

Safe Handling of

Caustic Soda

(Sodium Hydroxide)

Japan Soda Industry Association

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Introduction

Caustic soda (excluding solutions containing not more than 5% caustic soda) is designated as a deleterious substance under Japanese laws, and is a strongly corrosive substance. Persons who handle caustic soda should learn about related laws and regulations (such as the Poisonous and Deleterious Substance Control Law), its properties, and precautions on handling; and should observe them to ensure safety.

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

I. Information about Caustic Soda

1. Commercial Caustic Soda

- Commercial caustic soda is classified into solid types and liquid types according to its phases as well as into industrial, reagent, and Japanese Pharmacopoeia grades according to its uses. Of the solid types of commercial caustic soda, flaked caustic soda is also a commercial product.
- The types of solid caustic soda are as shown in the following table, and the qualities and testing methods are specified in JSIA (Japan Soda Industry Association) Standards, JIS (Japanese Industrial Standards), the Japanese Pharmacopoeia and the JSFA (Japanese Standards for Food Additives).

Quality of caustic soda

Grade	Type	Quality	Testing method
Industrial caustic soda	Liquid, type 1, type 2	JSIA-01	JIS K 1200
	Solid, type 1, type 2	JSIA-02	JIS K 1200
Reagent grade caustic soda	Special grade, class 1	JIS K 8576	
Pharmacopoeial caustic soda		NaOH \geq 95.0%	Japanese Pharmacopoeia Testing method

Quality of caustic soda for food additives (JSFA)

Purity	Crystalline caustic soda: 70 ~ 75% Caustic soda, anhydrous: \geq 95%
Form	Crystalline grade: White crystalline powder or granules Anhydrous grade: White spherical shapes, flakes, rods, or other solid forms; white powder
Dissolved state	Colorless, substantially transparent
Sodium carbonate content	\leq 2%
Arsenic content	\leq 4 μ g/g as As ₂ O ₃
Heavy metal content	\leq 30 μ g/g as Pb
Mercury content	\leq 0.1 μ g/g as Hg

2. General Characteristics of Caustic Soda

- Caustic soda is the most typical of the strong alkalis. Although there is no danger of it exploding or igniting, it reacts with various acids, such as hydrochloric acid, and is neutralized and generates considerable exothermic heat of neutralization.
- It corrodes metals, such as aluminum, tin, and zinc. During this process, it generates hydrogen, which has the potential to behave as an explosive gas.
- It is highly hygroscopic, and absorbs the moisture, carbon dioxide, or sulfur dioxide in the air. It is also highly deliquescent and absorbs moisture to form an aqueous solution.
- When liquid caustic soda is diluted, it generates a considerable amount of heat of dilution. Since this rapidly generates strong heat and the resulting solution may spatter if the water is carelessly poured into it, care must be taken.
- Caustic soda easily decomposes animal fibers. Although plant fibers are also decomposed, they have a higher resistance than animal fibers. Although materials resistant to corrosion by caustic soda include stainless steel, steel-epoxy resins, and fiber-reinforced plastics, steel and rubber-lined steel are the most frequently used.

3. Effects of Caustic Soda on the Human Body

- Alkalis have a decomposing effect on proteins, which may gradually penetrate the deep tissues unless the adhered alkali is completely removed. In particular, if the eyes are exposed to an alkali, since eye tissue is rapidly affected causing a lowering or loss of vision, great care should be taken.
- Even a dilute solution can affect the tissue of the skin if it repeatedly comes into contact with the skin, which may cause dermatitis or chronic eczema.
- If the concentration of the solution is high, the affected tissue rapidly decomposes.
- If the solution is swallowed by mistake, it causes inflammation in the mouth,

throat, esophagus, or stomach.

- The inhalation of caustic soda dust or mist causes various degrees of injury in the respiratory tract. Thus, the allowable concentration of caustic soda dust or mist in the air in a working area is specified as 2 mg/m³ (upper limit).

II. Containers for Caustic Soda

1. Kinds of Containers

- Solid caustic soda is contained in thin steel drums.
- Flake caustic soda is contained in drums or PVC-lined paper bags as shown in the table.

No.	Outer diameter (mm)	Height (mm)	Outlet (mm)	Total weight (kg)	Tare weight (kg)	Net weight (kg)	Name
1	575	900	403	174	24	150	Drum
2	450	735	326	83	8	75	〃
3	235	375	125	16	1	15	〃
4	400	550	395	53.5	3.5	50	Fiber drum
5	Length:700 Width: 400	100	Machine sewn	25.3	0.3	25	PVC-lined paper bag

- Liquid caustic soda is contained in rectangular cans or drums. For the transportation of a large quantity of liquid caustic soda, tank trucks, rail tanks, or tankers are used.
- Reagent-grade caustic soda is contained in glass bottles.

2. Displays on the Containers

- The “Poisonous and Deleterious Substances Control Law” requires the following to be displayed on the containers:
Container (outside): “No Medical Use” and “Deleterious Substance”

(red characters on a white background)
Name, grade, net weight of the contents
Name and address of the manufacturer or importer

Tank truck: "Poison" (white characters on a black background)
(On the front and back of the truck)

- On both sides of rail tanks, "Exclusive Use for Caustic Soda" is displayed.
- Care must also be taken to the display requirements of other related laws and regulations.

III. Handling of Containers

1. Transportation

(1) General precautions

- Close the lid or cover of the container so that it is airtight in order to avoid moisture absorption during transportation.
- For transportation in drums, use boxcars, but if gondola cars are used, cover the drums with sheets.
- In the case of consolidated transport, keep acids away from the caustic soda, and do not place the containers of caustic soda on top of other containers containing organic chemicals.
- Since crystals are precipitated from liquid caustic soda when the temperature lowers, do not expose it to low temperatures for a long period of time.
The freezing point of standard commercial liquid caustic soda is 5 ~ 12 °C
- When solid caustic soda is being handled directly, or liquid caustic soda is being handled, be sure to wear protective goggles and rubber gloves, and wear rubber boots or rubber clothing as required.

- Dispose of items contaminated by ambient caustic soda mist, or that have been soaked in liquid caustic soda, after treatment to make them harmless.
- Since caustic soda generates heat when it is diluted by water or neutralized by an acid, and may form a mist, make sure the eyes or skin are not exposed to the mist.

(2) Transportation of caustic soda by tank truck

- The laws require that each tank truck be provided with a document describing the name, components and grade of the contents, and the first aid measures to be taken in case of an accident, protective equipment, tools, and so on. In the case of long period of transportation, a standby driver is required to ride in the truck.
- The driver must be certain to close the manholes or valves so that the liquid does not leak.

(3) Transportation of caustic soda by ship

- When caustic soda is transported by ship, refer to the “Ship Safety Law.”

2. Precautions for Storage

- Caustic soda is specified by the “Poisonous and Deleterious Substances Control Law” as a non-medical deleterious substance. Therefore, the characters for “No Medical Use” and the red characters for “Deleterious Substance” on a white background, as well as a description of the contents and their constituents must be displayed on the tank.
- In addition, the storage place must have measures to secure it against losses or theft (locking), and preventive measures to control splash, leakage, outflow or penetration to the external environment must also be taken.
- In storage areas, caustic soda must be stored separate from other chemicals. In anticipation of any breakdown of the containers, caustic soda must be isolated from acids, metals, explosives, organic peroxides and so on.

- When caustic soda is stored in steel drums, store it in a warehouse or indoor stock yard that is as dry as possible to prevent the external corrosion of drums, moisture absorption, and freezing.
- Although the tank for the caustic soda solution can be a steel tank, it is safer to use other tanks lined with rubber or alkali-resistant synthetic resins.
- It is desired that outdoor tanks for caustic soda solution be equipped with an insulation system and heating system such as steam heating coils.
- A facility should be available to supply large quantities of water so as to flush any spilt caustic soda.

IV. Tank Trucks, Rail Tanks, and Tankers

- The capacity of a tank truck is normally 8 m³.
- The capacity of a rail tank is normally 30 m³.
- The capacity of tankers is normally 50 to 300 m³.

1. Structure

- When caustic soda is transported, shipped, or received using a tank truck, rail tank, or tanker, it is important to have an accurate knowledge of its structure and the materials of the valves and pipes, as well as the interior and exterior 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 them.

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 the receiving, and the checking of

the quantities received.

- When loading or unloading using a tank truck, make sure that the manual brakes and a vehicle lock are applied so that the truck cannot move during the operations. Under no circumstances should the truck be left unobserved.
- When unloading a tank truck, rail tank, or tanker, use a pump or compressed air (or nitrogen). If nitrogen 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 caustic soda, 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 of the tank truck, rail tank, or tanker to allow air to enter. Remove the blanking plate of the delivery pipe, connect the pipeline of the storage tank to the flange of the delivery pipe, and start up 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 that the solution does not come in contact with other parts, or it is not spilt. However, if it is spilt, flush it away with a large quantity of water.
- When caustic soda 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. Should there be any defects, the caustic soda might be ejected from that part to cause an accident. Open the block valve slowly and properly adjust the flow rate to the tank. Although the internal pressure of the tank is rapidly lowered after delivery has been completed, continue air injection until the pipeline is emptied before closing the valve. Any mist discharged when the internal pressure is returned to normal pressure must be absorbed in water and neutralized using an acid before disposal.
- The facility for pressure-pumping a caustic soda 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, the 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 Caustic Soda

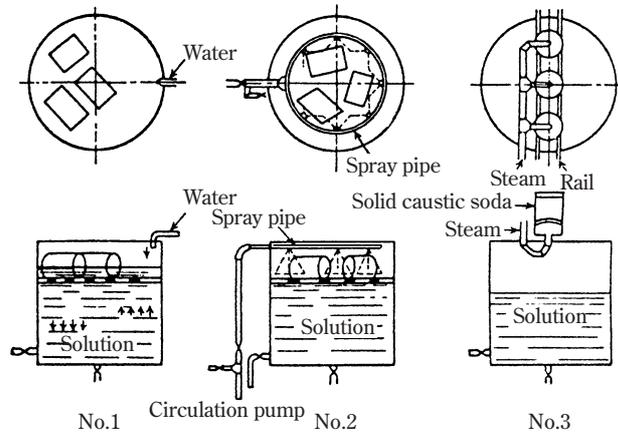
1. General Precautions

- Install a facility that can discharge large quantities of water to flush away any accidentally leaked or spilt caustic soda.
- Although caustic soda must be handled with care so as not to leak, in case of leakage follow the procedures in Section VI Action to be Taken in Case of Leakage.
- When solid caustic soda is being taken out of a drum, cut the seam of the drum. Since solid caustic soda taken from a drum quickly absorbs moisture from the atmosphere and becomes slippery, take great care not to slip on it.
- In the case of liquid caustic soda, carefully remove the cap of the drum while standing it in the upright position, and connect a nipple pipe. Lay the drum down with its air purging valve facing upward and loosen the valve to introduce air into the drum, then open the valve to take out the liquid.

2. Methods for Dissolving

- When solid caustic soda is being dissolved, it generates a large amount of heat. It is dangerous if a large quantity of solid caustic soda is dissolved at once since it will boil and the liquid may blow up if it is in a confined space.
- In particular, since flaked caustic soda dissolves rapidly in warm water, when it is dissolved in water without stirring this results in spattering, so it must be dissolved slowly while constantly stirring the solution.

- Simple methods of dissolving solid caustic soda are described in the following sections (refer also to the diagram).



Method 1

A mesh plate on which drums are placed is set one-third the way from the top of a dissolving tank with a height of 1.5 to 2.0 m, and blocks of solid caustic soda from which 1/2 to 2/3 (in area) of the steel sheet has been removed are placed on the mesh plate. When the blocks of solid caustic soda are immersed in water to half of their thickness, dissolution starts, and as the upper layer is replaced by the lower layer, dissolution proceeds.

Method 2

While using the same system as in Method 1, the solution is circulated using a pump at the same time. Without immersing the solid caustic soda in the water, the solution is pumped from the bottom of the tank and sprayed over the solid caustic soda that is placed on the mesh plate to dissolve it. If the water is sprayed strongly enough, the dissolution can be expedited.

Method 3

In this method, solid caustic soda packed in drums is dissolved. The packed drums are placed on bars which support the drums installed above the tank, and steam is injected from the bottom of the drums.

3. Treatment of Empty Containers and Waste

- Thoroughly wash empty containers that have contained caustic soda, or containers in which there is a possibility that caustic soda has been mixed with water and has adhered to the interior of the container before its disposal.

- Dispose of waste caustic soda solution after diluting it further with water, neutralizing it with an acid, and diluting the solution with a large quantity of water. Do not flush any caustic soda waste solution into the sewage system or a river without first applying treatment to neutralize it.

4. Accident Prevention Measures

(1) Education and training

- Operators that handle caustic soda should be required to observe the operating standard for safe operations. For this, it is necessary to provide education and training concerning:
 - The characteristics, level of hazard, and methods of handling of caustic soda
 - The location of protectors, showers, eye washers, water taps, 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
 - For operators filling tanks, measures for preventing a lack of oxygen.

It is also important to train supervisor 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 the case of a chemical injury.

(2) Operational rules

- It is important to establish rules concerning the proper use the facilities for handling caustic soda or any associated facilities, and to operate them in accordance with the rules.

(3) Voluntary inspection

- Caustic soda is a highly corrosive substance. It is important to periodically inspect equipment that is used for handling caustic soda and to retain the inspection records.

(4) Prevention of erroneous operations

- For the piping of facilities for handling caustic soda, it is important to take measures such as indication of the name and the direction of flow of the liquid, as well as color-coding and indication of the opening or closing direction of major valves and cocks. Furthermore, for inspection of the operating procedures or facilities, the utilization of a checklist is effective.

5. Prevention Measures for Hygiene

- The storage of food in places where caustic soda is stored or working areas where it is handled is prohibited, and smoking, eating or drinking in such places is also prohibited.
- The operator must wear cotton or synthetic-fiber work wear, a work cap, protective goggles, rubber boots, rubber gloves, and a rubber apron. In the area where mist or dust is in the air, wear a dust mask.
- Protective cream has no effect. Wash the face and hands thoroughly at the end of the work operations.
- In places where caustic soda is handled, provide a shower and face washing facility that can be used immediately at any time.

VI. Actions to be Taken in Case of a Leakage

- Since caustic soda is highly corrosive, avoid contact with the human body. If body contact occurs, treat it following Section IX Emergency measures (p. 15).
- In the case of solid caustic soda, promptly recover it and place it in a container (by scraping it together with sand or soda ash), neutralize it with an acid, and flush it away using a large quantity of water.
- In the case of a large quantity of leaked liquid, put together it at once in a ditch or pit. If this is impossible, surround it with sand or other materials, and follow the instructions for disposal described above.
- In the case of a small quantity of leaked liquid, flush it with water or wipe it off,

and sprinkle a large quantity of sodium bicarbonate over it so that no caustic soda remains. The discharged water used for washing must be neutralized before draining it.

- Accidents during transportation must be reported to the health center, the police station and the fire station, and measures described above must be carried out.
- To detect any leakage, apply several drops of a phenolphthalein indicator. If caustic soda is present, the color changes to red.

VII. Maintenance of the Facilities (Cleaning and Repairing)

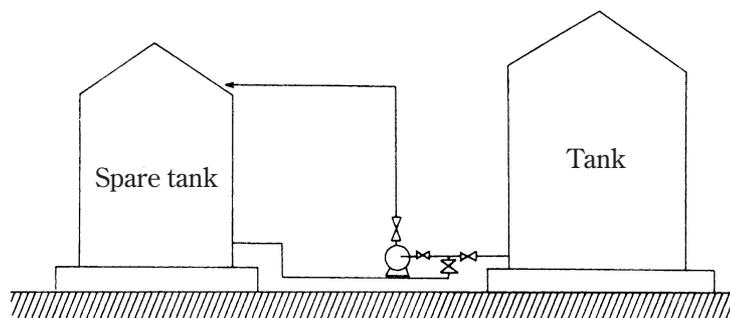
The cleaning or repair of a facility after the use of caustic soda solution must be directed by an experienced supervisor who knows the dangers well. In addition to general precautions, take care of the following:

- 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.
- Dismantle 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 facility.
- When the piping is being repaired, remove the solution in the pipe beforehand, and clean the pipe sufficiently with warm or cold water.

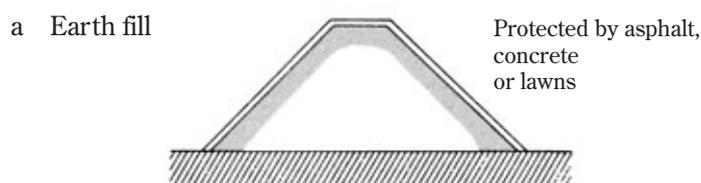
VIII. Safety Facilities

In order to prevent leaked caustic soda from flowing out of storage facilities, it is preferable to install facilities for the safe storage of caustic soda or facilities for recovering it and preventing it from causing harm. Examples of such facilities are as follows:

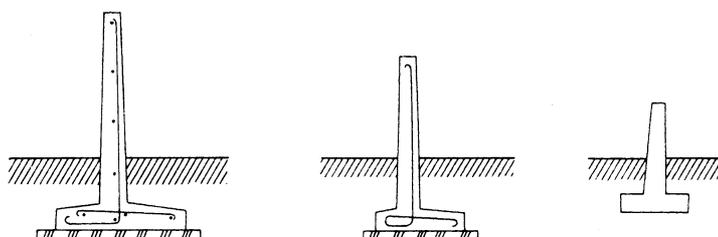
- Spare tanks that can receive caustic soda in a short time in an emergency



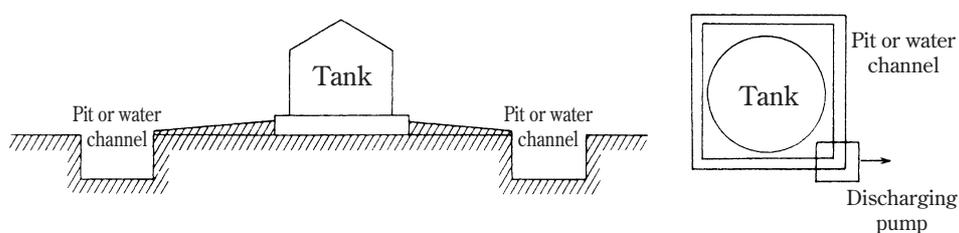
- Liquid bank around the tank or group of tanks



- b Concrete



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



The leaked caustic soda is recovered or disposed of. For disposal, neutralize it with an acid and wash it away with a large quantity of water.

IX. Emergency Measures

1. Skin Exposure

- If caustic soda comes into contact with clothing, immediately remove the clothing and wash the skin with a large quantity of flowing water for a long time. Then neutralize the caustic soda with a boric acid solution or ammonium chloride solution. However, any attempt to neutralize it with a weak acid from the beginning could turn out to be dangerous.
- The best way to clean the skin is to wash it under a water shower.
- Since shock may be experienced in cases of severe injury, or chemical injury to a large area of the skin, lay the patient down quietly and warm him/her moderately, and immediately call an ambulance.
- Do not apply oils or other ointments except under the direction of a physician.

2. Eye Exposure

- If caustic soda gets into the eyes, immediately rinse it out with a large quantity of flowing water for at least 15 minutes. In this case, hold the eyelids open wide with the fingers so that water can reach every part of the eyeballs and eyelids.
- Call an ambulance, or if possible, an ophthalmologist. If the arrival of the physician is delayed, rinse the eyes with water for a further 15 minutes.
- After first washing for 15 minutes with plain water, then wash the eyes with a sodium bicarbonate solution or boric acid solution. It is preferable to administer a few drops of 0.5% pontocaine solution or an equivalent local anesthetic agent as a first aid treatment.
- It is necessary to continue washing the eye for a long time to sufficiently remove the alkali from the eyes.

3. Swallowing

- If swallowed, even a diluted solution affects the mucous membranes of the mouth, throat, esophagus, and stomach.
- Never force the patient to vomit, since the stomach wall that is penetrated and thinned by caustic soda may be punctured.
- If the patient becomes unconscious, do not give food or drink orally.
- If the patient is clearly conscious, wash the mouth out with a large quantity of water, and if possible, give him/her milk mixed with egg white. In addition, give him/her vinegar, olive oil, or fruit juice to promptly neutralize the caustic soda.
- If the measures described above cannot be taken immediately, have the patient drink as much water as possible.
- Inform a physician of the details of the accident and the location of the patient.

X. Reference Items

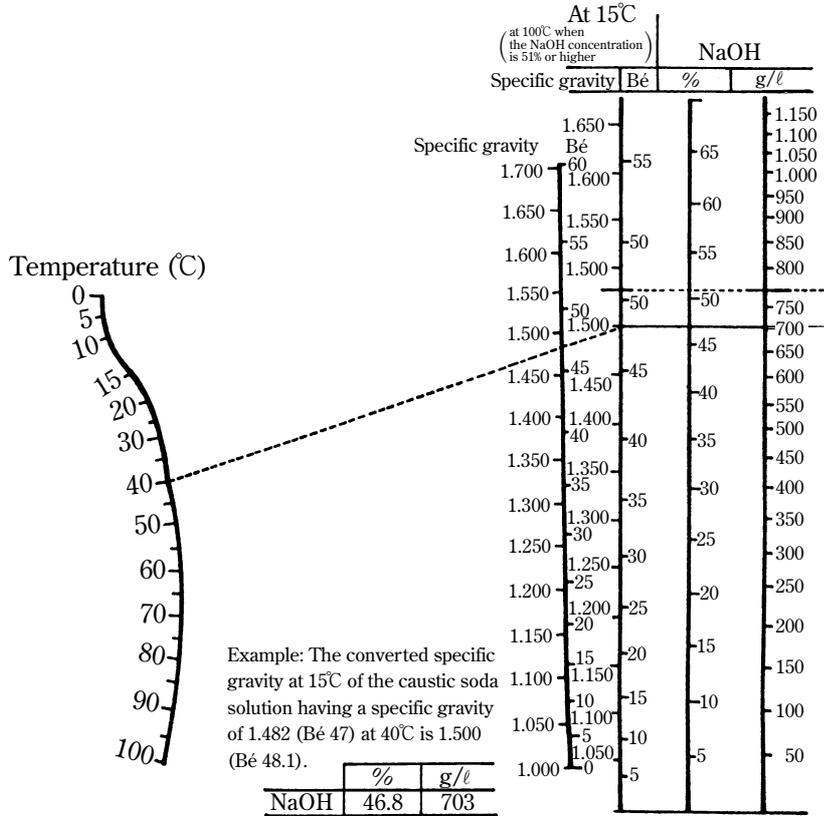
1. Properties of Caustic Soda

- Molecular formula : NaOH
- Molecular weight : 40.00
- Specific gravity : 1.48 (45% concentration)
1.50 (50% concentration)
- Melting point : 9 °C (45% concentration)
- Boiling point : 136 ~ 137 °C (45% concentration)
- Vapor pressure : 3.24 mmHg (20 °C, 45% concentration)

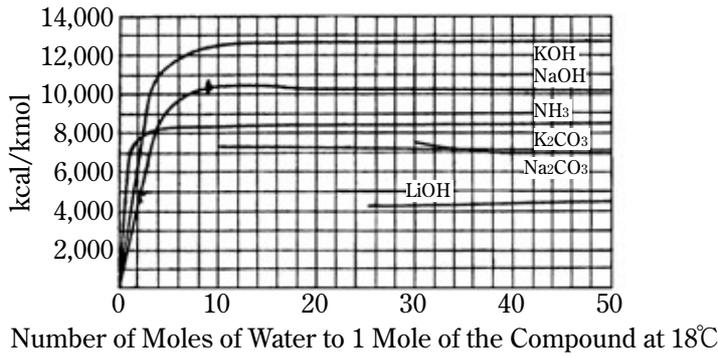
2. Specific Gravity and Concentration of Caustic Soda Solution

$d^{15/4}$	Bé	NaOH %	NaOH g/ℓ	$d^{15/4}$	Bé	NaOH %	NaOH g/ℓ
1.007	1	0.59	6.0	1.220	26	19.65	239.7
1.014	2	1.20	12.0	1.231	27	20.60	253.6
1.022	3	1.85	18.9	1.241	28	21.55	267.4
1.029	4	2.50	25.7	1.252	29	22.50	281.7
1.036	5	3.15	32.6	1.263	30	23.50	296.8
1.045	6	3.79	39.9	1.274	31	24.48	311.9
1.052	7	4.56	47.3	1.285	32	25.50	327.7
1.060	8	5.20	55.0	1.297	33	26.58	344.7
1.067	9	5.86	62.5	1.308	34	27.65	361.7
1.075	10	6.58	70.7	1.320	35	28.83	380.6
1.083	11	7.30	79.1	1.332	36	30.00	399.6
1.091	12	8.07	88.0	1.345	37	31.20	419.6
1.100	13	8.78	96.6	1.357	38	32.50	441.0
1.108	14	9.50	105.3	1.370	39	33.73	462.1
1.116	15	10.30	114.9	1.383	40	35.00	484.1
1.125	16	11.06	124.4	1.397	41	36.36	507.9
1.134	17	11.90	134.9	1.410	42	37.65	530.9
1.142	18	12.69	145.0	1.424	43	39.06	556.2
1.152	19	13.50	155.5	1.438	44	40.47	582.0
1.162	20	14.35	166.7	1.453	45	42.02	610.6
1.171	21	15.15	177.4	1.468	46	43.58	639.8
1.180	22	16.00	188.8	1.483	47	45.16	669.7
1.190	23	16.91	201.2	1.498	48	46.73	700.0
1.200	24	17.81	213.7	1.514	49	48.41	732.9
1.210	25	18.71	226.4	1.530	50	50.10	766.5

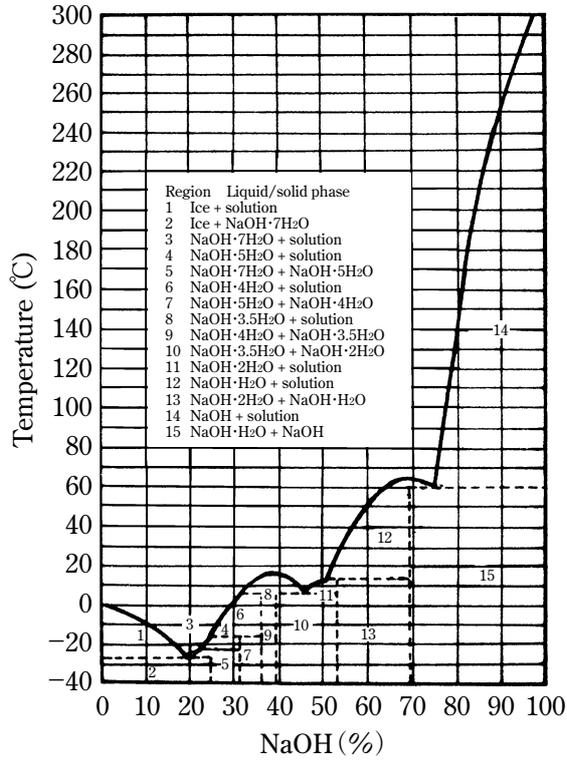
3. Specific Gravity, Concentration, and Temperature of Caustic Soda Solution



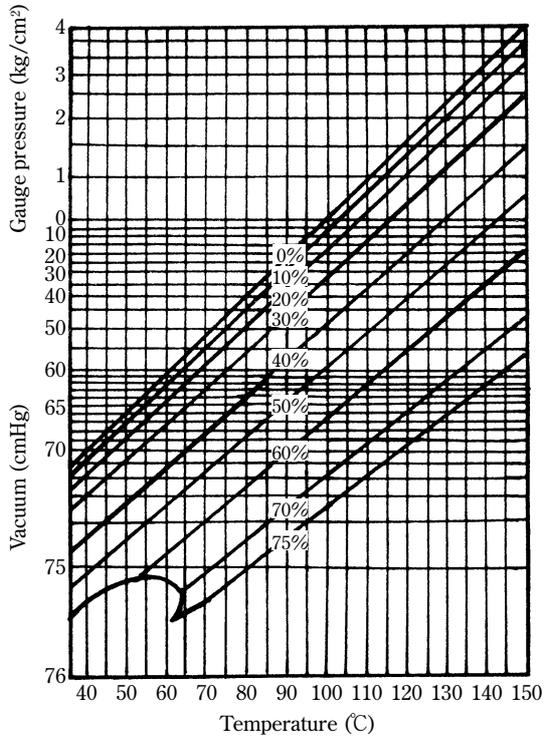
4. Heat of Dissolution of Caustic Soda in Water



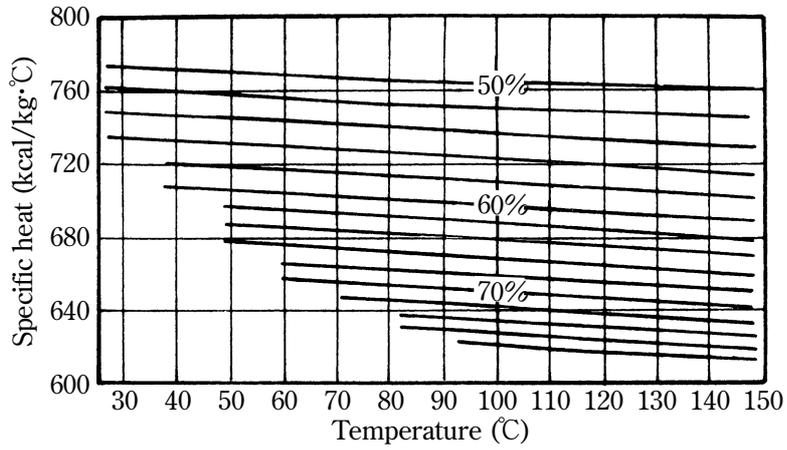
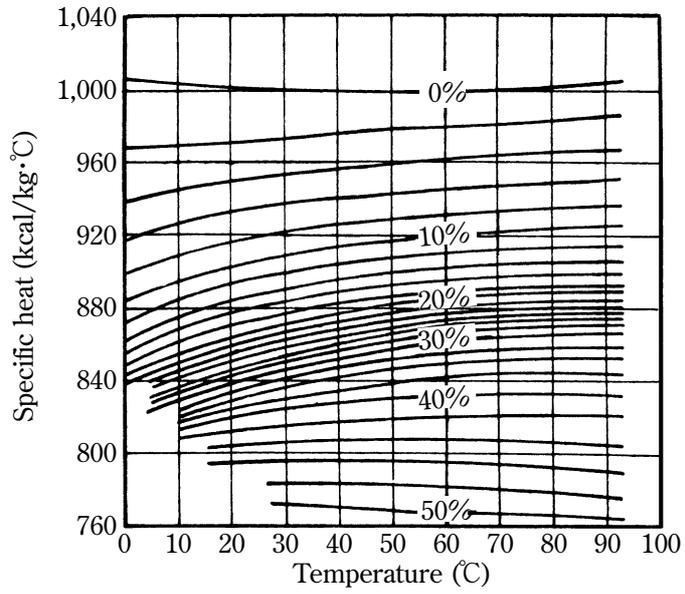
5. Phase Diagram for Caustic Soda



6. Boiling Point of Caustic Soda Solution



7. Specific Heat of Caustic Soda Solution



XI. Related Laws and Regulations

Caustic soda is mainly regulated by the Poisonous and Deleterious Substances Control Law. Since it is also covered by the Pharmaceutical Affairs Law, the Food Sanitation Law, the Ship Safety Law, the Water Pollution Control Law, and Waste Disposal and Public Cleaning Law, great care should be taken when handling caustic soda.

(1) Poisonous and Deleterious Substances Control Law

Caustic soda (excluding solutions of 5% or less) is specified as a deleterious substance, and is subject to regulation as to its marketing, storage, consumption, transportation, etc.

- (a) Dealers in caustic soda, and carriers using motor vehicles with a loading capacity for caustic soda is 5 tons or more, or motor vehicles on which containers of a capacity of 1,000 liters or more are loaded must appoint a person in charge of handling poisonous and deleterious substances at each establishment to prevent health hazards. All persons who handle caustic soda on the job have managerial responsibility under the law regarding loss and leakage prevention, displays, measures to be taken in case of an accidents, and so on.
- (b) When a dealer sells or provides caustic soda, the required items must be recorded, and a record must be kept retained.
- (c) If 5 tons or more of caustic soda is being transported at a time using a motor vehicle, the required signs must be displayed, and the required protective equipment for at least two persons must be carried. If the specified time (4 hours of continuous driving, or 9 hours of driving in one day) is exceeded, a standby driver must accompany the driver.
- (d) The standards related to the first aid measures in case of driving accident must be established, and the drivers must carry a document in which these measures are described. The education and training of the first aid measures are also required.
- (e) When caustic soda is discarded, the use of the neutralization method is stipulated “after adding water to form a diluted solution, and neutralizing it using an acid (diluted hydrochloric acid, diluted sulfuric acid, etc.), it must be diluted

with a large quantity of water and flushed away.”

- (f) For the tank storage (outdoors, indoors, and underground) of liquid caustic soda, the standards for the structure and facilities have been established.

(2) Pharmaceutical Affairs Law

Caustic soda (excluding solution of 5% or less) is specified as a deleterious substance under the Pharmaceutical Affairs Law, and is subjected to regulations of its handling.

- (a) On the containers or packages, the name and the characters “Deleterious” must be written in red within a red frame on a white background.

- (b) Marketing, provision, storage, and displays are also regulated.

(3) Food Sanitation Law

Caustic soda 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, or processed.

(4) Ship Safety Law

Caustic soda 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.

(5) Water Pollution Control Law

Since caustic soda affects the hydrogen ion concentration specified by regulations and standards related to water discharges from factories, care should be taken.

(6) Waste Disposal and Public Cleaning Law

Waste alkali is specified as industrial waste, and its collection, transfer, and dis-

posal must be carried out by corporations and companies 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) In a certain soap factory, since no protective goggles were used when solid caustic soda material was taken out of a drum and crushed, fine powder from the caustic soda entered the operator's eyes and he suffered chemical injury.
- (2) While solid caustic soda was being crushed, small pieces entered the operator's eyes from the side of the protective goggles and he was injured.
- (3) In the manufacturing of caustic soda flakes, when the water supply fed into the flaker was being adjusted, the flaker exploded with a loud noise, and molten caustic soda was suddenly scattered. As a consequence, two operators were exposed to hot caustic soda over their whole body and died.
- (4) In an experiment for making soap in a certain primary school, since a student carelessly grasped the caustic soda using the bare hands, the student's skin was penetrated and burned. The hand was immediately washed with water, but it was too late and the hand suffered injury.
- (5) Fine caustic soda powder adhering to a pipe cock entered an operator's eyes, but he thought it was ordinary dust and thus treatment was delayed. As a result, the symptoms worsened and this required 5 days leave for chemical injury.
- (6) An operator was washing an electrolysis tank together with three other cooperators. When the cleaning water in the electrolysis tank was pumped with a siphon using a rubber hose, he was below the floor level and when he looked up to receive the end of the rubber hose, the caustic soda solution adhering to the funnel under the caustic soda solution outlet of the decomposing tower fell into his right eye since he was not wearing protective goggles.
- (7) When an operator was cleaning an electrolysis tank, he transferred the caustic soda solution into a drum from the decomposing tower, and tilted the drum to move it by rolling it. He then lost balance and the solution splashed and

soaked his gloves. His hands slipped and the solution on his gloves entered his left eye. At that time, he was not wearing protective goggles.

- (8) In preparation for replacing the salt box under the electrolytic caustic soda evaporator, an operator cleaned the interior of the tank and pumped out the cleaning solution. When he fully opened the drain valve to remove the cleaning solution safely, one drop of the cleaning solution dripped from the gland holder of the valve and entered his left eye.
- (9) Since electrolytic caustic soda had crystallized and remained in the decomposing tower it did not come out of the caustic soda outlet, and thus an operator warmed the lower part of the caustic soda cooler using steam. While dissolving the crystals, the caustic soda solution filling the tower came out of the upper part of the cooler and entered his right eye from the gap in the protective goggles.
- (10) While sampling a low concentration of caustic soda solution, an operator received the solution from the sampling tube installed in the inlet pipe of the evaporator to a sampler. However, since he opened the cock too much, a large quantity of the solution suddenly came out and hit the sampler, and droplets rebounded and entered his eyes from a gap in the protective goggles.
- (11) During saponification for soap production, when an operator added the caustic soda solution to the oil material using a bucket while heating it with steam, droplets of the caustic soda solution splashed up, and since the operator did not wear protective goggles the droplets entered his left eye and he was injured.
- (12) In a refinery, since a caustic soda pipe in the cleaning plant became clogged due to the deposition of crystals, an operator wearing protective clothing began to check the point of crystal deposition near a 7inches cock between the soda dissolving vessel and the soda tank by introducing steam into the soda pipe. However, since his protective goggles were fogged up, he slipped them off and wiped them off near the cock. At that time, the caustic soda suddenly leaked out and droplets entered in his left eye.
- (13) When liquid caustic soda was transferred from the transport tank to the main tank, the victim (assistant driver) received the liquid remaining in the rubber hose in a small can after finishing the work and droplets from this

entered in his eyes.

- (14) In a sampling operation, since the caustic soda solution happened to overflow from the dome of a railroad wagon transporting the caustic soda solution, an operator rode the wagon to check it and droplets of caustic soda solution fell from the hose handled by another operator on the wagon and entered his left eye.
- (15) When an operator was heating a cock in which caustic soda had been frozen in order to disassemble and repair the cock, the handle suddenly came off and the caustic soda solution was ejected and entered both of the operator's eyes.
- (16) When a pump for caustic soda solution was being operated in a methanol plant and the prime water cock was opened, the caustic soda solution in the discharging pipe flowed back and sprayed over the face of the operator, causing chemical injury to both eyes.
- (17) When a pump used for transporting caustic soda solution was being cleaned, the solution entered the ear of an operator causing hearing loss in that ear.
- (18) To install an overflow pipe for a cleaning solution (10% caustic soda solution) tank in a factory, an operator tried to climb the tank by stepping on a 3/4" branch pipe that was a lateral branch from a 2" vertical pipe at a height of about 1.5 m from the floor. However, since the branch pipe was broken due to corrosion, the cleaning solution remaining in the pipe sprayed out over the face of the operator and he suffered chemical injury.
- (19) In the port of a certain paper mill, the operation for pumping caustic soda solution was started on the ship side, but the solution could not be pumped. Thus, the operator turned off the source switch once, slowly opened the air discharge valve of the pump of the permanent tank and removed a clamping nut holding the suction valve. At that moment, the caustic soda solution sprayed out and the operator was injured.
- (20) When caustic soda solution was being transferred, while the operation of the pump was stopped in order to switch to another pump, the priming water funnel broke and the caustic soda solution was ejected and sprayed over the

head of the operator. Although the funnel was bonded using an adhesive, it became separated due to the pressure of the backflow of the caustic soda solution.

- (21) When an operator was cleaning the inside of a vacant rail tank for liquid caustic soda, he fell unconscious due to lack of oxygen. An observer who entered the rail tank to rescue the operator also fell unconscious, and both suffered from chemical injury to the upper half of their bodies (face, eyes, head and chest) due to the caustic soda cleaning solution that remained in the bottom of the rail tank.
- (22) When an operator was immersing paint cans into a hot caustic soda solution (80 °C) to clean them, he slipped on the wet floor and fell into the vessel and died. The top of the vessel was at the same level as the floor and no slip prevention measures were provided.
- (23) In a soda plant, two operators entered the tank of a rail tank for liquid caustic soda returned by a customer for cleaning and were asphyxiated by the gas filling the interior, including carbon monoxide, fell unconscious, and died. One operator who entered the tank with a hose mask and safety rope to rescue the two operators also inhaled carbon monoxide and fell unconscious since the mask was removed after being caught by the rope and he suffered chemical injury due to caustic soda on the back, neck and head. Although the liquid is normally discharged using compressed air, since they discharged the liquid using the exhaust gas from an engine at the site of the customer, the tank was filled with carbon monoxide.

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