Safe Handling of

Sodium Hypochlorite

Japan Soda Industry Association

Contents

Introduction

Sodium hypochlorite is not designated as a toxic or deleterious substance under the Poisonous and Deleterious Substances Control Law, or as a hazardous material under the Fire Defense Law; however, if it is accidentally mixed with an acid during handling, an accident may occur, such as the generation of chlorine gas. Therefore, persons who handle sodium hypochlorite should learn about its properties, precautions on handling, and the related laws and regulations (such as the Food Hygiene Law), and should observe them to ensure safety.

This leaflet compiles the information that dealers, transporters, and consumers handling sodium hypochlorite need to know as a guideline for the routine prevention of accidents.

I. Information on Sodium Hypochlorite

1. Commercial Sodium Hypochlorite

Commercial sodium hypochlorite is normally a transparent light greenish yellow liquid containing not less than 12% of available chlorine and having a pH of 12 or more. To inhibit the decomposition of the sodium hypochlorite, the product contains free (excess) sodium hydroxide. Specifically, the product called sodium hypochlorite is an aqueous solution containing sodium hypochlorite, sodium chloride (normally about 12%, but some grades contain 4 to 6%, or about 1%), and a small quantity of sodium hydroxide. In addition to this, sodium hypochlorite for use in waterworks (JWWA K 120-2005), or sodium hypochlorite for food additives (available chlorine: 4 to 6%) is also available.

The quality standards for sodium hypochlorite for waterworks are as follows:

Quality standards of sodium hypochlorite for waterworks (JWWA K 120-2005)

Appearance	Transparent light yellow liquid
Available chlorine (%)	≥ 5
Free alkali (%)	≥ 2

Sodium hypochlorite for use in waterworks shall comply with the above quality, as well as the ministerial ordinance for facility criteria.

2. General Characteristics of Sodium Hypochlorite

- Unstable compound even at normal temperatures, which gradually decomposes naturally.
- Decomposition is accelerated by sunlight, especially ultraviolet rays.
- The decomposition rate rises with elevation of the temperature.
- Decomposition is significantly accelerated if a heavy metal, such as cobalt, nickel, copper, and iron, or its salt is present.
- Decomposition is accelerated if the pH is lowered.

・ If an acid is added and the pH lowers to 7 or less, a decomposition reaction takes place rapidly, and chlorine gas is generated.

・ Since commercial aqueous solutions are diluted with a large quantity of water, there is no danger of ignition or explosion.

・ Most metals and fibers are corroded by sodium hypochlorite due to its oxidizing properties. Excellent corrosion resistant materials are titanium, glass, and ceramics. Other corrosion resistant materials are rigid polyvinyl chloride, polyvinylidene chloride, polyethylene, fluororesin, flexible polyvinyl chloride, and ebonite. Rubbers are less resistant to corrosion by sodium hypochlorite.

3. Effects of Sodium Hypochlorite on the Human Body

・ The level of corrosive action is comparable to sodium hydroxide. If an acidic solution is added, hypochlorous acid is isolated and irritates the human skin and mucous membranes, but there is hardly any systemic poisoning due to absorption.

・ Exposure to the eyes causes severe pain, and the cornea can be damaged unless the eyes are washed immediately.

・ Exposure of the skin to sodium hypochlorite for extensive periods may cause skin inflammation or a rash due to irritation.

・ Inhalation of the mist from an aqueous solution of sodium hypochlorite irritates the mucous membrane of the respiratory tract and causes a hoarse voice, burning sensation and pain in the throat, severe coughing, and pulmonary edema. Oral intake may cause a burning sensation and pain in the mouth, esophagus, and stomach; and may rarely cause perforation of the esophagus or stomach.

II. Containers for Sodium Hypochlorite

1. Types of Containers

For bulk supply, sodium hypochlorite is frequently transported by tank trucks, and for small quantities, containers with capacities of 500 milliliters to 20 liters are usually used.

2. Displays on the Containers

When sodium hypochlorite is used for food additives, mandatory information specified by laws and regulations must be displayed on the containers.

III. Handling of Containers

1. Transportation

(1) General precautions

・Since sodium hypochlorite is highly corrosive, use corrosion resistant shipping containers and liquid transfer facilities (pipes, valves, pumps, etc.).

・Since sodium hypochlorite is easily decomposed, avoid long-distance transportation as far as possible. Transportation under direct sunlight is unfavorable since decomposition is accelerated with a rise in temperature.

・Since sodium hypochlorite is decomposed to release chlorine gas when it comes in contact with an acid, avoid the consolidated transport of sodium hypochlorite in small containers along with acids.

・Do not use the containers for sodium hypochlorite as containers for other materials.

・When small containers containing sodium hypochlorite are transported, load them with the caps facing up.

(2) Transportation of sodium hypochlorite by ship

・When sodium hypochlorite is transported by ship, refer to the “Ship Safety Law”.

2. Precautions for Storage

・Store sodium hypochlorite in a cool dark place, away from direct sunlight.

・Since heavy metals (such as cobalt, nickel, copper, and iron) act as a catalyst and accelerate the decomposition of sodium hypochlorite, care must be taken so that they are not mixed in the storage containers.

・Use a concrete or steel tank whose inner surface is lined or coated with a corrosion resistant material, or a tank fabricated using a corrosion resistant material. The tank should be of a structure that makes it easy to flush precipitates (such as silt).

・Since sodium hypochlorite is highly corrosive, and generates chlorine gas if erroneously mixed with an acidic solution, it is desirable to appoint a person in charge of the indication, acceptance and inspection of the tank, and ensure that this person witnesses the acceptance.

IV. Tank Trucks, Rail Tanks, and Tankers

・The capacity of a tank truck is normally 8 m^3.

・The capacity of a rail tank is 10 to 35 m^3.

・The capacity of some tankers is 160 m^3.

1. Structure

When sodium hypochlorite is transported, shipped, or received using a tank truck, rail tank, or tanker, it is important to have an accurate knowledge of the structure and materials of the valves and pipes, as well as the interior and exteri-

or of the storage tanks related to transport, receiving, and shipping operations on the basis of correct and accurate drawings; and to keep everyone informed about these.

2. Unloading from Tank Trucks, Rail Tanks, and Tankers

- On receiving, make sure that the person in charge of the establishment continually observes the checking of pipes, opening and closing of valves, checking of the commencement and termination of receiving, and the checking of the quantities received.

- When loading or unloading using a tank truck, make sure that the manual brakes and the vehicle lock are applied so that the truck does not move during these operations. Under no circumstances should the truck be left unobserved.

- When unloading from a tank truck, rail tank, or tanker, use a pump or compressed air. If a gas other than air (nitrogen or carbon dioxide gas) is used, immediately inform the loading operator or indicate this fact on the tank. If the operator needs to enter the tank, replace the contents with water, measure the oxygen concentration, and wear protective clothing so that there is no fear of suffocation.

- The supervisor of the unloading should make sure that the operators have sufficient knowledge of the properties of sodium hypochlorite, the joints and the pipelines; and allow them to operate these only after checking the contents of the tank and testing the vents and the safety valves.

- When unloading using a pump (or siphon), remove the vent flange of the tank in the tank truck, rail tank, or tanker to allow the entry of air. Remove the blanking plate of the delivery pipe, connect the pipeline of the storage tank to the flange of the delivery pipe, and activate the pump (or siphon) to start delivery. When the tank has been emptied, stop the pump (or siphon), remove the pipeline from the delivery pipe, and close the vent and the flange of the tank. During this operation, care should be taken so as not to spill the solution. However, if it is spilt, flush it away with a large quantity of water.

- When sodium hypochlorite is delivered by air injection, make sure in advance that there are no defects in the lid of the tank, the flange connected to the

pipeline, the valves and so on. Open the block valve slowly and properly adjust the flow rate to the tank. Although the internal pressure of the tank is rapidly lowers after delivery has been completed, continue air injection until the pipeline has been emptied before closing the valve.

・ The facility for pressure-pumping a sodium hypochlorite solution through a flexible pipe, such as a rubber hose must be equipped with a pressure gauge, and an anticorrosive and pressure-resistant hose must be used. Before pressure-pumping, inspect the hose, pressure gauge, and the connection of the hose; and take sufficient care as to the limit of the working pressure of the hose.

V. Use of Sodium Hypochlorite

1. General Precautions

・ Since sodium hypochlorite is highly corrosive, iron cannot be used as a material for the facilities. Titanium or plastics, such as rigid polyvinyl chloride, are suitable. Since some rubbers expand over a long period of time, care should be taken.

・ Before handling sodium hypochlorite, the operators should maintain close contact with each other, and check for any abnormalities in the opening and closing of the valves and the connection of the hose.

・ Before delivery, check the facilities so that decomposition or leakage does not occur. Provide indications on the container to warn outsiders not to touch the valves or cocks of the container.

・ Since oxygen or chlorine is released if the temperature rises, the pH is lowered, or foreign matter, such as a heavy metal, is mixed in during handling operations, care should be taken.

・ After use, make sure that the valve or cock has been closed. Install safety covers on valves and cocks so that outsiders cannot touch them.

・When the sodium hypochlorite solution is being transferred between the tanker and the land, if the solution leaks into the water, fish and shellfish may be harmed. In particular, if the delivery hose becomes immersed in the water, care should be taken since any leakage may not be apparent.

・When the solution is being divided into smaller portions, make sure that the containers used for this have been thoroughly cleaned so that no acidic solution and no other materials remains in the container.

2. Treatment of Empty Containers and Waste

・Inspect the containers thoroughly after use, and to prevent leakage or deterioration in the quality, check for deformation of the containers, cracking and peeling of the inner lining and coating, or the presence of residual matter, then wash the containers with water and drain them.

・During inspections or repairs, ensure a proper airflow and good ventilation. If ventilation cannot be assured, wear a gas mask.

・If any waste solution or silt is disposed of without treatment, rivers may be contaminated. In addition, farm or fishery products maybe damaged. Thus, such waste materials must always be disposed of after treatment.

・If the sodium hypochlorite is to be decomposed using an acid, this produces chlorine gas, which negatively affects air quality ; thus, it should be disposed of only after decomposition has been performed using a sealed container equipped with a safety apparatus for the absorption of chlorine gas.

3. Accident Prevention Measures

(1) Measures to prevent erroneous operation

・Keep the containers and tanks containing sodium hypochlorite separate from other materials, and display an indication of the contents, such as the words "SODIUM HYPOCHLORITE." Store containers containing sodium hypochlorite in a yard exclusively used for this purpose as far as possible, or keep them separated from other chemicals (especially acids). Do not use the containers

for other purposes. When a tank is being used, it must be separated from other tanks, especially from tanks containing acids. In all cases, display the indication of the contents as "SODIUM HYPOCHLORITE."

・Separate the receiving piping from other piping. Display a white band of a width of 5 cm or more around the receiving port for sodium hypochlorite, and display the product name in a place where it can be easily seen. The product name and flow direction should also be properly displayed on piping used for other chemicals. These are the first steps for preventing erroneous operation. Periodically check these displays to make sure that they have not been erased or removed.

(2) Education and training

・Ensure that operators handling sodium hypochlorite observe the operating standard for safe operations. For this, it is necessary to provide education and training concerning:

- ○ The location of protectors, showers, eye washers, cleaning hoses, and first aid facilities
- ○ Proper method for the use of protectors and first aid facilities
- ○ First aid measures to be taken in case of an emergency
- ○ Properties, hazards, and proper handling of sodium hypochlorite
- ○ For operators filling tanks, measures for preventing a lack of oxygen deficiency

It is also important to train supervisors concerning the following, and regularly carry out training drills for dealing with disasters:

- ○ Proper usage of the first aid facilities
- ○ Measures to be taken in case of chemical injury

4. Prevention Measures for Hygiene

・During handling operations, keep the working area well ventilated, and as required, use proper protective wear (such as a face mask, rubber gloves, rubber boots, rubber clothing, and protective goggles).

VI. Actions to be Taken in Case of a Leakage

・ If sodium hypochlorite is accidentally mixed with an acid, immediately neutralize it with an alkali, such as sodium hydroxide (caustic soda) or calcium hydroxide (hydrated lime). Should a large quantity of chlorine gas be formed, and there is the possibility that the chlorine gas will become diffused into the ambient air, inform the relevant authorities, such as the fire station and the police, so as not to cause harm to others; at the same time take action to evacuate people or guide them upwind.

・ If chlorine gas is inhaled, take the following action:

○ If the patient is simply coughing, take him/her to a place that is well ventilated with fresh air, and get him/her to rest comfortably.

○ If the patient is coughing very hard and feeling that is hard to breathe, get him/her to inhale the vapor of a 1:1 alcohol-ether mixture, or give him/her buttery coffee, candies or sweet syrup to make him/her comfortable.

○ If the eyes are injured by chlorine gas, immediately wash the eyes with flowing tap water for at least 15 minutes. Depending on the symptoms, consult a doctor.

○ In case of severe symptoms, immediately call a doctor and follow the instructions given, and then take the following action.

a) Gently move the patient to a chlorine-free place, and if possible, lay the patient on the back in a room at about 20℃ with the head and back held higher, and keep the him/her warm with a blanket.

b) If the patient has difficulty in breathing, perform oxygen inhalation. Give oxygen for 2 minutes, and then stop for 2 minutes. and repeat the treatment for 30 minutes. (If possible, use an oxygen cylinder for medical use.)

c) If breathing stops, perform mouth-to-mouth resuscitation. However, do not perform this more than 18 times per minute.

・ If sodium hypochlorite comes into contact with the human skin or clothing, immediately wash it off with a large quantity of flowing water.

・ If sodium hypochlorite gets into the eyes, immediately rinse it with a large quantity of flowing water for at least 15 minutes, and consult a doctor.

VII. Maintenance of Facilities (Cleaning and Repairing)

The cleaning or repair of a facility after the use of sodium hypochlorite solution must be directed by an experienced supervisor who knows the dangers well. In addition to general precautions, take care of the following:

- Make sure that the solution is completely blocked off at the inlet port of the tank.

- When an operator enters the tank or the facility, remove the contents by pumping or flowing out as much as possible, and thoroughly clean it with water.

- Remove all the pipes connected to the tank or the facility. If possible, remove them by sorting them into groups.

- Supply fresh air with a small air blower. Do not use compressed air since this is dangerous.

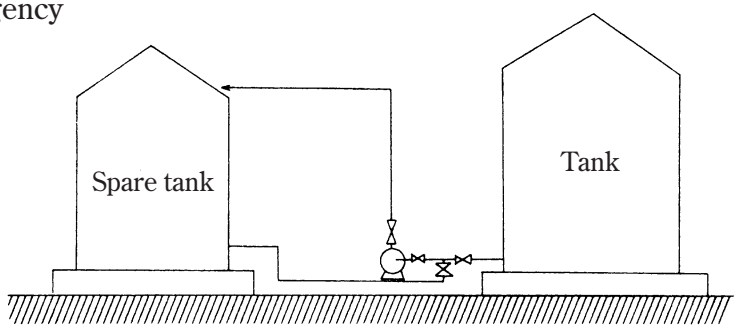
- Display a warning sign when an operator is inside the tank or the facilities.

- When the piping is being repaired, remove any solution in the pipe beforehand, and clean the pipe sufficiently with water.

VIII. Safety Facilities

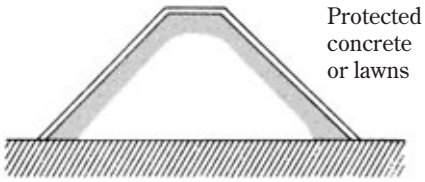
In order to prevent leaked sodium hypochlorite from flowing out of the area of the storage facilities, it is preferable to install facilities for the safe storage of sodium hypochlorite or facilities for recovering and preventing it from causing harm. The examples of such facilities are as follows:

・Spare tanks that can receive sodium hypochlorite in a short time in an emergency

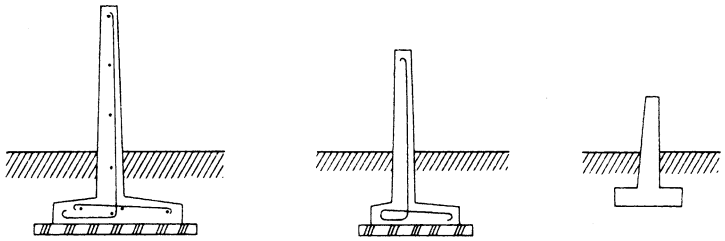


・Liquid bank around the tank or group of tanks

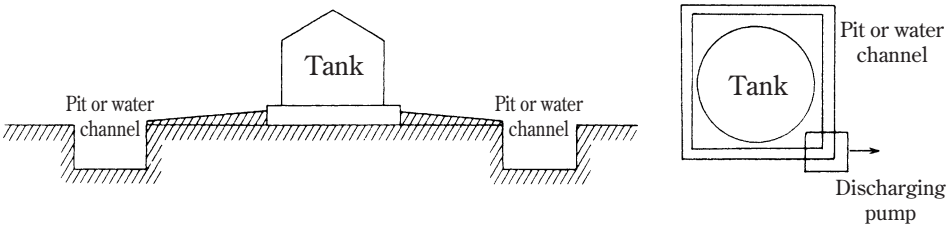
a Earth fill



b Concrete



・Pit-like structure, pond and depression, etc.



The leaked sodium hypochlorite is recovered or disposed of. For disposal, flash it away with a large quantity of water.

IX. Emergency Measures

- If sodium hypochlorite comes into contact with the human skin or clothing, immediately wash it off with a large quantity of flowing water.

- If sodium hypochlorite gets in the eyes, immediately rinse it with a large quantity of flowing water for at least 15 minutes, and consult a doctor. In this case, if clean lukewarm water is easily available, it is more effective in reducing the pain than cold water.

- Should sodium hypochlorite be swallowed, immediately wash the mouth out with water, and give the patient a large quantity of water, milk or raw egg. (If the patient is unconscious, give nothing through the mouth.) Do not force the patient to vomit, and consult a doctor promptly.

- If chlorine gas is inhaled, take the following action:
  - ○ If the patient is simply coughing, take him/her to a place that is well ventilated with fresh air, and get him/her to rest comfortably.
  - ○ If the patient is coughing very hard and feeling hard to breathe, get him/her to inhale the vapor of a 1:1 alcohol-ether mixture, or give him/her buttery coffee, candies, or sweet syrup to make him/her comfortable.
  - ○ If the eyes are injured by chlorine gas, immediately wash the eyes with flowing tap water for at least 15 minutes. Depending on the symptoms, consult a doctor.
  - ○ In case of severe symptoms, immediately call a doctor and follow the instructions given, and then take the following action.
    a) Gently move the patient to a chlorine-free place, and if possible, lay the patient on the back in a room at about 20℃ with the head and back held higher, and keep him/her warm with a blanket.
    b) If the patient has difficulty in breathing, perform oxygen inhalation. Give oxygen for 2 minutes, and then stop for 2 minutes. and repeat the treatment for 30 minutes. (If possible, use an oxygen cylinder for medical use.)
    c) If the breathing stops, perform mouth-to-mouth resuscitation. However, do not perform this more than 18 times per minute.

X. Reference Tables

1. Relationship between the Specific Gravity of Sodium Hypochlorite and the Effective Chlorine Concentration

Specific gravity (20℃)	Effective chlorine concentration (g/ℓ)	Sodium hypochlorite (wt %)	Specific gravity (20℃)	Effective chlorine concentration (g/ℓ)	Sodium hypochlorite (wt %)
1.05	30.0	3.00	1.16	110.0	10.05
1.07	40.0	3.94	1.17	120.0	10.76
1.08	50.0	4.87	1.18	130.0	11.53
1.09	60.0	5.76	1.20	140.0	12.28
1.11	70.0	6.64	1.21	150.0	13.03
1.12	80.0	7.50	1.22	160.0	13.75
1.13	90.0	8.34	1.24	170.0	14.45
1.15	100.0	9.16	1.24	178.0	15.00

The specific gravity of commercial sodium hypochlorite solution is about 1.20.

2. Relationship between the Concentration of Sodium Hypochlorite and the Specific Heat

(20℃)

NaClO (g/ℓ)	Specific heat (cal/g・℃)	NaClO (g/ℓ)	Specific heat (cal/g・℃)
140.48	0.918	56.26	0.969
92.58	0.949	28.22	0.987

3. Change in the Available Chlorine

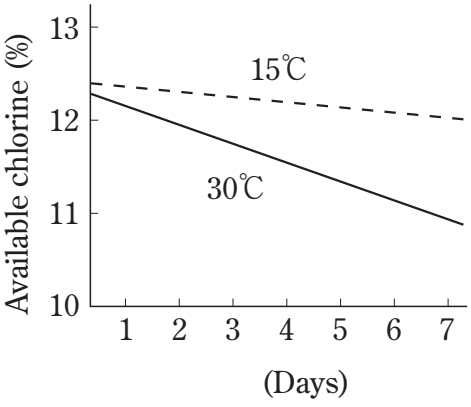


Figure 1 Change in the available chlorine over time at a solution temperature of 15℃ and 30℃ (available chlorine: 12%, shielded from light)

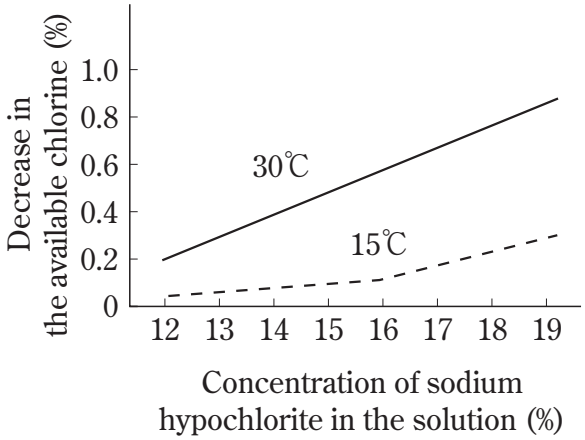


Figure 2 Decrease in the available chlorine per day according to the concentration of sodium hypochlorite in the solution at a solution temperature of 15℃ and 30℃ (shielded from light)

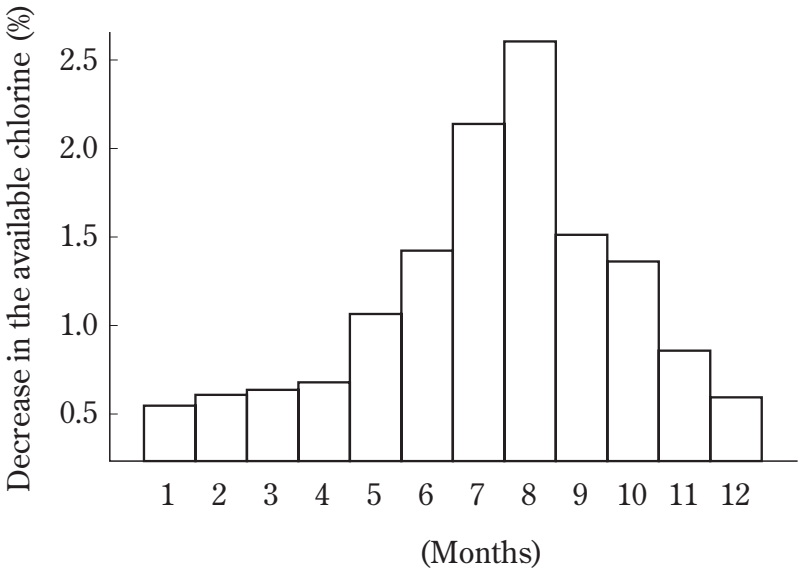


Figure 3 Decrease in the available chlorine by month (available chlorine: 12%, shielded from light, after standing for 10 days)

XI. Related Laws and Regulations

(1) Food Sanitation Law

Sodium hypochlorite is specified as a chemically-synthesized compound when it is intended for use as a food additive, and is subject to restrictions when it is marketed, displayed, manufactured, and processed.

(2) Ship Safety Law

Sodium hypochlorite (excluding solutions containing 5% or less of available chlorine by weight) is specified as a hazardous material (corrosive material) in the regulations for shipping and storing hazardous materials under this Law, and the shipper must observe the preparation of hazardous material specifications, the rules for packaging, the notification of hazardous materials when shipping by motor vehicle ferry, etc.

(3) Water Pollution Control Law

Since sodium hypochlorite affects the hydrogen ion concentration specified by regulations and standards related to water discharged from establishments, care should be taken.

(4) Waste Disposal and Public Cleaning Law

Waste alkali is specified as industrial waste, and its collection, transfer, and disposal must be carried out by enterprises themselves in accordance with specified standards, or entrusted to industrial waste disposal services approved by the Governor that exercises jurisdiction over the district.

XII. Cases of Disasters

(1) Accidents during handling and transportation

(a) When an operator was checking the rotating conditions of a pump for loading sodium hypochlorite solution into a tank truck, the rubber hose for loading broke, the solution sprayed out, and the droplets entered the operator's left eye causing a mild case of conjunctival congestion.

(b) Since a tank truck was overloaded during a shipping operation for sodium hypochlorite solution, the solution was returned to the shipping tank. When the hose was removed from the inlet pipe of the shipping tank, the droplets entered both eyes of the operator causing a mild case of conjunctival congestion.

(c) Since an operator accidentally connected a wrong receiving pipe to a tank truck, and sulfuric acid was fed into a sodium hypochlorite tank, chlorine gas was emitted. Twenty-one operators and 115 nearby residents were affected by the gas, and five of them had to take time off from work.

(d) A truck for transporting chemicals rolled onto its side, the base of the steel tank cracked, and sodium hypochlorite solution used as a fixing agent in dyeing leaked out, causing the traffic to be blocked.

(e) Since an operator accidentally connected the wrong pipe in a chemical receiving station for a wastewater treatment facility, and sodium hypochlorite solution was fed into an aluminum sulfate tank, chlorine gas was emitted. A dozen nearby residents were affected by the gas.

(2) Accident in a manufacturing plant

(a) When an operator closed a cock for the maintenance of the manometer for measuring the circulation in a sodium hypochlorite manufacturing facility, a glass U-tube was accidentally broken, some solution was ejected, and droplets entered both eyes of the operator, causing superficial keratitis in both eyes, which required 7 days for recovery.

(3) Accidents during use

(a) In a building that used a 12% sodium hypochlorite solution for the disinfection of the toilets and hydrochloric acid for cleaning, when a female cleaner mixed the two chemicals so as to try to finish both jobs at the same time, chlorine gas was generated, and she inhaled the gas and died.

(b) When sulfuric acid was poured into a plastic bucket from a tank to feed the sulfuric acid into a drain treatment facility, sodium hypochlorite had been left in the bucket and reacted with the sulfuric acid to generate chlorine gas, and one person was intoxicated.

(c) When an operator fed dilute sulfuric acid into plating drain for chromium treatment without knowing that an excess of sodium hypochlorite had been added to the plating drain, chlorine gas was generated, and the person was intoxicated.

(d) When sodium hypochlorite was fed after dilute sulfuric acid was extracted from a dilute sulfuric acid tank and the tank was cleaned for changing it to contain sodium hypochlorite, since the cleaning was insufficient, the sodium hypochlorite reacted with the remaining dilute sulfuric acid to emit chlorine gas, and 20 operators and other persons were affected by the gas.

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