
- Vapors from concentrated sodium hypochlorite solutions can cause irritation when inhaled.
- Solution temperature and strength will affect corrosion rates with various materials.
- Storage tanks should be located to minimize piping runs. It is equally important to locate storage and piping in low traffic areas to minimize potential exposure to personnel.

The following mechanical features are desired for sodium hypochlorite storage tanks:

- Filling inlet at the top of the tank
- Outlet to the process
- Vent
- Manway
- Level indicator

Labeling

Tanks, piping systems, and other handling systems should be clearly labeled to identify chemical contents. Labels or stencils noting the entire, formal product name, e.g., “sodium hypochlorite” are preferred and especially beneficial to contractors and others not intimately familiar with the tank farm.
Labels should comply with OSHA’s HAZCOM Standard (29 CFR 1910.1200) and with Canada’s WHMIS (Workplace Hazardous Materials Information System) for Canadian sites, In addition, U.S. EPA pesticide registration and or Canada Pest Management Regulatory Agency (PMRA) requirements.

A recommended practice is to post the Class 8 – Corrosive placard with the UN number (UN 1791) on the storage tank and the unloading connection point.

Labeling of pipelines provides critical information regarding the intended contents and associated product hazards. General pipeline labeling indicating the product and flow direction can be especially helpful when performing line-tracing activities.

The labeling of receiving pipelines, particularly near the delivery connection point, is important because it can provide an additional layer of protection against accidental delivery of the wrong chemical by providing a visual reference of intended contents for delivery and unloading personnel.

The ASME/ ANSI A13.1 standard for pipe marking, requires an employer to use labels that state what a pipe contains and what hazards are related to that substance. Always review all federal, province, state, county, city/municipality labeling requirements.

Sizing

As part of the storage system strategy, the vessel should be large enough to easily accommodate a full inbound bulk shipping container, compensate for likely transit times, and tank heels. A general rule of thumb is to size the tank at least 1.5 times as large as the full bulk shipping container to maximize freight savings and have ample room to avoid tank overflows and pneumatic stresses during filling and line clearing. However, consumption rates also should be considered because of the decomposition nature of the product. For low-volume requirements or where the tank is subjected to high ambient temperature and sunlight exposure, a smaller tank volume might be appropriate. Vertical tank designs, rather than horizontal, are preferred.

Materials of Construction

The tank selection process has a number of important components to consider. While many are obvious, others are not intuitive because of the unique attributes of sodium hypochlorite. Tanks should be located to minimize piping runs, accommodate shipping container movement for inbound deliveries, and be installed in secure areas to avoid tampering/vandalism concerns. Local, state, province, and federal environmental regulations should be reviewed before tank installation. Local building codes and fire regulations also may influence tank farm construction and location.

A part of the process of the purchase and installation of a new storage tank should be planning for future inspection and replacement. Accurate records about the particulars of the tank design (drawings and notes) and materials of construction should be provided to those responsible for ongoing maintenance and inspection of each tank. The tank vendor should be asked to supply recommendations for initial inspection scheduling and tank life expectancy. Proper replacement timing should always be intended to replace the vessel well before the end of its expected useful life.

Storage Tanks

Titanium

There are a limited number of materials that are chemically compatible with sodium hypochlorite. These materials can be categorized into metallic and non-metallic systems. Titanium and tantalum are the only chemically compatible metals and offer the longest lifetime. Their high cost generally limits use to critical applications such as reactor vessels and filter housings, and internal components of pumps, meters, valves, etc.

Rubber-Lined Steel

Rubber-lined steel tanks are often selected for high-capacity vessels or ones that are subjected to multiple fill/discharge cycles. The lining should be of a 100 percent chlorobutyl rubber composition. Rubber-lined storage tanks require a simple but specialized mechanical integrity test (IP-4-13 “Procedure for Spark Testing Elastomeric Sheet Lining”) to evaluate lining integrity on a periodic basis. Exposure of lining to the product can resultin the exposed rubber surface dislodging or flaking over time. This flaking phenomenon is often more pronounced for tank/liner combinations that have been exposed to different chemical service. For sensitive applications, aparticulate filter on the tank discharge nozzle may be required.

Fiberglass Reinforced Plastic and Dual Laminates

Fiberglass reinforced plastic (FRP) is frequently used in storage applications and offers good mechanical strength and a failure mechanism that is typically preceded by small leaks that warn of its weakened condition. However, fabricator experience, resin, curing mechanism, and stored product strength are important variables influencing vessel performance. FRP vessels are sensitive to ultraviolet (UV) degradation and should incorporate the use of a UV inhibitor for tanks located outdoors.

Hand-laid application of the reinforcement mat or chopped strand filament winding is preferred over continuous filament wound construction. Should the corrosion barrier fail, continuous wound filament reinforcement is at a higher risk of chemical attack via product wicking, which increases the risk of catastrophic failure. Avoid the use of cobalt napthenate as a curing agent because cobalt may catalyze hypochlorite decomposition upon failure of the corrosion barrier.

FRP tanks also can be lined with a fluoropolymer such as PTFE, PVDF, etc. or PVC to produce a dual laminate vessel. Dual laminate construction offers the mechanical strength of FRP combined with a robust, chemically compatible internal liner.

Poly Tanks

High-density polyethylene (HDPE), cross-linked (XHDPE) and linear (HDLPE), have been successfully used in sodium hypochlorite service and are typically known as poly or plastic tanks. However, fabricator experience, resin, product strength, mechanical hammer, temperature, sunlight exposure,and pipe connection methods are important variables influencing vessel performance. If cross-linked HDPE is used, it is important to confirm that the resin chosen is suitable for sodium hypochlorite. Additionally, tanks should comply with ASTM D-1998, "Standard Specification for Upright Polyethylene Storage Tanks."

Poly tanks have excellent chemical resistance and are often chosen for smaller volume vessels. Lateral expansion and contraction of the tank wall is a significant concern with poly tanks as the walls will tend to flex depending upon the product level inside the tank. The mechanical hammer associated with compressed air chemical deliveries, automated valve cycling, and pump operations that introduce structural stress on poly tanks are other significant factors affecting tank service lifetimes. Additionally, the use of bulkhead type fittings may significantly shorten the life of the tank because of the tendency to experience stress crackingaround the cutout for this type of fitting. As with FRP, poly vessels are sensitive to ultraviolet (UV) degradation and should incorporate the use of a UV inhibitor for outdoor installations.

Long-term contact with hypochlorite causes embrittlement of the polymer so that a sudden mechanical shock can cause a catastrophic failure of the tank. As with other non-metallic piping and tank materials, an inspection and replacement plan should be developed for poly tanks, so they are replaced before failure occurs.

HyPure® Bleach can be stored and handled in the same equipment as standard sodium hypochlorite solutions. Consult with your tank manufacturer to ensure the tank is of adequate design to manage the increased corrosivity and oxidation associated with this concentrated product. Insulation and cooling may be needed if the material is held at high concentrations for prolonged periods of time.

Fabricator Evaluation

The fabrication and lining processes are critical to long-term success when storing sodium hypochlorite. Industry experience has shown merely utilizing chemically compatible material alone is not a guarantee for lengthy tank service lifetimes. The aggressiveness of sodium hypochlorite dictates that special evaluations of the fabricator and the material of construction should be performed, regardless of the type of construction chosen.

Fabricators should be selected based on:

- Their experience in fabricating tanks intended for this product.
- The performance record of their tanks in sodium hypochlorite service.
- The fabrication process used.

Once a fabricator is determined, it is important that the manufacturers' recommendations on usage and preventative maintenance are strictly followed. Capital, tank location, and desired service life will dictate the choice of the material of construction. However, if the storage tank is properly specified and maintained, useful lifetime can be maximized.

Venting

Adequate venting is critical for ensuring a rapid release of air surge when tanks are filled via pneumatic transfer. The tank will be subjected to an immediate, large volume of compressed air at the end of the shipping container unloading process using pad air as the motive force. Compressed air surges approaching 1200 SCFM, (Standard Cubic Feet perMinute) are typical from tank trailers, for example. Without an appropriately sized vent, the tank will temporarily act as a pressure vessel, which can lead to tank wall flexing to accommodate the pressure load. Repeated flex cycles can weaken tank walls and could lead to catastrophic tank failure.

As a general guide, tank vent diameters should be at least twice (2X) the size of the inlet piping diameter. Factors such as the length of the vent piping and number of turns can impede the release of compressed air and will require further upsizing of the vent. It is important to consult the manufacturer on the type of venting system that should be designed to support your bulk unloading system.

Overflows

If the tank becomes over-filled, overflow nozzles allow chemicals that normally would spray out of the tank vent or manway opening to be safely channeled via directional piping into the containment system. Overflow nozzles and directional piping are sized at least 1.5 times (1.5X) larger than the inlet pipe to ensure adequate capacity. Overflow nozzles should be installed below the roof line and on the sidewall of the tank. This overflow piping should discharge near ground level in an area and direction away from the typical area occupied by personnel. Consult your tank fabricator for additional design guidance.

Receiving Pipeline - Inlet/Outlet Nozzles

Receiving Pipeline

Two-inch piping is typical for tank trailer serviced locations with short pipe runs, while three- or four-inch diameter pipelines are often used for tank car unloading to facilitate rapid product transfer. Pipe diameter guidance will vary depending on site layout.

The receiving pipeline should be equipped with a drain valve (where practical) near the delivery hose attachment point routed to containment. This valve can be used to collect delivery samples or relieve hose and pipeline pressure after unloading is completed.

Flexible Connections and Piping Support

Non-metallic tanks are very easily stressed from axial and lateral forces originating from factors such as the act of tank filling and the expansion/contraction of attached discharge piping as ambient temperatures change. Unsupported discharge piping connected to a heavy valve can exert significant torque on the tank's outlet fitting area that can culminate in sidewall cracks/ damage. Rigid connections tend to concentrate these stresses in the nozzle area of the tank. Installation of proper piping support and/or use of flexible connectors may help eliminate many of these potential tank stressors. Tank nozzles on non-metallic tanks should never be used for support of valves and piping. Consult your tank vendor for specific guidance.

Outlet Nozzles

Selection of tanks with a low-point drain should be considered. Low point drains offer the benefits of complete product heel removal for applications that are sensitive to product decomposition byproducts, such as chlorate. Low point drains also facilitate periodic internal tank inspection and cleaning activities.

Level Measurement

A level measurement system is important for maintaining process operation and for avoiding an overflow condition during inbound delivery. Gauging systems range from simple visual readings to complex remote readouts. Under certain scenarios, the inventory may be read directly from the "shadow" of a translucent, clear-tinted poly tank equipped with markers molded into the side wall.

External "sight glasses" can provide effective level indications. However, similar to reading inventories from the "shadow" of a translucent tank, use of external "sight glasses" may also lead to erroneous readings under certain lighting conditions. External "sight glasses," such as polyethylene or polypropylene tubing, also present an opportunity for catastrophic loss of tank contents upon "sight glass" failure or damage and should be guarded to prevent impact of any kind.

Differential pressure or electronic level indicators are frequently used for tank level measurement. Level indicators that are not immersed in the product typically perform best, but all electronic level transmitters should be assigned a scheduled periodic recalibration cycle to ensure accurate readings over the long term. Equipping the indicator to activate an alarm or automatic shutoff at preset inventory levels can provide an important additional layer of protection against accidental tank overflow conditions. The reliability of the high-level alarm or automatic shutoff can be enhanced by using an activation device independent of the regular level transmitter (redundancy).

Posting the maximum allowable storage tank volume in a location clearly visible to unloading personnel will facilitate calculation of available volume for incoming chemical. This, coupled with a local level readout, will allow the unloading staff (and delivery driver for tank trailer shipments) to monitor tank levels more effectively during unloading.

Tank Securement

Tanks should be secured using the appropriate means as required or suggested from the manufacturer, as well as required by county and or state regulations to prevent tank movement from high winds or seismic activity.

Cleaning, Inspecting & Preparation

Cleaning

Tank cleaning frequencies will be affected by factors such as the purity ofthe incoming product, consumption volumes, and internal tank inspection cycles. Tank rinsing may be desired for removal of sedimentation that can occur over time, as well as removal of residual contaminants that may adhere to tank walls after the product has been consumed. Tanks purchased with a 'full drain' nozzle will foster complete cleaning and flush activities. Tanks equipped with ground-level manways can facilitate cleaning activities by providing convenient vessel access without the useof ladders and scaffolding.

Inspection

A periodic, scheduled inspection should be performed regardless of materials of construction chosen. Personnel performing inspections should be given specific guidance regarding areas to inspect and the types of failure/damage to identify. Detailed criteria and photos can be useful inspection aids. Use of a checklist has been found to be particularly helpful to ensure inspection consistency between different personnel.

For non-metallic tanks, the exterior of the tank should be inspected for evidence of drips or seepage, sidewall or roof bulges, and surface cracks or crazing, to name several key attributes and areas for inspection. Keep detailed inspection records, both from visual inspections and the non-destructive testing (NDT) data obtained during mechanical inspections, for future reference.

Preparation

New or repaired piping and tank systems should be water tested under use conditions before being placed in sodium hypochlorite service.

Containment Systems

A well-designed handling system should incorporate an effective secondary containment system to contain potential drips or spills in product storage and unloading areas. Secondary containment regulations often vary by location, so it will be important to review local codes/city ordinances, as well as province, state, and federal requirements when considering storage of sodium hypochlorite, whether the tank is indoors or outdoors.

As a general guide, containment systems should be capable of holding at least 110 percent of the largest tank capacity found in the contained area. Appropriate containment must be designed to address the quantity of sodium hypochlorite that would be discharged from the primary containment system (e.g., container, equipment), such that the discharge will not escape secondary containment before cleanup occurs. In determining the most likely quantity, the facility owner/operator should consider factors such as the typical failure mode (e.g., overfill, fracture in container wall, etc.), resulting sodium hypochlorite flow rate, facility personnel response time, and the duration of the discharge. In addition, the system designer should identify any bottlenecks and implement modifications that address them.

Containment sizing should take into account “freeboard” space in the event of a heavy precipitation event or other items that could be introduced into the secondary containment such as water foam from a fire suppression system.

Incompatible chemicals – especially those that release hazardous gases when mixed – should be separated by walls within the overall containment area and in the drain-system piping.

There are a number of options for secondary containment systems including concrete, double-walled tanks, and open-top containment tanks. Concrete is typically the preferred choice for bulk storage containment systems. A well-designed system will have reinforced floors and walls. Application of an industrial coating can extend concrete containment lifetime and to limit the potential of chemical migration through cracks or open expansion joints. The effectiveness of industrial coatings will be influenced by the overall condition of the concrete, amount of surface preparation before application, and the type of coating applied. Two-part epoxy coatings intended for strong alkalis are preferred.

Good maintenance and housekeeping practices that eliminate small piping or pump leaks soon after they develop and that keep the area clean and dry will extend the life of the enclosure. Maintenance becomes critical as minor imperfections that allow chemicals to contact the concrete structure may not be rinsed away from rainfall or housekeeping events.

Double-walled tanks are often considered for vessels if there is limited room for the tank and containment system. Use of a liquid-detection monitor in the open space between the tanks can provide notification of internal vessel failure. The double-walled feature does, however, impede the ability to perform important visual inspections of the tank wall.

Shipping container unloading stations also should incorporate secondary containment to collect leaks, spills, or wash-down water. Reinforced concrete is the preferred material of choice for tank trailer unloading station containment systems because most unloading areas must be able to accommodate vehicular traffic weight loads.

For tank car unloading, the presence of railroad ties and the occasional need for track maintenance make removable containment pans preferable to concrete sumps or pits. Polyethylene or fiberglass reinforced plastic (FRP) containment pans are offered from many containment system vendors for liquids collection between track rails. They offer the benefit of beingremoved for future track maintenance purposes. *Routing of containment system drains should avoid exposure to incompatible chemicals.*

Incompatible Chemicals During Unloading

The oxidizing property of sodium hypochlorite requires that special care be taken to avoid incompatible chemical contact also known as accidental mixing. Accidental mixing may result in personnel injury or environmental damage as a result of introducing sodium hypochlorite residues to a wide variety of incompatible chemicals.

Although reactions vary depending on the chemical composition, sodium hypochlorite will generate chlorine gas when exposed to acids, acid residues,or other chemicals that may lower the pH of the hypochlorite solution.

Production of oxygen gas and significant amounts of heat may accompany other reactions with sodium hypochlorite.

The opportunities for incompatible chemical contact at a storage facility are many and variable but typically can be grouped into three categories:

- The shipping container unloading process.
- Secondary containment for unloading and storage.
- Small containers, such as drip collection devices.

The Chlorine Institute (www.chlorineinstitute.org) bulletin, “Sodium Hypochlorite Incompatibility Chart,” provides a list of chemical families that are incompatible with sodium hypochlorite. Design considerations tohelp prevent accidental mixing are discussed in the ‘Unloading Station’ section of this manual and the SDS.

Piping

When making initial decisions about piping, it is critical to select the appropriate material of construction because sodium hypochlorite is incompatible with all metals except titanium and tantalum. Use of non- metallic materials throughout is often embraced when only economic and compatibility perspectives are considered. However, the role of external stresses in pipe life, effective means to mitigate their detrimental effects, and the mechanical capabilities of the organization's maintenance personnel should be evaluated before choosing pipeline materials. Exposures to direct sunlight and wide temperature extremes, to identify just two common examples, are external stresses that can weaken non-metallic piping and lead to premature component failure.

Threaded pipe should be avoided as the pipe wall section containing the threads is thinner and more prone to failure or leakage. For flanged pipe installations in close proximity to personnel or equipment, installation of flange guarding should be considered. All piping systems should undergo scheduled integrity inspection, regardless of material of construction utilized. Non-metallic piping typically requires even more frequent inspection and replacement cycles.

Piping Materials of Construction

There are a number of acceptable materials of construction for sodium hypochlorite piping systems. Each material of construction presents unique attributes, and in some instances requires special care in installation and inspection to help ensure successful long-term use. Structural strength, chemical resistance, and operational conditions are important factors to consider when selecting piping materials of construction.

Because of their superior structural strength, metals are widely used in piping services for many alkali chemicals. However, unlike many alkalis, sodium hypochlorite is highly reactive with most metals and metal alloys and is compatible only with titanium or tantalum metal. Lined-steel piping using thermoplastics such as polypropylene, polyvinylidene fluoride (PVDF or Kynar® polymer) or polytetrafluoroethylene (PTFE or Teflon® polymer) as the liner is often used as an alternative pipe material for portions of the systemswhere mechanical stresses or impacts are expected. Lined metal is often chosen for the initial portion of the receiving pipeline, especially near the hose connector where external stresses are expected to be more significant.

PVC and CPVC are chemically compatible, non-metallic materials often used in lower mechanical stress applications. Certain specialty grades of polyethylene also have been successfully used in sodium hypochlorite service. Pipe specifications should be at a minimum schedule 80 or higher for most applications. Mechanical impact from hazards such as liquid/gas mechanical hammer, temperature expansion/contraction cycles, pressure surges from pump start-up and operation, sunlight/ultraviolet light degradation, and potential foot or vehicular contact should be carefully considered when selecting PVC/CPVC for sodium hypochlorite service. PVC/CPVC materials are sensitive to these types of external stresses and if not properly installed, supported, and inspected, can often fail unexpectedly during use. For end-use applications such as dosing meters, small diameter PVC/ CPVC piping is often used. As with larger diameter piping, proper support is required. A protective enclosure such as a conduit or equivalent device should be used where foot or vehicular traffic is likely.

Most polyvinyl chloride monomers have recommended temperature ranges that should not be exceeded. In many instances, ambient conditions exceed these recommendations and elevate the risk of fracture. A related factor is ultraviolet damage as a result of long-term sunlight exposure. Repeated sunlight exposure will weaken monomer bonds, making the pipemore prone to fracture. Consult with your pipe vendor for added guidance.

Fiberglass reinforced plastic (FRP) has been used successfully in hypochlorite service, but it requires extreme diligence in carefully managing all aspects of fabrication and installation. Successful service is typically dependent upon fabricator experience (those specializing in manufacturing pipe expressly intended for sodium hypochlorite), selecting the correct resin composition and the curing process (avoiding cobalt napthenate curing chemicals), and using certified installers that employ stringent quality assurance methods, to name several critical aspects.

Piping Installation

Where possible, pipe runs should be installed to eliminate the presence of low points because products left standing in pipelines can experience decomposition (oxygen generation and chlorate formation) when not in use. Where low points cannot be avoided, installation of drain valves discharging to a suitable containment system should be considered. Piping feeding metering pumps creates a special situation wherein oxygen gas formation can result in pump vapor lock. Installation of suction piping sloped up away from the pump can minimize gas collection and associated cavitation concerns. For underground pipe installations, pipes should be placed in an impermeable trench with removable inspection covers.

Piping Support

Adequate pipeline support is important regardless of material of construction. However, support becomes increasingly critical for non-metallic systems as they have lower structural strength and require additional support consideration. Proper spacing of the support system (e.g., hangers, trays, or clamps) will be influenced by the pipe size, operating temperature range, and the weight load of the filled pipe. Special care is required with hangers, support devices, and clamps to ensure a smooth contact surface, free of rough edges. They should not compress or distort the pipe but should allow axial movement resulting from changes in thermal expansion and contraction. Because of these factors, use of a continuous support system should be strongly considered for non-metallic pipe runs. If non-continuous support systems are chosen, consult your pipe vendor for recommended support spacing.

Pipe Glues

Sodium hypochlorite will attack the fumed silica additive used as a thickening agent in some glues or cements intended to join PVC/CPVC (polyvinyl chloride and chlorinated polyvinyl chloride) components. Because of the likelihood of joint separation or leakage, only glues/cements that are fumed silica-free should be used. Containers for these glues typically indicate their compatibility with oxidizers and alkalis. Proper preparation of the surface and application techniques for the primer and cement are important, but often overlooked, aspects of pipe installation. Proper preparation of the glued joint is critical to long-term performance. Diligently follow the glue manufacturer’s guidance for all assembly steps.

Transfer Hoses

Note: Lined steel hose connection for strength and product quality

Bulk shipments of sodium hypochlorite will require a flexible hose to connect the shipping container to the storage tank's receiving pipeline. Although most tank trailer serviced customers rely on the carrier to provide the transfer hose, use of customer-provided hoses remains an option. Tank car deliveries require customers to supply the transfer hose. Hoses should be constructed of sodium hypochlorite-compatible materials and be rated to withstand the working pressures expected during the transfer process. Hose construction must avoid any wetted metallic surfaces, such as pipe nipples or quick-connect fittings, because of the corrosive nature of sodium hypochlorite and the sensitivity of this product to experience metallic-induced decomposition. From a mechanical integrity standpoint (as shown above), metallic connector components that have a fluoropolymer or HDPE lining on the wetted surface are the preferred construction. Polyethylene, including the Ultra-High Molecular Weight Polyethylene (UHMWPE or UHMW) subset and polypropylene are common lining materials of construction. The choice of material should be discussed with your hose vendor regarding expected service conditions including, but not limited to, strength sodium hypochlorite and temperature ranges to be experienced throughout a calendar year. The potential for external surface abrasion can also influence the type of protective sheath, if any, chosen for the hose.

As with all expendable components, hoses and hose connectors should undergo a visual inspection prior to each use to identify and prevent potential failures. Use of an inspection checklist by a knowledgeable inspector trained in defect identification helps maximize inspection effectiveness. The Association for Rubber Products Manufacturers' bulletin, IP-11-7, (www.arpminc.com) can provide added details regarding maintenance, testing, and inspection of chemical hoses.

Pump & Meters

Pumps are typically selected based on service. Centrifugal, diaphragm, canned, and magnetically driven pumps are more common for high- volume transfers or for recirculation-type activities. Regardless of application, all internally wetted components must be constructed of sodium hypochlorite compatible materials, and the use of all metals excepttitanium must be avoided. Non-metallic materials such as Teflon®, Tefzel®, Halar®, or Kynar® polymers, and polyvinylchloride are common internal components for pumps.

Design features are influenced by the type of pump selected. Positive displacement pumps should incorporate a pressure relief device to protect against 'deadheading' situations whereas mechanically sealed centrifugal pumps should employ a seal-shaft shroud to help prevent potential seal leakage from being slung onto nearby personnel or equipment. A low-ampcut-off switch should be considered for magnetically driven pumps to protect against "burn-out" resulting from operating under damaging low or no-flow conditions.

Although piston, gear, and peristaltic positive displacement pumps are most frequently used in metering situations, all pump styles have been used successfully in these situations. The overriding factor in determining which type of pump to use may lie in past plant experience. The pump type most familiar to maintenance personnel and for which spare parts are readily available may be the best choice. A centrifugal pump coupled with a measuring device (rotameter, mag meter, or mass flow meter, etc.) may prove easier to calibrate and more compatible with automated control systems than metering pumps. Without an independent flow-measurement devices, metering pumps require routine calibration to ensure accurate output.

"Vapor lock" caused by entrained gas can be a problem with centrifugal,diaphragm, and peristaltic pumps, especially in low-flow metering applications. Typically, entrained gas is a result of trace-metal induced product decomposition (oxygen gas formation), so efforts to eliminate the source of such contamination would be the preferred solution. However, this problem can be minimized by sloping pump intake piping so that entrained gas bubbles move away from the pump suction or by employing other means of separating entrained gases before liquid reaches pump suction.

Valves

Valve type selection will depend on the intended application. Materials of construction range from plastic to fluoropolymer-lined steel valves.

Where cavity valves, such as ball or plug designs are used, a vented valve design should be used to prevent pressure buildup and potential valve or piping damage resulting from metallic-induced decomposition of sodium hypochlorite and associated buildup of decomposition gases. Vented valve body designs will also be critical in pipe runs wherein sodium hypochlorite liquid or residues may remain trapped between closed valves. Storage tank outlets should be equipped with positive shut-off capability and avoid the use of "butterfly" designs. Flanged or glued valves are preferred over threaded valves as they eliminate the threaded connection, which is a potential leakage point.

Shipping Sodium Hypochlorite

Hazardous Materials Transportation System (Regulatory)

The safe transport of hazardous materials such as sodium hypochlorite involves several different organizations:

- Regulatory Agencies (U.S. Department of Transportation, Transport Canada, U.S. Coast Guard, others)
- Chemical Manufacturer (Olin)
- Carriers (Railroads & Trucking)
- Tank Car / Tank Truck / Equipment Owners (various)
- Receiving Customer

Each of those mentioned above plays an important role in the safe shipment of hazardous materials.

Table 3: Shipping Organizations

Shipping Mode	Regulation/Enforcement Agency
Rail	USDOT – Federal Railroad Administration (FRA); Transport Canada
Roadway	USDOT – Federal Motor Carrier Safety Administration; Transport Canada
Waterway	U.S. Coast Guard; Transport Canada
Pipeline	USDOT – Pipeline & Hazardous Materials Safety Administration (PHMSA); Transport Canada

Regulatory Agencies are the governing bodies in the transportation arena that oversee the safe movement of all hazardous materials whether by land, air, or water. They define and enforce the rules covering the safe handling and transport of hazardous materials.

Each regulatory agency has an enforcement arm to assure compliance with record-keeping and equipment regulations. Penalties, including fines and potential jail terms for corporations and individuals, can be imposed for violations of regulatory requirements.

While the U.S. Department of Transportation (and Transport Canada for Canadian shipments) regulates the movement of hazardous materials by rail, road, and pipeline, enforcement of these regulations in the U.S. is carried out by different agencies depending on the mode of shipment.

Olin's responsibility in the hazardous material transportation system includes the safe operation of its loading facilities as well as maintaining and delivering the transportation equipment in good working order for shipment whether owned, leased, or contracted by Olin. A variety of inspection and maintenance procedures are carried out before the shipping container is offered for shipment after loading. Olin's goal is to ensure the safety of our personnel and, to the extent possible, all those who come in contact with a shipment of sodium hypochlorite, while effectively using our fleet and complying with all applicable laws.

The **carrier**'s (railroads, trucking & marine towing companies) responsibility in the hazardous transportation system is to safely move the sodium hypochlorite shipping containers from the shipper to the customer. The carriers must comply with a variety of regulations governing the movement of hazardous materials from agencies, including the Department of Transportation, Transport Canada, the Association of American Railroads, and individual state regulatory agencies.

It is important to note that in the case of tank cars (empty after use), the customers or end-users become the shipper of record when they offer the sodium hypochlorite container for shipment back to Olin. Carriers (rail and truck) rely on the shipper (Olin and/or the customer) to provide them with clean, safe, and secure Sodium Hypochlorite shipping equipment.

The sodium hypochlorite **customer's** responsibilities in the hazardous materials shipping process are similar to Olin's. Customers must follow the appropriate regulations in the handling and unloading of sodium hypochlorite containers, and in the case of tank cars, prepare them for shipment back to Olin.

A customer's goal is to safely handle and unload sodium hypochlorite containers, comply with all regulatory requirements, and where applicable, prepare the container for safe shipment back to Olin. As the legal "shipper of record," customers assume full responsibility for proper inspection, preparation and securement of tank cars released to the carrier. Failure to prepare containers for reverse movement may result in regulatory fines or citations.

Sodium Hypochlorite Shipping: Tank Trucks, Tank Cars

At Olin, sodium hypochlorite is shipped in tank trucks and tank cars, only. The fittings present on the tank trucks and tank cars, as well as the recommended unloading procedures, are described in the following pages.

For more detailed information regarding shipping container configurations or unloading procedures, contact **Olin's** Technical Services Group.

Tank Truck

Olin contracts with trucking companies to deliver Sodium Hypochlorite solutions by tank truck, also known as cargo tanks. Tank trucks used in sodium hypochlorite service must meet standards issued by the regulatory agencies (U.S. DOT, Transport Canada) and include equipment that conforms to the Department of Transportation (DOT) or Motor Carriers (MC) designations, which as of the year 2017 were MC-307, DOT-407, MC-312, and DOT-412 designations. Rubber-lined or fiberglass reinforced plastic (FRP) trailers of 24 – 38 metric tons (26 ST – 42 ST) (4,500 to 7,300 Imp. Gal. or 5,400 to 8,800 US

Gals) capacity are available for shipping sodium hypochlorite, based on over-the road weight limitations. Product unloading configurations include bottom discharge or a top-unloaded dip-leg arrangement.

Most sodium hypochlorite tank trailers typically have a double-valve arrangement on the outlet port. The internal valve is pneumatically operated and can be closed remotely in case of an emergency. The unloading connections on each tank truck are typically located at the rear. A specification plate specifying tank fabrication, inspection, and other regulatory information is typically located on the driver's side of the trailer frame near the front.

Transport regulations require these trailers to be inspected on a scheduled frequency, including internal and external visual inspections as well as leak, thickness, and pressure testing. These inspection dates are stenciled on the front head or on the front driver side of the trailer.

Tank trailers can be unloaded by the driver or by properly trained employees (DOT/Transport Canada function-specific) at the customer's or end user's facility. Delivery tractors are equipped with an air compressor for pneumatic product transfer. Onboard pumps are not available for sodium hypochlorite tank trailers.

Compressed air is applied up to a maximum of 25 psig to displace the sodium hypochlorite out of the tank trailer through the eduction pipe. Trailers are equipped with a rupture disk set at *approximately* 30 psig to protect the tank truck from over pressurization. *In applications where more than 25 psig of compressed air pad is required, customers should consider use of a fixed pump for tank trailer unloading.* For additional information on the size and location of fittings, contact **Olin's** Technical Service Group.

Tank Cars

Olin owns and/or leases a fleet of rubber-lined tank cars that meet DOT specification 111A100W5. Tank cars have capacities ranging from 70–90 metric tons (77 ST–100 ST). It is recommended to install a storage tank of 140 tons (26,200 Imp. Gal. or 31,500 US Gals) to accept the full contents of an inbound tank car.

Numerous important regulatory, environmental, safety, and health informational items are available on each tank car. Tags and stenciling display required regulatory, car maintenance, and operating information as well as safety, spill mitigation, and first-aid information along with emergency response contacts.

Sodium hypochlorite tank cars do not have bottom outlet valves. They are unloaded through a 3 in. diameter flanged eduction pipe located in the dome. A 2 in. rubber hose equipped with flanges is normally used for unloading and must be provided by the customer. The sodium hypochlorite solution is discharged by the application of compressed air or by use of a customer-supplied pump.

When unloading tank cars via a compressed air pad, a 25 psig (172 kPa) air pressure pad should be adequate for most transfer applications. In applications where more than 25 psig of compressed air pad is required, customers should consider use of a fixed pump for tank car unloading.

Unloading Sodium Hypochlorite Solutions

Unloading Procedures & HazMat Training

- Establishment of robust unloading procedures should occur before product is received and then be reviewed on a periodic basis or revised when operational practices dictate.
- Unloading procedures will be unique to each facility, receiving area, and delivery mode. However, well-written unloading procedures include several common attributes and components.
- Although the primary focus of the unloading procedure is to ensure the correct product is safely delivered into the storage facility, it also should be written to address unexpected events such as spills or other incidents.
- All procedures should be documented with periodic training provided to ensure personnel understand the procedure requirements. Verbal procedures for unloading should be avoided as they can foster inconsistency between staff members and an ever-changing standard.
- Use of pre- and post-unloading checklists offers the advantage of physically carrying the key elements of the unloading procedure to the work area for review/completion. Errors that potentially can occur from relying upon recollection of the formal unloading procedures can be avoided. Checklists help ensure all key unloading items are reviewed/inspected and encourage consistency between different staff members. Typical components include:
- Review of paperwork (bill-of-lading/shipping papers and certificate of quality) to verify they match the shipping container placard and receiving pipeline label.
- Delivery address and purchase order numbers are verified.
- Ensure adequate tank space exists to safely receive the entire shipping container contents, regardless of delivery mode.
- Safety shower and eyewash units have been located and verified operational.
- PPE has been inspected and donned.
- Mechanical inspection of the shipping container and transfer hoses has been completed.

Because it is a hazardous material (Hazmat), all personnel handling sodium hypochlorite must be properly trained or "qualified" on the topics of General Awareness, Function Specific, Safety, and Security as required by 49CFR 172.704 (U.S. DOT) and Transport Canada's Transport of Dangerous Goods Act S.C. 1992, c.34 (Canada) before handling this product. Regulations require Hazmat personnel to undergo this training at least once every three years.

General Unloading System Requirements

Customers should carefully consider the way that sodium hypochlorite will be received and handled at their facilities. Each receiving location needs adequate equipment, facilities, personal protective equipment, and procedures to safely unload this chemical. Personnel should be prepared to deal with both normal and abnormal situations.

Unloading system features to consider include:

- Sodium hypochlorite unloading operations must only be performed by properly trained personnel who understand the hazardous materials they are handling.
- All workers must wear proper protective equipment and clothing per the function specific task being conducted. They also must strictly observe all prescribed safe-handling procedures and practices. Contact with sodium hypochlorite can cause severe burns to skin and eyes. If inhaled, it may cause mild irritation to severe burns of the lungs and respiratory tract.
- Safety showers/eyewash stations and other personal protection equipment should be located in close proximity to the unloading connections. *However, the safety device should be located so that they will not be affected by an accidental release event if that were to occur.* This critical equipment must be easily and quickly accessible by those who need it. For example, someone with sodium hypochlorite in their eyes will have impaired vision making it difficult to locate the eyewash unless it stands out very clearly from the surrounding equipment. They would also have difficulty with stairs, curbs, narrow walkways, turns or other obstacles on the way to the safety shower/eye wash. By ANSI Standard, these safety appliances should be located on the same level as the hazard, void of access impediments such as steps, curbs, doors, and be located within 10 seconds of reach, and within 55ft.
- Connection points should be clearly identified to eliminate the possibility of connecting the transfer hoses to the wrong unloading line or system. For maximum effect, receiving pipelines should be clearly identified near the delivery hose attachment point and include the words, "Sodium Hypochlorite" and "UN 1791."
- Safe, unobstructed access to and from work areas around unloading connections is required for both routine operation and emergency situations.
- Leak containment systems (catch pans under tank cars, paved pads under tank trucks) should be provided for those places where spillage may occur. This includes the transfer hose connection drain valves, pump seals, and valves. These systems should provide positive control for leaks or spills that might occur during the handling of sodium hypochlorite. It is important to make sure that the materials of construction for the containment equipment are compatible with all sodium hypochlorite concentrations that might be handled in the system. The containment system should be designed and operated such that accidental mixing with other chemicals does not occur. Containment liquids should be verified or tested prior to reuse, recycle, or disposal.
- Adequate lighting is available in all work areas, especially at the unloading connections.
- Adequate supplies of water (equipment rinsing and spill cleanup), or other utilities should be readily available.
- The unloading area should be roped off/barricaded and warning signs posted during unloading operation to help ensure the safety of anyone passing by the area.

- Tank cars and tank trucks should be chocked to prevent accidental movement during the unloading operation.
- Level indicating devices and communication procedures should be used to ensure that there is enough space in the receiving tank for the entire product load.
- If a pad gas unloading system is used, air is the preferred pad gas. A point of use/ particulate filter should be installed on the source air to prevent metal particulates from entering into the sodium hypochlorite in the tank car or tank truck during unloading. The source air line should be equipped with a regulator set to a maximum of 25 psig to prevent over pressurization of the shipping container. If any other compressed gas is used, the customer should exercise due caution and Olin should be notified. Gases other than air can have additional hazards associated with them. For example, inert gases, like nitrogen, can present a potential suffocation hazard to workers who work on the tank car, tank truck, or storage facility.
- The vent system on the receiving tank should be properly sized and discharged to handle sodium hypochlorite vapors.
- In the case of tank car unloading systems, access by roadway to the unloading station should be considered as a backup in case truck shipment becomes necessary.

Other sections of this product stewardship manual contain additional information on the design and operation of sodium hypochlorite handling facilities. If you have any questions or need additional assistance, contact an Olin Technical Service representative.

Tank Truck Unloading

When unloading sodium hypochlorite tank trucks, the safety aspects of the operation should be uppermost in the minds of personnel. The unloader must verify that the requirements for receiving, and spotting have been completed before beginning transfer operations. Additionally, the receiver of the inbound delivery is responsible for checking and accepting the sodium hypochlorite before unloading. Procedures should be established and followed to be certain the product is acceptable before unloading. The unloading area must be large enough for easy turning and positioning of the tractor and trailer. Wherever possible, drive-through unloading stations are preferred over backing of the tank truck into the unloading station. The tank truck should be parked on a level unloading surface to ensure complete product unloading. The surface of the unloading area should contain potential spills and allow recovery, re-use, or clean-up of any sodium hypochlorite spilled during the unloading process. The wheels of the vehicle should be carefully blocked, and the brakes applied during the unloading.

Most tank trucks are equipped with an internal valve, an auxiliary product outlet valve, a two- or three-inch quick connect fitting for unloading hose attachment, and a *front driver's side and rear* emergency shut-off device. In addition, each tank truck is also equipped with a one-inch air connector for pneumatic product transfer.

The delivery driver normally unloads tank trucks. They are responsible for following the proper safety rules and operating procedures as prescribed by the recipient, Olin, and government regulations. If the truck driver is performing the unloading, it remains the customer's responsibility to verify the driver has attached the unloading hose to the proper tank connection and that the tank has enough available capacity to receive the full load.

The Department of Transportation requires that the entire truck unloading operation be attended by a competent unloader who is alert, located within 25-feet of the trailer, and has an unobstructed view of the unloading hoses. If the plant representative is in close proximity to the sodium hypochlorite hose connection points, they should don and also wear all applicable personal protective equipment.

In addition to being trained in the use of proper protective equipment and specific unloading procedures and equipment, site personnel assisting the delivery driver should be trained in the location and activation of the emergency shut-off device. Note: Most tank trucks are equipped with an emergency shut-off device located at the driver's side front and rear of the tank truck.

The recipient is responsible for providing competent and knowledgeable supervision, safety equipment special to the site, and a properly designed and maintained unloading area. The exact steps of the unloading operation will depend on each site's unique configuration.

Tank Car Unloading

Tank car unloading must be conducted by qualified personnel according to Transport Canada Dangerous Goods (TDG) and Department of Transportation (DOT) regulations. Placards on each side of the tank car, as well as the valve tags should be reviewed and compared against the Bill-of-Lading and certificate of quality prior to unloading to confirm the product ordered is the product delivered.

The tank car should be accurately spotted at the unloading station, the hand brake applied, wheels blocked by standard wheel clamps (wheel chocks) and the DOT/TDG-required blue flag "Stop – Tank Car Connected" signs displayed as a protection against disturbance during unloading. Derail attachments are recommended at open ends of the siding at least 1-½ car lengths away.

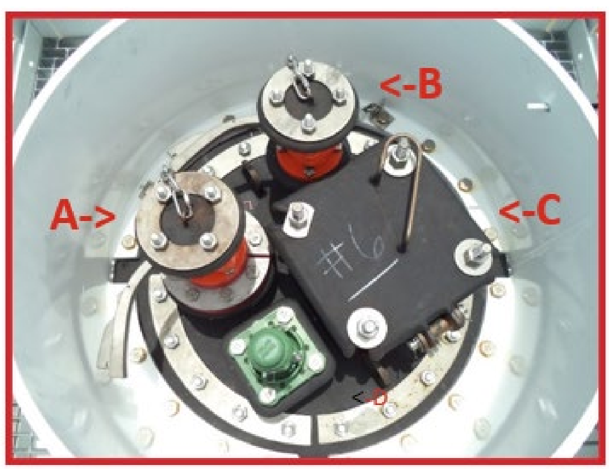
Adequate personal protective equipment should be worn during the unloading. Ensure that safety showers and eye wash fountains are operational before beginning any active operational tasks that may expose personnel to unexpected drips or residues.

An elevated platform and gangway system should be provided for safe access and egress from the top of the tank car. The platform should incorporate fall protection devices such as protective cages, or equivalent fall arrest systems. The pad gas filtration device and hose connection, as well as the receiving pipeline are typically located within arm's reach of the unloading platform, which limits hose length and associated clutter, while maximizing convenience for component access.

Tank cars require a four-bolt flanged connector to attach to the product outlet valve. Because of the elevated potential for" mechanical hammer" and other unloading stresses, the transfer hose should have a robust support system in place to limit stresses on the tank car connection. Because of these unloading stresses, a fluoropolymer lined, flanged metal connector is preferred for tank car unloading. The dome fittings and safety appliances should be inspected for evidence of leaks or other defects before unloading to prevent bleach spray after the tank is subjected to air pressure.

The following equipment is on the top of every *Olin* sodium hypochlorite tank car:

- 3" Flanged Unloading Valve with Blind Flange (connected to the eduction pipe)
- 2" Flanged Vapor Valve with Blind Flange
- Fill Hole Cover (for loading purposes)
- Pressure Relief Valve



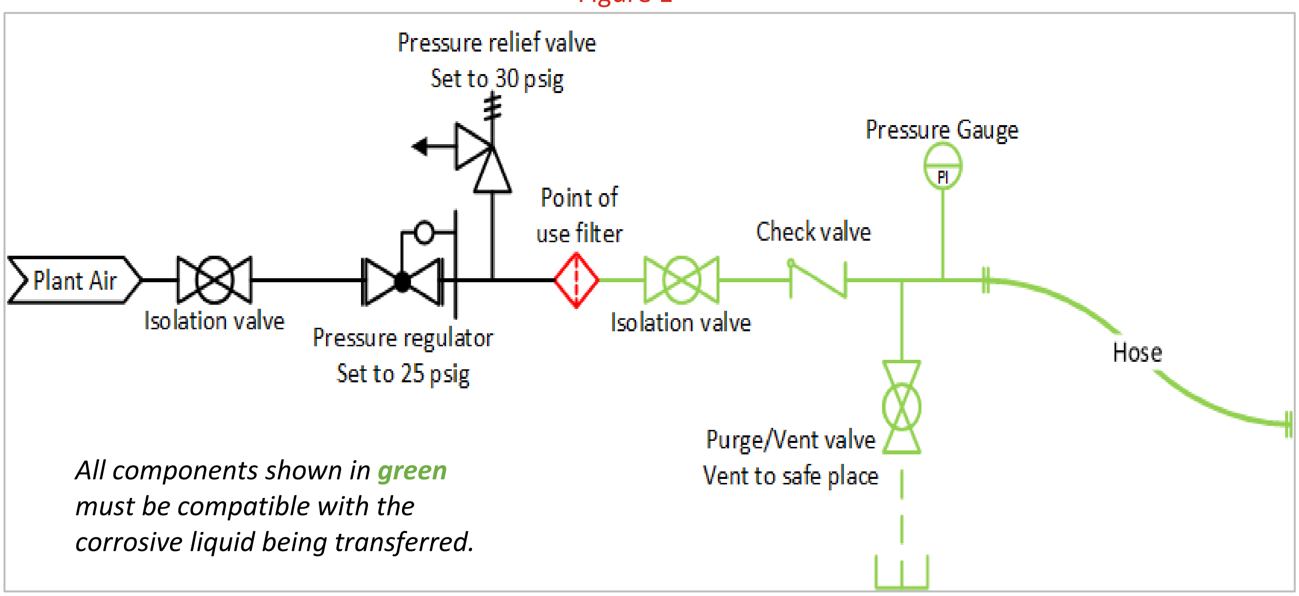
Pad Air Quality - Point of Use

As a customer receiving chlor alkali chemicals such as sodium hypochlorite, it is important to understand and implement a proper air padding system for unloading any of these chlor alkali corrosive liquids. Air padding systems can be a significant source of product contamination and require on-going inspection and maintenance to prevent failure. An additional engineering control "point-of-use filter" is recommended for the pad air system at the point of use or connection point to the shipping container. This filter will help ensure pad air quality while eliminating contaminants such as oil and or solid particulates from being introduced into the shipping container and product from the pad air system.

Note: The diagram that follows represents components within a properly designed pad air system. Proper installation and maintenance of pad air systems can significantly minimize contaminants from entering the shipping container during unloading. Safety features include isolation valves, pressure regulator, pressure relief valve, point of use filter, check valve, pressure gauge, and purge/vent valve for safe line evacuation prior to disconnection.

- Piping (in green) that is used downstream of the point-of-use filter must be made of product-compatible material to protect against chemical vapor introduction and corrosion.
- Pad air connector and hose must be made of product-compatible material.
- Effective pad air system maintenance program

Figure 1



Suggested Filter Arrangement

Point-of-Use Filter

The point-of-use filter should meet these requirements:

- *Be located close to or at the shipping container* — all 'downstream' components must be chemically compatible.
- Be a high-efficiency filter with a rating of 1.0 micron or less.
- Have a pressure drop indicator and auto-drainer.
- Safety Features: Pressure Regulator, Pressure Gauge, and Pressure Relief Valve

The use of high pressure on the pad air systems has the potential to overpressure the shipping container, resulting in the *activation** of the safety relief valve on shipping containers and the potential of a chemical leak. It is often misunderstood that unloading rates are directly related to pad pressures. As a general guide, the volume of compressed air and piping diameter, not the pressure of pad air, have the greatest influence on unloading rates.

In most applications, it is important for the pad air delivery to be regulated so that it does not exceed 25 psig using a pressure regulator. A pressure gauge equipped with a diaphragm made of compatible material of construction such as Teflon® (PFA, FEP PTFE) should be installed to allow the control of the pressure during the unloading process.

A good safety practice includes the installation of a pressure relief device set to a maximum operating pressure of 30 psig, immediately downstream of the pressure regulator. The pressure relief device provides redundant protection against possible shipping container over-pressurization if the pressure regulator fails.

** Typical safety relief valve settings: approx. 32-35 psig tank trucks, approx. 165 psig tank cars.*

Isolation Valve

As shown in Figure 1, it is imperative that the isolation valve nearest to the shipping container be in the closed position any time it is not actively being used to apply air, including when the unloading process is stopped. This isolation valve helps ensure corrosive vapors do not back flow into the air system.

Pad Air Piping Material of Construction

Experience has clearly shown that when dealing with corrosive liquids, a careful selection of the pad air system's material of construction at point of use is critical to provide adequate structural strength, chemical resistance, and prevent product contamination.

Materials of construction are especially critical for sodium hypochlorite. Iron or copper-based metals are not compatible with sodium hypochlorite and will corrode over time. When exposed to these chemical vapors, the resulting corrosion and rust produced will enter the pad air and contaminate the product, as well as the shipping container.

At the point of use or where sections of piping may be exposed to chemical vapor, (green section shown in Figure 1), chemical-resistant piping is recommended. For a lined piping system, the liner offers the chemical resistance needed, while the metallic piping offers structural strength. Liners such as Polypropylene, Teflon® (PFA, FEP PTFE), PVDF (fluorinated polyvinylidene) and PVC/CPVC (polyvinylchloride/chlorinated polyvinylchloride) are compatible with sodium hypochlorite.

Note: *Although solid PVC or CPVC piping offers an adequate product corrosion barrier to chlor alkali products, it is not suitable for use in compressed air service primarily because of the safety risk from shattering and injury to personnel. These materials do not provide the structural strength of lined metallic piping.*

Pad Air System Maintenance

A timely and effective maintenance program is critical for ensuring delivery of clean, water droplet-free, oil-free, and particulate-free pad air to the shipping container. Despite the implementation of scheduled preventative maintenance programs and well-trained personnel, failures can occur and go unnoticed, regardless of equipment design or configuration.

A white-rag test should be performed at least once monthly to provide a redundant verification of proper operation. To be effective, the *white rag* test should be performed at the shipping container end of the pad air hose by introducing compressed pad air into a clean white rag at regular full flow rates, not throttled, for one to two minutes.

Performance of the white rag test should incorporate safety provisions such as hearing and eye protection, avoidance of line-of-fire body positioning, use of the buddy system, hand protection, and a means to mechanically secure the rag to the end of the discharge system. Any particulate matter, moisture, or discoloration observed indicates a failure in one of the system's upstream components and should prompt further investigation.

System maintenance practices will vary by the age of the system, equipment design, manufacturer, and operating environment or conditions, but several general guidelines are applicable in all situations. An inspection checklist should be used to confirm that all components of the system have been inspected or serviced and that any noted deficiencies are corrected.

Maintenance guidelines issued by the compressor manufacturer should be consulted and typically represent the minimum frequency at which maintenance should be performed. General inspection guidelines for delivering high-quality padding air are shown in Table 4.

Distribution hoses should be visually inspected for evidence of damage such as bulges, cracks, or cuts to the exterior sheathing, connector wear, or evidence of moisture, residue, or corrosion on the connector.

Table 4: Inspection Guidelines

Hose & Connector	Before each use. Daily Visual inspection for evidence of fatigue, wear, or damage.
White rag test at point of use	At least monthly.
Trap & filter inspection/service	At least monthly.
Pressure drop indicators	Daily inspection / during use.
Filter replacement	Per manufacturer guidelines, white rag test or pressure drop.
Regulator or check valves	Annual preventative maintenance.

Note: The information above is given merely as an example. Actual operating conditions, age of system, system design, and frequency of use should be considered when developing inspection and maintenance frequencies. Over time, experience and inspection data records may indicate need for further adjustment of maintenance cycles.

Unloading by Pump

Where unloading with "pad air pressure only" is not possible, the tank car or tank truck may be unloaded using a pump. Pump unloading is favored by customers desiring to minimize pressures in the receiving storage tank.

It is recommended that self-priming, sealless, centrifugal pumps be used to prevent packing leaks which may occur with pumps equipped with packing or mechanical seals. Sealless pumps should be equipped with low amperage flow safety switches to ensure the pump is not operated in a dry or deadheaded state to prevent catastrophic pump damage.

The pump manufacturer should be consulted before selecting a pump. Items such as the required vertical lift distance from the shipping container to the storage tank or process, type of service (continuous or intermittent), and desired flow rate to determine the best pump for your particular application, and pressures required for safe and continued uses in this environment. The pump should be located at ground level for ease of maintenance service and should be located within a containment area to collect or contain any leak or dripping from the hose and/or sampling. The pump inlet and discharge should be equipped with drain valves to remove any solution in the unloading hose or transfer piping when hoses are disconnected, or pump maintenance is required. Customers may utilize the drain valves located on the pipeline or pump for product sampling activities as well.

The procedures and equipment necessary for pump unloading will be determined by the type of pump selected and whether provisions are available for a closed-loop vapor exchange between the storage tank and shipping container. Additional details may be obtained by contacting Olin's Technical Service Group.

Analytical Guidelines

Importance of Accuracy

The accurate determination of sodium hypochlorite assay is influenced by many factors including sample point selection, sample technique, sample handling, analytical methodology, and analytical equipment and technique. The assay of sodium hypochlorite will continually decline over time at a rate determined by a variety of factors including sodium hypochlorite concentration, temperature, residual sodium hydroxide levels, and exposure to UV light and trace metals such as nickel, copper, and iron.

This manual describes a number of important guidelines to improve the accuracy of assay determination of sodium hypochlorite in the shipping container (tank truck or tank car). The steps and guidance presented should be thoroughly reviewed for applicability at a particular site with a hazard review covering the site-specific functions to identify the best procedures and personal protective equipment (PPE) for the health and safety of site personnel and the environment. Refer to the Safety Data Sheet (SDS) for sodium hypochlorite for additional information on appropriate PPE.

Sample Collection

Whenever possible, the sample should be collected directly from the shipping container using a clean and appropriately designed sample collection device. Steps should be taken to avoid contaminating or damaging the shipping container during sampling. If a shipping container sample cannot be safely obtained, a properly designed sample point should be installed directly on the unloading piping where there is flow through the sample point. Procedures should be in place to ensure the sample point is purged sufficiently to provide a representative sample of the shipping container. Consult the SDS for appropriate PPE to be worn during sample collection activities.

Sample Handling

All wetted surfaces of sample collection equipment (thief, bottles, and bottle cap inserts) should be non-metallic. Sample bottles should be cleaned and flushed with the sample media. Fill the bottle no more than two-thirds of its capacity to avoid over-pressurization, leakage, or bottle bulging which may be induced as the product warms in storage. The sample should be identified and analyzed as soon as practical after collection—typically within two hours when stored at room temperature. Prior to analysis, the sample should be kept away from heat sources and out of direct sunlight or other UV exposure as these factors will increase the decomposition rate of the product. If there is going to be a significant delay in analysis, the sample should be cooled/refrigerated until analysis is possible.

Analytical Method

The most common analytical method used to determine assay of sodium hypochlorite solutions is a titration with a standard sodium thiosulfate solution. The titration is based on the principle of ion substitution in a pH-buffered environment, where the substitution element (iodine) is more easily titrated than the hypochlorite ion. In this method, a sample is treated with excess potassium iodide, neutralized with glacial acetic acid, and the liberated iodine is titrated with sodium thiosulfate. The titration endpoint is determined using a starch indicator solution. The exact steps involved in this method are dependent on the product concentration, grade, and application. The reactions involved in this are shown below:

Equation 7:

$NaOCl + 2\ KI + 2\ HAc \rightarrow I_2 + NaCl + 2\ KAc + H_2O$

Equation 8:

$Cl_2 + 2\ KI \rightarrow I_2 + 2\ KCl$

Equation 9:

$I_2 + 2\ Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2\ NaI$

Discussion of Units

Hypochlorite strength can be expressed in other units. Because the density of the solution changes with a variety of factors including caustic concentration, salt concentration, temperature, etc., it is critical to use a measured density (or specific gravity) in the following calculations for conversion.

- gpl available chlorine = wt% NaOCl × 10 × SG/1.050
- trade % available chlorine = wt% NaOCl × SG/1.050
- wt% available chlorine = wt% NaOCl ÷ 1.050
- wt% = weight percent
- gpl = grams per liter of solution
- SG = specific gravity
- NaOCl = Sodium Hypochlorite

It is also important to communicate the full units when reporting sodium hypochlorite strength to ensure everyone is aware of the measurement being reported.

Best Practices

- The use of an auto titrator can increase the accuracy and precision of the analytical results when measuring sodium hypochlorite strength. Please contact Olin's Technical Service personnel for additional assistance with auto titration systems.
- Starting the analysis using a weighed sample can improve the accuracy of the analysis by re-moving the error introduced by measuring the density of the solution.
- NOTE: The density will still need to be used to convert the result to other units.
- A study, such as a gage repeatability & reproductivity, should be used to determine the variation in results expected from the method and the analyst.

- The study examines measurement system errors in terms of repeatability, or equipment variation and reproducibility, or analyst to analyst variability. It is important to gain an understanding of the site's capabilities in terms of accuracy and precision as well as the factors that are influencing these results.
- Good laboratory practices and techniques should be included in the training for all personnel analyzing samples in order to improve consistency from person to person. Good laboratory practices would include a robust training program, documented procedures that utilize validated test methods, and the use of statistical controls on equipment and reagents.

Reference Materials
The Chlorine Institute – Reference Pamphlets

The Chlorine Institute offers a wide variety of safety and technical information associated with sodium hypochlorite. Contact the Chlorine Institute at www.chlorineinstitute.org to access the pamphlets referenced in this publication.

- **Pamphlet 65**, "Personal Protective Equipment for Chlor Alkali Chemicals" – Provides personal protective equipment recommendations for working with sodium hypochlorite.
- **Pamphlet 96**, "Sodium Hypochlorite Manual" – Provides information regarding all aspects of sodium hypochlorite solutions.

Product Safety Questions? Contact Us

At Olin, safety and environmental protection are top priorities. We provide technical assistance and resources for our customers to ensure the safe and environmentally sound use and handling of our products. Please contact your Olin representative for further information and support.

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