CAUSTIC POTASH

POTASSIUM HYDROXIDE PRODUCT STEWARDSHIP MANUAL

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Introduction

Olin is the second largest producer of caustic potash in North America. Our state-of-the-art production facility and strategically located distribution terminal system further augment our ability to provide rapid, reliable delivery across North America.

This product stewardship manual on the safe handling and storage of Olin Caustic Potash, also called Potassium Hydroxide, is offered by Olin Corporation as a service to its customers and others who handle, use, store, ship, or dispose of caustic potash. This manual contains information on the physical and chemical properties of caustic potash, health hazards, precautions for handling, first aid, personal protection, containment and cleanup of spills and leaks, disposal, procedures, and equipment for safe handling and storage of bulk shipments. Contact your Olin representative with questions.

Stewardship, Sustainability, & Responsible Care®

At Olin, safety and quality are integral to everything we do. Our goal is zero when it comes to safety, with a focus of preventing accidents, injuries, and chemical incidents not only within Olin, but also as part of Olin's Chlor Alkali Products & Vinyls stewardship program. Olin has internal processes to foster continuous improvement in the areas of product quality, environmental protection, safety, and product stewardship.

Product Stewardship & Sustainability

At Olin, our product stewardship program is guided by our core values of Integrity, Customer Success, Innovation, and 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 Care® company, we assess the safety, health, and environmental information on our products, and then take appropriate steps to protect employees, public health, and the environment. Ultimately, the success of our product stewardship program rests with each and every individual involved with Olin products – from the initial concept and research to the manufacture, sale, distribution, use, disposal, and recycling of each product.

At Olin, we understand that integrating sustainability into everything we do is paramount in our privilege to operate. Olin's stewardship not only extends to care of people and the environment, but also incorporates embodying sustainable practices in our entire value chain.

Responsible Care®

Olin has a long-standing policy to ensure that its operations do not have an adverse impact on the community or the environment. To uphold this policy, Olin is committed to the guiding principles of Responsible Care®, a continuing effort by the chemical industry to improve the responsible management of chemicals.

Under Responsible Care, Olin follows the 12 Guiding Principles and Codes of Management Practices that cover all aspects of research, development, manufacture, distribution, transportation, use, and disposal of products. These principles also extend to prompt reporting, customer counseling, community awareness, support of external research, participation with government and others, and promotion of Responsible Care worldwide.

Olin recognizes that no single entity can protect the quality of all of our air and water. However, by working together on a global basis, the public, industry, and government can make the future brighter and safer.

The Chlorine Institute & The American Chemistry Council

Olin has a long history of embracing and promoting chemical safety and is a founding member of The Chlorine Institute. The Chlorine Institute is a technical trade association of companies involved in the safe production, distribution, and use of chlorine, sodium and potassium hydroxides, sodium hypochlorite, and hydrogen chloride. Since 1924, Olin has supported the development of The Chlorine Institute to promote continuous improvement in safety, protection of human health and the environment, and security associated with the production, transportation, handling, and use of chlorine, hydrochloric acid, sodium and potassium hydroxide, and other related products. As a Chlorine Institute member, Olin is committed to adopting the Institute's safety and stewardship initiatives to achieve measurable improvement over time.

Olin is also an active member of the American Chemistry Council (ACC), America's oldest trade association of its kind. The ACC represents companies engaged in the business of chemistry who are committed to continuously improving the safety, health, environmental, and security performance of the chemical industry.

Quality & Certifications

Olin manufactures two solution strengths of potassium hydroxide: 45 and 50 % solution using membrane electrolytic cell technology. Depending upon your region and industry, potassium hydroxide is frequently called caustic potash. This electrolytic cell technology converts potassium chloride brine to high-quality caustic potash solution, as well as the co-products chlorine gas and hydrogen gas. In certain regions, diluted caustic potash may be available. We offer product certification upon request for various industry and regulatory standards including the American Water Works Association (AWWA B300), NSF International's NSF/ANSI 60: Drinking Water Chemicals, Kosher, Food Grade and Food Chemicals Codex, (FCC). Certification offerings may vary by location. Contact your Olin sales representative to discuss solution strengths and certifications available in your particular region.

Physical & Chemical Properties

Physical Properties

Caustic potash solutions are clear and colorless in appearance and are odor-free. Solid potassium hydroxide is an opaque-to-slightly white, crystalline material that can sometimes be observed on equipment such as delivery hose connections once the solution has evaporated. Other physical properties such as density, freeze point data, thermal properties, and viscosity information can be found in the Technical Data section of this manual.

Chemical Properties

Caustic potash is corrosive to a variety of surfaces including skin, eyes, some metals, and leather. Appropriate care must be taken when handling caustic potash to prevent injury to personnel and/or damage to equipment and the environment. This manual contains information on how to safely handle potassium hydroxide solutions.

Potassium hydroxide is a very strong base. A 50 % solution has a pH of 14. In fact, caustic potash is such a strong base that a caustic potash solution would have to be diluted to 5.5 % potassium hydroxide to detect a pH below 14. Even at concentrations of less than 0.2 %, caustic potash still has a pH greater than 11. In many situations, particularly in the case of environmental impact, pH 11 is still considered very basic, and solutions with pH greater than this warrant further processing and/or special handling. It is important to keep caustic potash solutions separate from strong acids as the reaction can be violent.

In addition to acids, other compounds including oxidizing agents, phosphorous, certain metals, acetaldehyde, acrolein, and acrylonitrile, can react (sometimes violently) with caustic potash. Exposure to metals such as aluminum, brass, bronze, tin, zinc, and their alloys can generate hydrogen gas. Care must be taken during storage and handling to prevent accidental mixing of caustic potash with any of these compounds. See the most current Safety Data Sheet (SDS) for additional information on compatible/incompatible chemicals.

Safety & Handling

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

The SDS must 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 caustic potash. To obtain a SDS, visit Olin's website at www.olinchloralkali.com or call Olin's Division Headquarters at (423) 336-4850.

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

- Toxicological Properties
- Personal Protection
- Safe Handling Procedures
- First Aid Procedures
- Critical Equipment/Safety Shower & Eyewash
- Spill & Leak Procedures
- Disposal
- Emergency Response

Toxicological Properties

Danger: Caustic potash is a strong alkali or base, which will present a serious health hazard if improperly handled. It is corrosive to the skin, eyes, mucous membranes, and the respiratory tract. Accidental eye contact with this material can cause permanent damage. Dusts or mists of caustic potash represents a hazard to the respiratory tract. If inhaled, symptoms may range from mild irritation to severe burns and permanent damage of the lungs and the respiratory system. Ingestion causes severe damage to the gastrointestinal tract with the potential to cause perforation. See the SDS for additional information.

Personal Protection

Individual Personal Protective Equipment (PPE) requirements may vary based on the specific work duties and the surrounding area. A PPE hazard assessment can help determine what PPE is required for any process operation or situation. 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. Formal evaluations should be performed for each job task to help ensure the PPE adequately protects against the associated hazards of the activity. These evaluations should be performed on a periodic basis and whenever operating practices, procedures, or conditions change. The typical PPE utilized for a number of common caustic potash handling situations likely to be encountered follow and are based on 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. Because of people's natural tendency to turn their head when there is sudden movement toward the face, both goggles and a face shield should be worn for eye and facial protection. This is especially important when performing "line-breaking" work.
- **When work duties include performing sampling activities, line breaking such as disconnecting unloading hoses, or maintenance activities, full PPE should be used, including: rubber (Neoprene or equivalent) jacket and pants, hard hat, safety glasses, goggles, face shield, rubber (Neoprene or equivalent) gloves, and boots.**
- Additional PPE may be required when containing or cleaning up spilled chemical, especially if the caustic potash solution has dried. If there is potential for caustic potash dust or mist in the area, an OSHA/NIOSH respirator approved for this situation should be available.
- In addition to each person's individual PPE, every caustic potash handling area should be equipped with the appropriate emergency PPE including full-face respirators for 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.

Handling Considerations

1. Always handle caustic potash in a way that prevents spillage. Liquid caustic potash makes floors slippery. Serious falls and injuries, complicated by caustic potash burns, may result if caustic potash is not immediately cleaned from floors, stairs, or other walkways. With adequate training and PPE, caustic potash can be safely neutralized by the application of dilute acetic acid or other weak acid. Make sure that caustic potash spills, residues, or products of neutralization are not discharged directly into sewers or streams in violation of federal, province, state, and local requirements. Do not use dilute acetic acid or any other material to neutralize caustic potash on skin or eyes unless directed to do so by medical personnel. Doing so may significantly increase the severity of chemical burns. See First Aid section.

Figure 1: Personal Protective Equipment

- Hard Hat
- Safety Glasses
- Face Shield
- Chemical Safety Goggles
- Chemical Resistant Suit
- Rubber (Neoprene) Gloves
- Rubber (Neoprene) Boots

2. Avoid bodily contact with any form of caustic potash (liquid or dry), and immediately flush exposed area with copious amounts of water. See First Aid section.
3. Caustic potash will readily attack leather and cotton-based garments. Launder exposed clothing and jewelry prior to reuse.
4. Do not mix caustic potash with water or acids except under the direction of trained personnel. This should only be done in equipment or facilities that have been designed to accommodate these types of reactions. Because of the large heat of reaction, spattering may occur.
5. Know the location of the nearest safety shower and eyewash fountain and confirm it is functioning before performing any work in that area.
6. Carbon monoxide can form from the reaction of caustic potash and carbohydrates, like those found in foods and beverages. Use particular caution by following appropriate vessel entry procedures before entering tanks and equipment used in this service.

Safety Shower & Eyewash Stations

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. The safety stations must be easily accessible and maintained to maximize visibility which can expedite access by injured persons and any responders. 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. By regulation, 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. Consult the most current edition of American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) Z-358.1 and a qualified safety or industrial hygiene professional for additional information.

First Aid Procedures

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 SDS and provide it to medical personnel administering care to injured persons. To obtain a SDS, visit Olin's website (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 present and easily removed. A sensation of heat indicates the water is effectively diluting the caustic potash – continue rinsing despite the temporary discomfort. 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 caustic potash on the head and face, do not remove goggles until after this area has been thoroughly flushed with water. Remove jewelry and clothing. Clothing that has come in contact with caustic potash 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, adequately ventilate the work area and equip personnel with proper respiratory protection.

Storage Tanks, Piping Systems, & Other Equipment

Caustic potash users are responsible for building and maintaining a properly designed storage and handling system. A trained engineer is best-suited to design systems that enhance safety, while at the same time minimizing maintenance needs. 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.

Four basic factors must be kept in mind when handling caustic potash:

1. Caustic potash is highly corrosive and can be hazardous to personnel.
2. The viscosity of 50 % caustic potash increases rapidly when the temperature falls below 68 °F (20 °C).
3. The weight of 50 % caustic potash is 1.5 times that of water.
4. Solution temperature and strength will affect corrosion rates with various metals.

Storage tanks should be located to minimize piping runs, especially exterior pipes in which caustic potash can freeze if a heating system malfunction occurs. It is equally important to locate storage and piping in low traffic areas to minimize potential exposure to personnel.

Labeling

Tanks, containment, and other handling systems should be clearly labeled to identify chemical contents. Labels or stencils noting the entire, formal product name, e.g., “Potassium Hydroxide” are preferred and especially beneficial to contractors and others not intimately familiar with the tank farm. Labels should comply with OSHA’s HAZCOM Standard (CFR1910.1200) and with Canada’s WHMIS (Workplace Hazardous Materials Information System) for Canadian sites. Certain local regulations, codes, or agencies may also dictate label content.

Storage Tanks

Sizing

The receiving vessel should be part of the bulk storage system strategy. The receiving tank should be large enough to easily accommodate a full inbound bulk shipping container and compensate for likely transit times and tank heels. A general rule of thumb is to size the tank at least 1.5 times larger than the full bulk shipping container to maximize freight savings and have ample room to avoid tank overflows during filling. Factors such as product consumption rates and distances from shipping points should be considered when selecting tank capacities.

Materials of Construction

Butt-welded stainless steel is the preferred material of construction for storing and handling caustic potash solutions, especially for applications where minor amounts of iron (Fe) pickup are of concern. Tanks should be constructed to American Petroleum Institute (API) 12F, 620 or 650 standards depending on the design parameters chosen. Weld annealing should be performed, especially for tanks subjected to temperatures above 120 °F (48.8 °C). A vertical tank design is generally favored over horizontal installations. The rate of change for a vertical tank’s inventory remains constant throughout the fill process, and in some applications a lesser tendency for accidental tank overflows can be realized. Tanks should be installed above grade.

Grades 304 L and 316 L of stainless steel are often selected for caustic potash service where product temperatures do not exceed 170 °F (76.6 °C). Stress crack corrosion becomes more prevalent above this temperature. For applications not sensitive to iron pickup during transfer and storage, carbon steel may be utilized. In iron-sensitive end-use applications where carbon steel is utilized, a suitable caustic potash-resistant coating or lining should be applied to the storage vessel. Liner choice will be influenced by factors such as the expected temperature conditions of the tank’s heating conditions. Use of an experienced, reputable coatings company can help ensure the correct coating is selected and that it is applied under optimal conditions for maximum performance.

Nickel and nickel alloys such as Monel® and Inconel® are preferred for high-temperature applications above 170 °F (76.6 °C). These materials and nickel-cladded steel are also frequently utilized in select areas of vessels such as the attachment nozzle for steam coils, which will be subject to localized high temperatures during operation.

Fiberglass Reinforced Plastic (FRP) and High Density Polyethylene (HDPE) materials can be used for caustic potash storage, but are typically limited to applications involving smaller product volumes due to the high specific gravity of caustic potash. A compatible surface veil, corrosion barrier, and curing procedure are critical design elements to review with your tank fabricator. Components made of aluminum, zinc (example: galvanized pipe), tin, copper, and brass will be readily attacked when exposed to caustic potash and should be avoided. Exposure to these types of metals may result in generation of hydrogen gas.

Venting

Adequate venting is critical for ensuring the tank is not subjected to excessive pressure or vacuum conditions. When unloading shipping containers by compressed air padding, the tank will be subjected to a nearly immediate, large volume of compressed air at the end of the shipping container unloading process. All tanks, regardless of material of construction, should have vents sized to allow a complete and rapid depressurization of the shipping container into the storage tank. Vents should be open to atmosphere at all times and never have valves installed. Tank vent diameters should be at least twice (2X) the size of the largest inlet piping diameter and installed on the roof of the vessel, as a general guide. Factors such as the length of the vent piping and number of turns can impede the release of compressed air pad gas and will require further upsizing of the vent. Consult your tank vendor for specific guidance.

Conduct periodic inspections of vent openings, especially those which incorporate a protective screen, to verify the mesh has not built up with dried caustic potash and carbonate. This phenomenon is most common for tanks that are often filled to near-capacity using compressed air. Vent discharge for indoor tanks should be routed outdoors and away from personnel or equipment.

Overflows

Tanks without overflow devices can spray chemical out of the vent or opened man-way during an over-fill event. Overflow systems can safely channel these liquids into the containment system instead. Overflow nozzles should be installed:

- On the upper side wall of the tank
- Below the roof line
- Away from the fill inlet nozzle

Piping should be attached to the overflow nozzle to direct liquid flow into containment and away from personnel work areas. Nozzles and piping from overflow devices are generally sized at least 1.5 times larger than the largest inlet pipe to ensure adequate capacity, but should be reviewed by your tank fabricator during the design phase of construction or when system modifications are made.

Receiving Pipeline & Inlet Nozzles

Two-inch piping is typical for most tank trailer-serviced locations, while larger diameter piping is common for other delivery modes to facilitate rapid product transfer. Three and 4-inch diameter receiving pipelines are typical for tank car unloading stations, whereas 8-inch piping is common for barge and other ocean vessel deliveries. Pipe diameter guidance will vary depending on site layout. The receiving pipeline should be equipped with a drain valve 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.

Top-filling is generally preferred for caustic potash tanks. Top-fill nozzles are typically installed on the roof of the tank. Bottom-filled tanks should employ a double-block valve arrangement to provide redundant back-flow protection.

Outlet Nozzles

Tanks should be designed to address normal product supply and periodic maintenance activities. Most outlet nozzles are located as near the bottom as practical. Where outlet nozzles are not located at tank floor level, a low point drain should be installed to remove product heels for maintenance activities. A side or roof-mounted man-way, typically 18- or 24-inches diameter, should be incorporated into the design to facilitate future maintenance needs.

Level Measurement

A level measurement system is important for maintaining process operations and for avoiding a possible overflow condition during inbound chemical delivery. External “sight glass” gauging devices are not recommended due to their potential for leakage and product freezing. Electronic gauging devices utilizing pressure differential, ultrasound, or radar are frequently utilized for tank inventory 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 shut-off at preset inventory levels can provide an important additional layer of protection against accidental tank overflow conditions. Use of a second high-level device, independent of the regular level transmitter, is desirable.

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 in clear view from the unloading station, will allow the unloading staff (and delivery driver for tank trailer shipments) to monitor tank levels more effectively during filling.

Heating

Solution strength and expected ambient temperature conditions are important factors when evaluating the need for heating the handling system, including pipelines, pumps, and tanks. The higher freeze point of 50 % caustic potash (39 °F or 3.9 °C) typically dictates the need for heating provisions. For storage of 45 % caustic potash, heating considerations become more critical as ambient temperatures approach its freeze point of -22 °F or -30 °C. Temperatures in the 80-100 °F range are often chosen when viscosities, pumping rates, potential product solidification, and metallic corrosion factors are considered for either product grade strength.

Insulation can significantly influence heating system efficiencies and costs. Heating costs and ambient temperature extremes should be considered when selecting the efficiency rating (R-factor) of the insulation. Insulation should be well-protected with jacketing to keep it dry and minimize external corrosion of the metallic surface. Jacketing materials made of aluminum can be easily damaged from potential caustic potash exposure and should be avoided.

Heating can be accomplished with steam or electric heat sources. For bayonet-style heating systems, a nickel or nickel alloy heating element should be considered. The heater should be attached to a nickel or nickel alloy flange on the tank nozzle to accommodate the localized high temperature associated with steam heating systems. Carbon and stainless heat exchangers and coils

are not recommended due to the accelerated rate of corrosion expected during operation. Horizontal bayonet coils should be properly positioned inside the tank to maximize heating efficiency and protect the tank surfaces from overheating. Horizontal heating coils should be properly supported, typically at least 8 inches above the tank floor, and extend across the center of the tank to about one foot of the opposite tank wall. A thermal agitation pattern will form in the tank, resulting in uniform contents heating as the caustic potash solution is warmed around the coils. Steam should be regulated to a maximum of 15 psig (104 kPa gauge) when heating caustic potash.

A preferred steam heating system involves the use of an external heat exchanger that is supplied caustic potash from the storage tank. External heat exchangers offer greater convenience when performing maintenance work, as the tank does not have to be drained for repairs or inspections. The potential for tank wall "hot spots" associated with internal-mounted steam heating systems is also eliminated. Shell and tube or plate and frame design configurations are frequently used. A recirculation pump is required to supply the exchanger.

Tank temperature management by use of a temperature controller is preferred as it eliminates the need to manually monitor and operate the heating system. The controller should include a high-temperature alarm and thermocouple at the same liquid level as the steam coils. This guards against the thermocouple erroneously reading the air temperature if the tank is nearly empty, which can cause coils and product heels to be super-heated. Installation of a second thermocouple at eye level provides a conveniently located, redundant temperature readout.

The storage tank can be heated using an electrical, horizontal bayonet-type heat exchanger similar to the steam-heated system described above if a source of steam is not available. Electric heat trace cabling or pads applied to the exterior offer another heating option. Insulation and protective sheathing should be used to minimize ongoing heat loss, especially when heat trace cabling or pads are the only heat source.

Tie Downs

Tanks should be adequately secured using tie downs installed from the factory to prevent tank movement from high winds or seismic activity.

Tank Cleaning, Inspection, & Preparation

Tank cleaning and inspection should be part of a scheduled, periodic maintenance program for caustic potash storage equipment. Tank cleaning frequencies will be influenced by factors such as the amount of product through-put and vessel inspection activities. Tank cleaning residues are hazardous and should be disposed of in accordance with local, province, state, and federal regulations.

Tanks should undergo scheduled visual, and mechanical inspections by qualified, trained personnel. Inspectors should adhere to the American Petroleum Institute (API) 653 standard or equivalent for inspecting and repairing steel tanks. Keep detailed inspection records, both from visual inspections and the non-destructive testing (NDT) data obtained during mechanical inspections, for future reference. New or repaired piping and tank systems should be water tested under use conditions before being placed in caustic potash service.

Unlike stainless steels, carbon steel requires special preparation before storing caustic potash. New, unlined carbon steel tanks, or those that have undergone significant repair will develop a fragile layer of ferric oxide surface scale when exposed to air. This scale will be readily dissolved upon the initial tank fill and will discolor clear caustic potash. Colors ranging from reddish-brown to dark grey or black are common. The tank should undergo passivation before the initial product filling process begins for applications sensitive to iron or visual appearance. Passivation is most effective when the tank walls can be continuously exposed to heated caustic potash for a minimum length of time, drained, and then immediately filled to reduce exposure to the atmosphere. The use of a rotating sprayer head inserted via a roof-top opening is often preferred for larger tanks, whereas filling the tank to its maximum fill level may be an option for small volume vessels. Solution strengths of 10-20 % caustic potash maintained at a temperature of 100-120 °F (37.8-48.9 °C) for at least 2-4 hours have been found to be successful. Use of stronger and/or warmer caustic potash solutions can reduce passivation times. The amount of external heating can be minimized by diluting 50 % caustic potash in the storage tank and relying on the heat of dilution to provide much of the heat source. After passivation, remove the product heel to minimize contamination of future inbound deliveries and immediately refill.

Containment Systems

Tanks should be installed on an appropriate foundation capable of supporting the weight load of a full tank, taking into consideration soil and sub-soil attributes. Reinforced concrete foundation pads or ring walls with an impervious material inside the wall are preferred. The tank pad or foundation should be designed to minimize moisture exposure and entrapment to the tank bottom. Elevating pads above the containment system floor is a preferred design concept to achieve this goal.

A well-designed handling system should incorporate effective secondary containment to collect 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 in the design phase. In general, containment systems should be capable of holding at least 110 % of the largest tank capacity found in the contained area. For outdoor tanks in high rainfall locations, additional capacity should be considered. Incompatible chemicals should be separated by walls within the overall containment area and in the drain-system piping.

Concrete is typically the preferred choice for bulk storage containment systems. A well-designed system will have reinforced floors and walls. The concrete should be sealed with an industrial coating to extend containment lifetime and to limit the potential of chemical migration through cracks or open expansion joints. The effectiveness of industrial coatings will be largely 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. The use of cinder blocks for containment walls is not preferred because of their porous nature and relatively weak strength.

Maintenance and housekeeping practices wherein systems are kept in good repair and any leakage is promptly cleaned up can greatly extend

containment system integrity. Maintenance becomes critical as minor imperfections that allow chemical to contact the concrete structure may not be adequately rinsed away from rainfall or housekeeping events.

Containment systems may vary by design and material of construction for non-metallic tanks or small volume storage applications such as “day” tanks. 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 tank walls 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 should also incorporate secondary containment to collect leaks, spills, or wash-down water. Reinforced concrete is generally the preferred material for tank trailer unloading station containment systems because most unloading areas must be able to accommodate delivery equipment weight loads. The presence of railroad ties and the occasional need for track maintenance make removable containment pans preferable to concrete sumps or pits for tank car unloading. Polyethylene or fiberglass reinforced plastic (FRP) containment pans are available from many containment system vendors for liquids collection between track rails. They offer the benefit of being removed for future track maintenance purposes. Routing of the containment system drains should avoid exposure to incompatible chemicals.

Piping

Materials & Heating

Schedule 40 or greater seamless stainless steel (grades 304 L or 316 L) piping is suitable for most caustic potash applications. Flanged piping is preferred, especially for 2-inch and larger diameters. The threads of threaded pipe tend to act as conduits for caustic potash to weep/leak from the threaded area due to caustic potash’s low surface tension. The act of thread cutting also reduces pipe wall thickness and can facilitate pipe failure in these areas if significant corrosion occurs. Use of threaded piping is generally discouraged for these reasons.

Piping should be heat-traced and insulated if ambient temperatures are anticipated to approach the freeze point of caustic potash, even for short periods of time. General temperature guidelines can be found in the Storage Tank Heating section of this manual. Self-regulating heat tracing cabling is preferred for most applications. Heated pipelines should be insulated to minimize heat loss. Insulation should be enclosed in sheathing to maintain integrity and minimize external corrosion of the metal surface that can occur via repeated exposure to rainwater. Sheathing should be chemically compatible with caustic potash to protect against chemical exposure from a mechanical failure. Steam tracing is generally not recommended for intermittent flow piping as the temperature of caustic potash can quickly exceed recommended maximum temperatures for carbon or stainless steels under static conditions. Excessive temperatures, especially for static product, will result in accelerated corrosion rates. When using steam in continuous-flow pipe applications, step-offs or insulators should separate the steam coil from direct pipe contact to avoid localized corrosion. Low-pressure steam, regulated to 15 psig or less should be utilized.

Routing & Flange Guarding

The piping system should be sloped/free-draining to facilitate maintenance and avoid low spots and collection of caustic potash, which can make freeze protection more difficult. Low point drains, if utilized, should be directed to containment. Likewise, pipe routing should be selected to minimize potential exposures to personnel or the environment if failure were to occur. Above grade piping is generally preferred. Flange guards prevent exposure to product sprays and drips that may occur at flanged connections when gaskets fail. Flange guards are particularly desirable in overhead pipe runs or high pedestrian and vehicular traffic areas. When buried piping is utilized, provisions for containment, leak detection, and inspection should be incorporated. Provisions to retard corrosion such as cathodic protection should be utilized for buried pipe runs.

Facilities with long pipe runs or those not equipped with pipeline heating often consider pigging to remove residual product once chemical transfer is complete. Pipelines intended to be cleared by pigging should be carefully designed. Piping will require long-radius curvature and pig guide bars, as well as a motive force (typically compressed nitrogen or air) to initiate the pigging process.

Pumps & Meters

Magnetic, centrifugal, or positive displacement pumps are frequently utilized in caustic potash service. Carbon and stainless steels are preferred for product temperatures maintained below 120 °F (48.9 °C). Nickel or nickel alloys are typical materials of construction for temperatures exceeding 170 °F (76.7 °C). Mag drive pumps are typically plastic lined. Pumps should be equipped with a power monitor to protect against “run-dry” or “dead-head” conditions. This protective feature is especially important for magnetically driven pumps. Sealed pumps should be protected by a shroud to prevent chemical leaking from the seal to be slung onto personnel and equipment in the area. Provisions for heating pump casings during cold ambient temperatures should be considered. Variable speed start/stop capabilities are preferred for limiting flow surges and are especially desirable in repackaging operations.

Metering of caustic potash is often achieved using rotameters, magnetic, or coriolis-style flow meters. Internal components should utilize stainless steel, nickel, or nickel alloys. Rotameters should avoid the use of glass, which is prone to chemical attack from caustic potash.

Valves

A number of different valve designs can be used with caustic potash and are generally chosen based on intended service and maintenance experience. Globe, ball, plug, diaphragm, and gate valves could be considered where positive shut-off is required. Check and butterfly valves are not recommended for positive shut-off applications. Globe, gate, and diaphragm valves offer the benefit of not trapping liquid inside the valve cavity, which can minimize potential for valve freezing in cold climates. Metal-to-metal and fluoropolymer seat designs are prevalent.

Shipping Caustic Potash Solutions

The Hazardous Materials Transportation System

Hazardous Materials System

The safe transport of hazardous materials such as caustic potash involves four different organizations:

- Regulatory Agencies (Department of Transportation, Transport Canada, Federal Railroad Administration, etc.)
- The Manufacturer (Olin)
- The Carriers (Railroads, Trucking & Marine Towing Companies)
- The Receiving Customer

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

Shipping Mode	Enforcement Agency
Rail	Federal Railroad Administration (FRA); Transport Canada
Roadway	Department of Transportation (DOT); Transport Canada
Waterway	U.S. Coast Guard; Transport Canada
Pipeline	Department of Transportation (DOT); State Regulatory Commissions; Transport Canada

Shipping Caustic Potash Solutions

The **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 released 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 caustic potash, while effectively using our fleet and complying with all applicable laws.

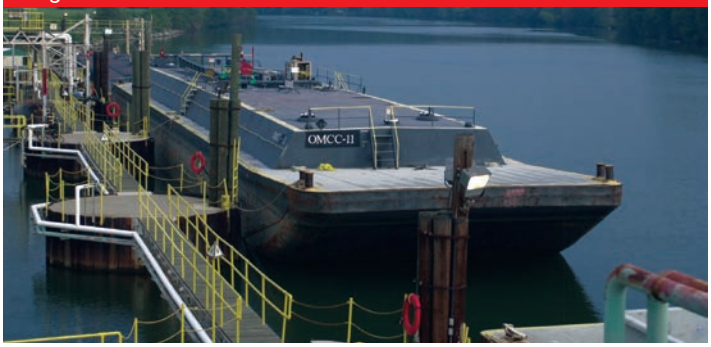
The **carrier's** (railroads, trucking & marine towing companies) responsibility in the hazardous transportation system is to safely move the caustic potash shipping containers from the shipper to the customer. The carriers must comply with a variety of regulations governing the movement of hazardous 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 and barges (empty after use), the customers or end-users become the shipper of record when they offer the caustic potash 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 caustic potash shipping equipment.

The caustic potash **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 caustic potash containers, and in the case of tank cars and barges, prepare them for shipment back to Olin. A customer's goal is to safely handle and unload caustic potash 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 and preparation of tank cars and barges released to the carrier. Failure to adequately prepare containers for reverse movement may result in regulatory fines or citations.**

Caustic Potash Shipping Containers

Caustic potash is shipped in a wide variety of container sizes, bulk and non-bulk, to meet the conditions of its many uses around the world. Olin ships caustic potash in bulk containers (tank cars, tank trailers, barges, ships, and by pipeline). Each delivery mode has unique advantages. Olin representatives can help you determine which type of delivery method best suits your needs.

Barges



Olin operates a fleet of barges for transporting liquid caustic potash. Capacities range from 600 to 1,000 tons (dry basis). These barges are double skinned, contain 2 to 4 internal storage tanks and have a diesel driven or electrically powered unloading pump on deck. The arrangement of the unloading lines, product valves, piping, and unloading pumps will vary between barges. Contact your Olin representative for additional information.

Customers are responsible for barge unloading. The specific unloading system used will depend on the needs and conditions of the receiving site. Very large caustic potash customers located on navigable waterways may save substantial freight costs by taking advantage of barge delivery.

Ocean Vessels

Olin also has the ability to service the industry worldwide with ocean vessels. Contact an Olin representative for more information.

Shipping Caustic Potash Solutions

Tank Cars

Olin owns and/or leases a large fleet of tank cars for shipping caustic potash. Tank cars are built to DOT specification 111S100W1 or 111A100W. Each car transports 16,000 gallons (52 tons dry basis) of caustic potash. These cars are lined with an alkali-resistant material to prevent iron contamination of the caustic potash. The insulation system has been designed to keep the car contents from freezing in cold weather over normal shipping times and consists of a 4-inch layer of insulation covered by an 11-gauge steel jacket. Most Olin caustic potash cars have a steam jacket for heating the bottom outlet valve area and most are equipped with external steam jackets for heating the entire tank.

A variety of important regulatory, environmental, safety, and health information is available on each tank car. Tags and stenciling display required shipping, car maintenance, and operating information as well as safety, spill mitigation, first aid information, and emergency response contacts. Tank cars also display the phone number for Chemtrec, a 24-hour emergency response call center, intended to assist emergency responders, shippers, customers, and carriers in the event of a transportation emergency. The Chemtrec number, 800-424-9300, is also noted in Olin's Safety Data Sheet.

Customers are responsible for unloading tank cars. Most cars are equipped for both top and bottom unloading (see Unloading section). The specific unloading method utilized will depend on available equipment at the unloading site.

Pipelines

For large users of caustic potash, pipeline supply from Olin's production or terminal locations may be an important consideration during site selection. In such cases, it may be possible for the customer to take caustic potash by pipeline. Olin can offer substantial help in planning for pipeline delivery.

Tank Trailers

Depending on the region, Olin has a dedicated fleet of company-owned tank trailers and company delivery drivers to provide product deliveries. Olin may also transport caustic potash via contract carriers. Customers may also have their own trucks or may prefer to use a contract carrier of their choice. Tank trucks used in caustic potash service must be authorized by the regulatory agencies (U.S. DOT, Transport Canada) and include equipment that conforms to the MC-307, DOT-407, MC-312 and DOT-412 designations. While tank trailer capacities vary from approximately 3,500 to 7,000 gallons, they usually contain no more than 12 tons of KOH (dry basis) because of the over-the-road weight limitations. The tank is usually stainless steel and can be insulated or uninsulated. The typically short transit time of a tank trailer makes steam coils or other auxiliary heating of the caustic potash unnecessary.

Caustic potash trailers incorporate a double valve arrangement on the unloading line. The internal valve is hydraulically or pneumatically operated and can be closed remotely in the case of an emergency. The unloading connections can be located in the middle or at the rear of the trailer. A data plate specifying tank fabrication, inspection, and other regulatory information is located on the driver's side of the trailer frame near the front. The DOT requires that tank trailers be inspected periodically (includes internal and external visual inspections as well as leak, thickness, and pressure testing) and that these dates be stenciled on the front head of the trailer. An Olin tag, located on the outlet valve, also provides environmental, safety, and health information.

Tank trailers can be unloaded by the driver or by employees at the receiving site. If the driver unloads the tank trailer, clearly defined procedures should be followed to ensure communication and coordination between the driver and the appropriate plant representatives. See the Unloading section for additional information.

Unloading Caustic Potash 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 a number of 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 and certificate of quality) to verify they match the shipping container placard and receiving pipeline label
- Delivery address and purchase order numbers are verified
- Adequate tank inventory exists to safely receive the entire shipping container contents
- 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 caustic potash 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. The Safety section of this manual and the Safety Data Sheet (SDS) for this product should be thoroughly reviewed before any person works with caustic potash or its residues.

General Unloading System Requirements

Customers should carefully consider the way that caustic potash 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:

1. Caustic potash unloading operations must only be performed by properly trained personnel who understand the hazardous materials they are handling.
2. Contact with caustic potash can cause severe burns to skin and eyes. If inhaled, it may cause mild irritation to severe burns of the lungs and respiratory tract. Therefore, all workers must wear proper protective equipment and clothing. They also must strictly observe all prescribed safe-handling procedures and practices.
3. Safety showers/eyewash stations and other personal protection equipment should be located in close proximity to the unloading connections. This critical equipment must be easily and quickly accessible by those who need it. For example, someone with caustic potash 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 regulation, 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.
4. Safe, unobstructed access to and from work areas around unloading connections is required for both routine operation and emergency situations.
5. 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 caustic potash. It is important to make sure that the materials of construction for the containment equipment are compatible with all caustic potash 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.
6. Adequate lighting is available in all work areas, especially at the unloading connections.
7. Adequate supplies of water (equipment rinsing and spill cleanup), steam (thawing of frozen caustic potash), or other utilities should be readily available.
8. Flexible unloading hoses should:
   - Be made of alkali-resistant material with a spiral wire wound structure
   - Have stainless steel connections
   - Have a suitable pressure rating for the service where they are used
   - Only be used to connect the caustic potash transportation equipment to the unloading piping. Generally, only one length of hose should be used to prevent safety and handling problems. If situations require use of multiple sections of hose for unloading, corrective actions should be identified to minimize the length of the unloading hose.
9. 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.
10. 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.
11. If a pad gas unloading system is used, air is the preferred pad gas. 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. An oil and particulate trap should be installed on the source air to prevent carry-over into the caustic potash 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.
12. The vent system on the receiving tank should be properly sized and discharged to a safe area (see Tank section for details). The discharge location of the vent is particularly important with air pad unloading systems as some caustic potash may be atomized in the air when the shipping container's pressure is relieved. If mist is discharged from the vent, it could pose a hazard to nearby persons.
13. 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 manual contain additional information on the design and operation of caustic potash handling facilities. Information can also be found in **The Chlorine Institute** *Pamphlet 87, Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic)* Tank Cars at www.chlorineinstitute.org. If you have any questions or need additional assistance, contact your Olin representative.

Tank Car Unloading

The Caustic Potash Tank Car – Top Connections/Equipment

The following equipment is on the top of every caustic potash tank car:

- 2" Ball Valve – Unloading Connection with Plug (Connected to the Eduction Pipe)
- 1" Ball Valve – Air Inlet with Plug
- Fill Hatch for Sample Collection
- Pressure Relief Valve (Or Rupture Disc)
- Protective Housing Cover

In addition to the above equipment, cars equipped with a top-operated bottom outlet valve also have a bottom outlet valve wrench handle located on the top of the car.

Some cars have all these valves and fittings arranged inside a single protective housing while other cars have only the 1- and 2-inch valves inside a smaller protective housing. The rest of the equipment on these

Unloading Caustic Potash Solutions

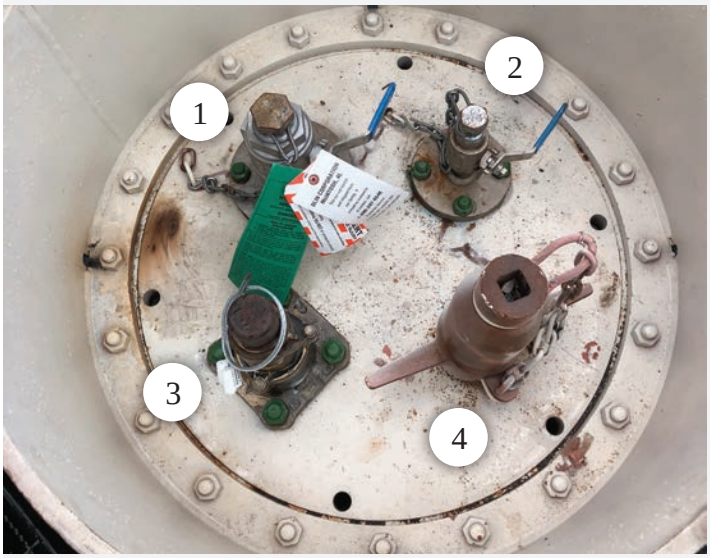
cars (fill hatch, safety relief, bottom outlet valve wrench handle) is located along the centerline near the protective housing. All valve plugs should have a chain securing them to the tank car. Figures 2 and 3 show two typical configurations.

The Caustic Potash Tank Car – Bottom Connections/Equipment

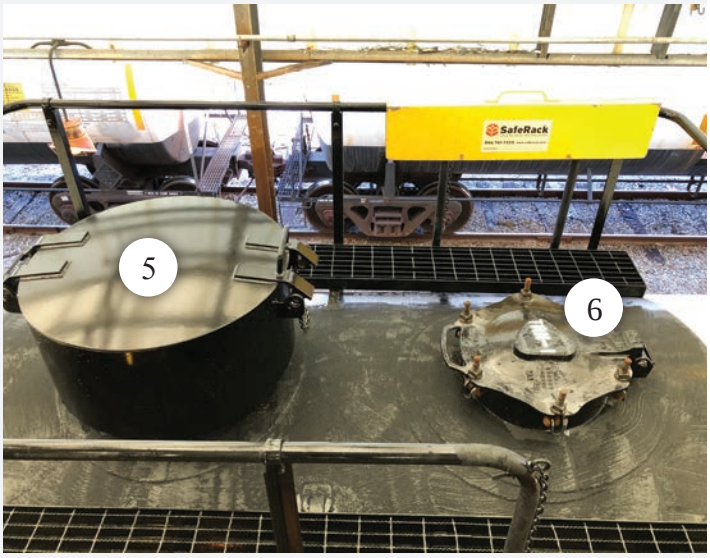
Most tank cars are equipped with an outlet valve for bottom unloading. However, bottom unloading has drawbacks due to safety reasons (see Top or Bottom Unloading section for additional information). On many tank cars, the bottom outlet valve is an internal valve, operated by a connecting or reach rod located near the other fittings on top of the tank car. This reach rod extends from the top of the car to the valve on the bottom of the car. The valve handle forms a protective cover for the reach rod itself. To operate this bottom outlet valve, the reach rod cover (4) is removed, inverted, and connected to the reach rod. Other tank cars have low-profile valves at the bottom of the car. These can be ball valves or wafer-sphere valves.

Figure 2: Typical Top Arrangement, Caustic Potash Car (16,000 gal.)

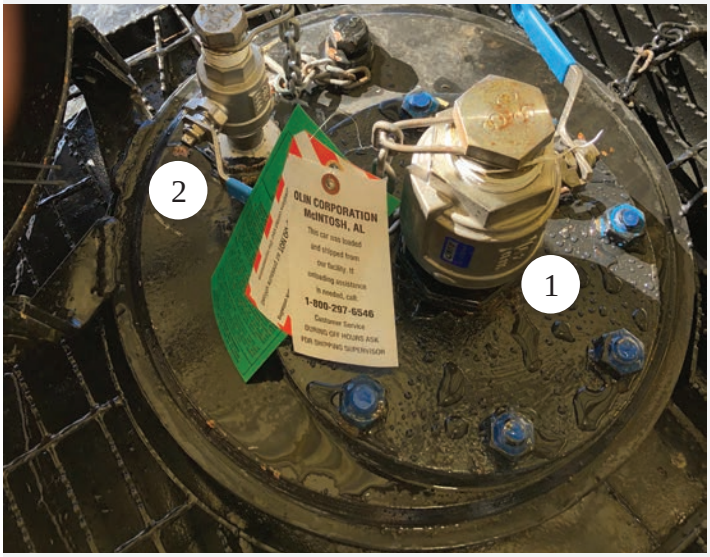
1. 2" Ball Valve (Product Outlet Connected to Eduction Pipe)
2. 1" Ball Valve – Air Inlet
3. Pressure Relief Valve (Or Rupture Disc)
4. Top-Operated Bottom Valve Wrench Handle
5. Protective Housing Cover
6. Fill Hatch



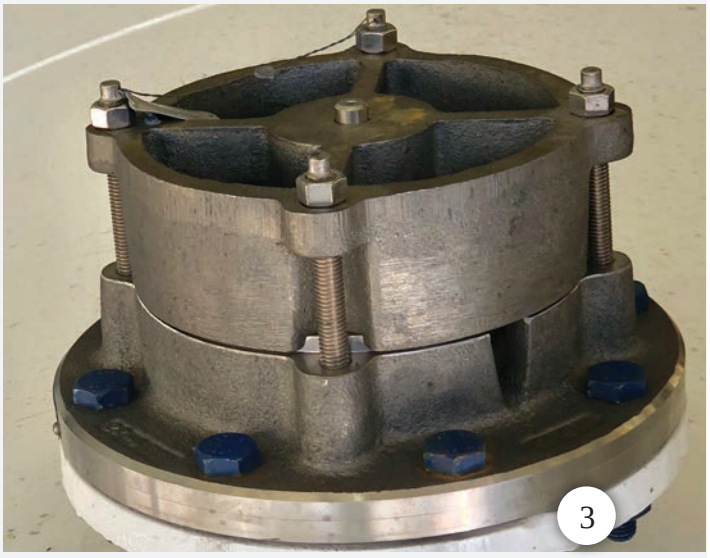
Top Connections & Valves



Protective Housing Cover & Fill Hatch



1" Air Inlet Valve & Product Outlet Valve



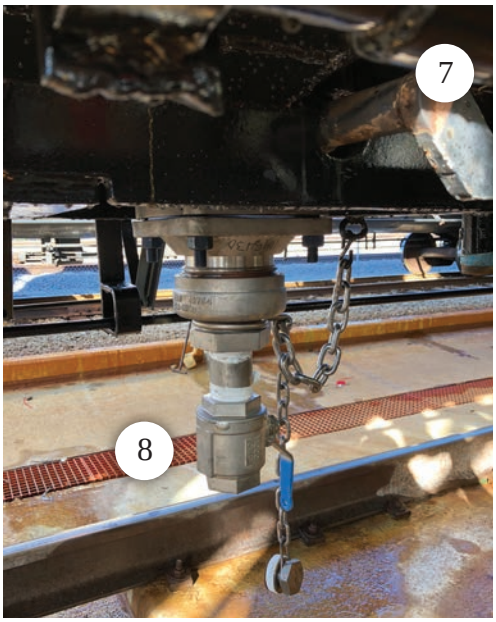
Pressure Relief Valve

Unloading Caustic Potash Solutions

Just below the bottom outlet valve (connected to handle (7)), there is an additional 2-inch auxiliary or external ball valve (8) provided for safety and operating ease. For bottom unloading, the operator connects the unloading line to the outlet of the auxiliary valve. Figure 3 shows typical bottom outlet valve configurations.

A steam chamber with individual steam inlet (9) and outlets may enclose the bottom caustic potash outlet in some tank car designs. Either steam connection may be used to attach a steam line when a car is being prepared for unloading. The other connection provides for condensate removal (see Steaming section).

Figure 3: Examples of Bottom Outlet Valves Found on Caustic Potash Tank Cars (valve designs may vary)



Bottom Outlet Valve & Handle; 2" Auxiliary Valve

Steam Coil Connection; Top Operated Bottom Outlet Valve and 2" Auxiliary Valve

The Caustic Potash Tank Car – Pressure Relief Devices

Rupture discs or pressure relief valves are installed on all tank cars to prevent over-pressurization. The maximum relief pressure depends on the tank car design. If a car is equipped with a rupture disc it will relieve at either 80 or 165 psig (550 kPa or 1140 kPa gauge). Tank cars equipped with a pressure relief valve will relieve at 165 psig (1140 kPa gauge). Details for individual cars are stenciled on the side of the tank.

Some tank cars may arrive with rupture discs that have burst or pressure relief valves that have opened in transit. This is usually due to excessive hydraulic shock when the carriers handle the cars. Efforts have been made to minimize such occurrences (increased rupture disc ratings and internal tank baffles). Contact your Olin representative immediately if tank cars are received with external chemical residue or have blown rupture discs. Failure to install a disc or use of an improper disc can cause an extremely unsafe situation and is in violation of DOT regulations. Additionally, DOT regulations require that persons performing repair/maintenance activities be certified to DOT regulations.

The Caustic Potash Tank Car – Insulation & Steam Coils/Jackets

Olin tank cars have insulation that is at least four inches thick. Because of the effectiveness of this insulation, tank cars with short transit times may require no or minimal steaming during cold ambient temperatures. However, where long hauls or extremely cold weather conditions prevail, tank cars may be equipped with external steam coils or jackets. If the temperature of the caustic potash makes steaming necessary, connection must be made to the steam coil/jacket as well as to the caustic potash outlet chamber.

The steam inlet for the coils/jacket is usually located near the bottom outlet valve. Figure 6 on page 23 shows a typical configuration for the steam fittings. Unless the connections are otherwise marked, steam may be applied to either end of the steam coil. The other connection serves for condensate removal and should be connected to a steam trap (see Steaming section).

Top or Bottom Unloading – Which Should You Be Using?

Although bottom unloading of caustic potash tank cars is fairly common, unloading caustic potash solutions from the top has significant benefits to both personnel and the environment. Bottom unloading is generally preferred when tank cars are pump unloaded via gravity or for sites where a compressed air source is not available.

Personnel Protection. A number of personnel protection benefits can be realized with a top unloading system. Rapid egress and access from underneath the tank car can be impeded by the undercarriage, grab irons, ladder, and other appliances. The track rails can also contribute to trips or sprains when moving in and out from under the tank car.

All of these issues are compounded if a problem, such as a leak, develops while working under the car because any personnel under the tank car are in a potentially awkward position. Anyone hurrying to move away from the bottom outlet runs a greater risk of getting hurt on the various obstructions and obstacles. The typical body positions under the tank car (crouching, sitting, and/or laying) can also impede visibility and restrict rapid access in the event of a leak, potentially increasing the risk to the worker.

Almost all of these factors are eliminated when unloading from the top of the tank car. Access and egress impediments to the connection points are minimized, and there are typically no or only minimal overhead obstructions when working from the tank car platform. In addition, improved body position increases the worker's ability to be more aware of everything that is going on around them. Use of a top access platform with drop gangway or equivalent maximizes these benefits. Use of a top access platform with fall protection is strongly recommended for both top and bottom unloading to maximize safety and efficiency. References are available for prefabricated platform systems.

Unloading Caustic Potash Solutions

Environmental Protection. When it comes to environmental protection, top unloading tank cars have gravity working in your favor. A broken connection or other leak on the unloading hose (or pipe) from the top of the tank car reduces, or in the case of pump unloading, eliminates the possibility of spilling the entire tank car contents. If a similar situation occurs in a bottom unloading system, there is a greater possibility that the entire tank car contents will be lost to the ground before the valve could be secured. All of Olin's caustic potash tank cars are equipped to allow top unloading. If you need additional information or would like assistance in converting from bottom to top unloading, please contact your Olin representative.

Pump Unloading

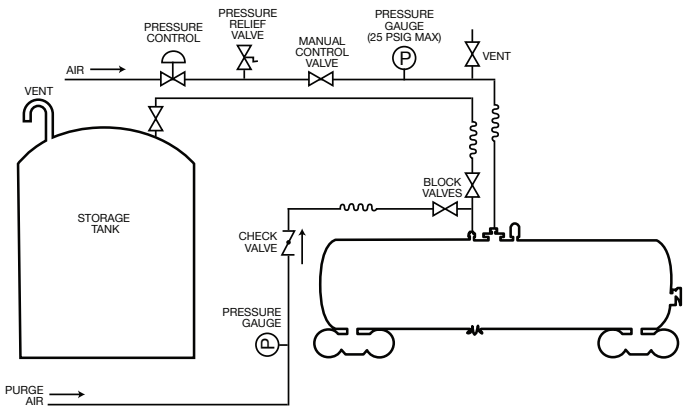
In a pump unloading system, some air pressure is needed to lift the caustic potash solution up to the top of the eductor or dip tube, at most 12.5 feet, and start the liquid flow to "prime" the unloading pump. To lift the caustic potash 12.5 feet requires approximately 10 psig air pressure. Once a pump prime has been established, the unloading will take the same time as if you were unloading from the bottom. It is important to safely depressurize the tank car and leave the fill hatch open when pump unloading to prevent a vacuum from developing in the tank car unless a "dual unloading mode" is utilized. **Leaving the fill hatch open is a DOT requirement. Failure to do so could lead to an interruption of the unloading or even damage to the tank car.**

The use of self-priming pumps is especially desirable for top-unloading of tank cars. For unloading facilities without self-priming pumps, a "dual-mode" unloading process utilizing a transfer pump and a positive compressed air pad application should be considered. The positive pressure pad provides the motive force for pump priming and also prevents the tank car from being placed under vacuum conditions. This type of unloading operation would require the tank car to remain sealed during unloading. To prevent accidental vacuum application, a pressure switch or other warning device should be installed to activate pump shut-down if a loss of air pressure occurs.

Top Unloading Caustic Potash Tank Cars

Top Unloading Procedure

Figure 4: Top Unloading Using Air Pressure Illustration



The preliminary steps of positioning the tank car and installing the necessary safety devices must be carried out in accordance with the instructions outlined in the General Unloading section. The unloading steps should generally follow this sequence:

1. The tank car should be protected during unloading by warning signs and derails and/or locked switches. The brakes should be set and the wheels chocked to prevent accidental movement. Warning signs (Blue Flags) meeting DOT regulations and a closed derail device must be placed at least one tank car length on the open end(s) of the tank car(s) being unloaded. These signs must remain in place and the derail set to derail a car as long as the tank car(s) is connected to the unloading system.
2. While wearing proper PPE, relieve any tank car pressure or vacuum by opening the 1-inch vent valve making sure that the valve discharge is pointed away from all personnel. Open the fill hatch by first loosening, but not removing, all the nuts. Lift the cover slightly with the opening away from all personnel to ensure there is no pressure, spray, or other problems. Take any necessary samples, and confirm that the contents are suitable for unloading.
3. Secure the tank car fill hatch so there are no air leaks. Fill hatch securement bolts should be evenly torqued using a "star" pattern when tightening.
4. If unloading is to be done by air pad, all air line fittings should be inspected before each use for potential leaks and the oil trap should be checked and drained regularly to prevent carryover of oil and other contaminants into the caustic potash. The unloading air system should be designed and operated not to exceed a safe working pressure: 25 psig (172 kPa gauge) is suggested as a maximum, and lower pressures are desirable. Contact Olin if pressures above 25 psig are required.
5. Make sure the storage tank is adequately vented to handle the air pressure surge (air pad unloading) that occurs when the tank car is empty.
6. Close the 1-inch ball valve if it was opened in step 2. If the tank car is not opened prior to unloading, remove the 1-inch plug from the air-inlet ball valve and connect the air line. Be sure to install safety pins if quick connect couplings are used.
7. Connect and apply steam to the steam chamber around the bottom tank well/unloading valve if needed. The bottom well and the top and bottom valves are not insulated and will be the first areas to experience product freezing in colder temperatures. The eductor pipe used during top unloading extends into the bottom well of the car to allow complete unloading of the car contents. Application of steam to the outlet valves and eductor pipe will not thaw chemical inside the tank. Consult the 'Steaming Section' for additional details.
8. Open the 2-inch ball valve on the car and the appropriate valves in the unloading line.
9. Verify the air supply regulator is assigned to a maximum of 25 psig (172 kPa) before opening the air supply valve. A valve in the caustic potash unloading line can be used to control the flow of the caustic potash. If pump unloading, shut off the air supply when caustic potash flow is established, disconnect the air line, and open first the 1-inch vent valve to release all air pressure, then the fill hatch to prevent a vacuum during the unloading process. This vacuum will stop the caustic potash flow at some point during the unloading operation and could cause the tank car to collapse. **DOT regulations require the fill hatch cover to remain open to provide adequate venting capacity when pump unloading.**

10. If air pad unloading, the unloading hose will jump or surge when unloading is completed. Allow the air to blow through the transfer lines to the storage tank for 3 to 4 minutes to clear the lines. Shut off the air to the tank car and allow the pressure to relieve to the storage tank. If pump unloading, shut off the pump when the car is empty (car level is visible through the fill hatch). Note that it is advisable to equip the pump motor with a "low-amp" cut out to avoid/minimize potential damage to the pump sealing mechanism or magnetically driven pump components, if equipped.
11. Close the tank car unloading ball valve and appropriate unloading line valves. Disconnect the unloading line and allow it to drain to an appropriately contained area. When disconnecting the hose, always assume caustic potash is present and under pressure until you are certain this is not the case.
12. Install the plugs on all tank car valves (air inlet and product outlet ball valves), making sure they are wrench tight and that all valves are fully closed (DOT requirement).
13. Wash the tank car and unloading station of any incidental product drippage and collect rinse water in the containment system.
14. Perform a mechanical inspection of the tank car consistent with 49 CFR 173.31 (d).
15. Secure the dome housings with pins and seals.
16. It is important to keep all equipment, tools, and PPE clean. After use wash all valves, hoses, wrenches, PPE, and any other items used during the unloading process to remove oil, dirt, grit, and caustic potash residues.
17. **As the legal "shipper of record," you are responsible for ensuring the tank car is prepared for safe return shipment before release to the carrier. Failure to adequately prepare the tank car may result in you accruing regulatory fines or citations.**

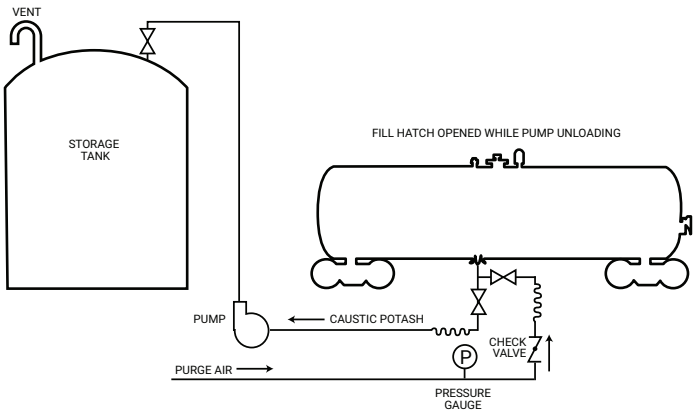
Bottom Unloading Procedures for Caustic Potash Tank Cars

Bottom unloading requires special procedures and PPE be in place to address personnel protection while under the tank car, should a leak or incident occur. A no or low-pressure pad unloading design concept should always be utilized when bottom unloading to further enhance safety. In general, gravity flow of chemical from the tank car to the transfer pump is the preferred method when bottom unloading. For unloading stations that have long transfer distances or do not have a pump, pressure padding or a 'dual motive force' using both a modest air pressure pad and a transfer pump are common options.

Regardless of bottom unloading mode chosen, HIGH PRESSURE (AIR PAD) TRANSFERS FROM THE BOTTOM OF THE TANK CAR ARE NOT RECOMMENDED. The design of the bottom outlet valve assembly dictates only LOW PRESSURE be applied. A pressure pad of ~ 10 psig is adequate for most facility configurations, but in no instance should pad pressures for bottom unloading exceed 25 psig. Figure 5 shows a typical arrangement for bottom unloading caustic potash by pump. The exact configuration will vary by facility design, but unloading steps should follow this general sequence:

1. The tank car should be protected during unloading by warning signs and derails and/or locked switches. The brakes should be set and the wheels chocked to prevent accidental movement. Warning signs (Blue Flags) meeting DOT regulations and a closed derail device must be placed at least one tank car length on the open side(s) of the tank car(s) being unloaded. These signs must remain in place and the derail set to derail a car as long as the tank car(s) is connected to the unloading system.
2. While wearing proper PPE, relieve any tank car pressure or vacuum by opening the 1-inch vent valve, making sure that the valve discharge is pointed away from all personnel. Open the fill hatch by first loosening, but not removing, all the nuts. Lift the cover slightly with the opening away from all personnel to ensure there is no pressure, spray, or other problems. Take any necessary samples, and confirm that the contents are suitable for unloading.
3. For pump or gravity unloading, vent the car by removing the outlet plug from the air inlet ball valve, connecting an appropriate vent line, and opening the valve. If air pad unloading, make sure all valves and the fill hatch are closed.
4. Exercise extreme caution when removing the plug from the 2-inch auxiliary bottom outlet valve in case the valves have leaked through for any reason.
5. Open the 2-inch auxiliary valve and any valves in the line to the storage tank. During cold temperatures, apply steam via a steam lance to the exterior of the bottom outlet valve assembly area prior to opening the bottom outlet valve (see Steaming section).

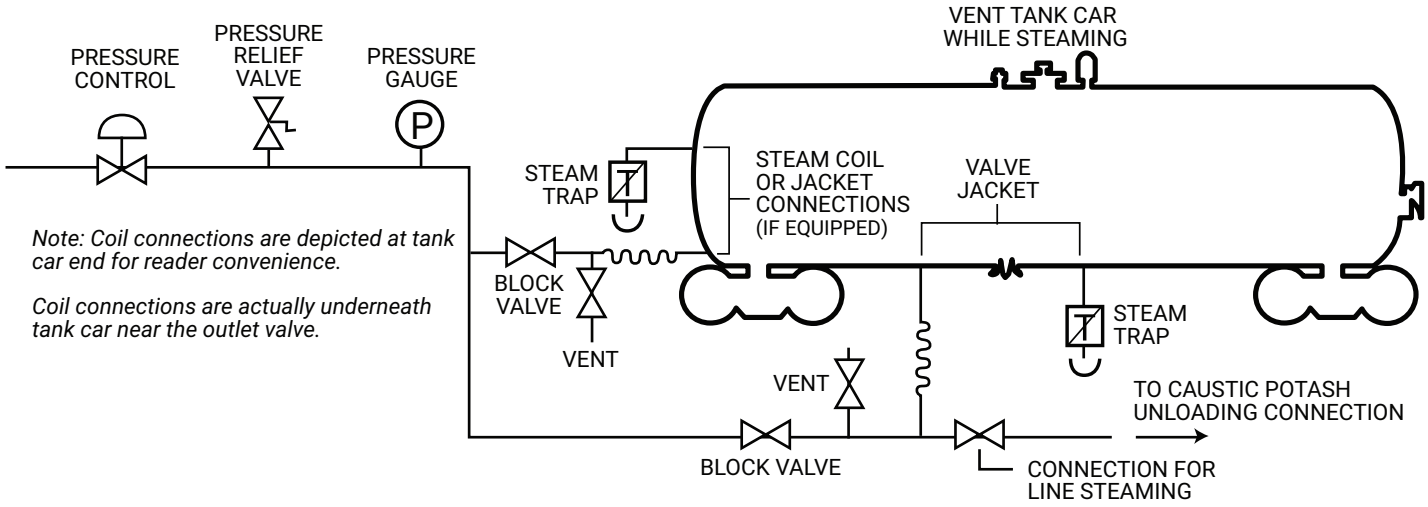
Figure 5: Bottom Unloading Arrangement



6. After connecting and securing the transfer hose to the tank car, open the main outlet valve on the car. **CAUTION: Do not force this valve's movement. Attempting to open/close frozen valves will damage them!** Steam should be applied to the outlet chamber until it opens easily (see Steaming section for additional information). Remember that many cars have an internal bottom outlet valve that is operated from the top of the car (see Bottom Connections section).
7. For pump or gravity unloading, it is important to verify the fill hatch is open to prevent buildup of a vacuum during the unloading process. This vacuum will stop the caustic potash flow at some point during the unloading operation and could cause the tank car to collapse. **DOT regulations require the fill hatch to be opened to provide adequate venting during pump unloading.** If pump unloading, turn on the pump and caustic potash will flow to storage.

Unloading Caustic Potash Solutions

Figure 6: Steaming Connections



8. Verify the air supply regulator is assigned to a maximum of 25 psig (172 kPa) before opening the air supply valve. A valve in the caustic potash unloading line can be used to control the flow of the caustic potash. If pump unloading, shut off the air supply when caustic potash flow is established, disconnect the air line, and open first the 1-inch vent valve to release all air pressure, then the fill hatch to prevent a vacuum during the unloading process. This vacuum will stop the caustic potash flow at some point during the unloading operation and could cause the tank car to collapse. **DOT regulations require the fill hatch cover to remain open to provide adequate venting capacity when pump unloading.**
9. If air pad unloading, the unloading hose will jump or surge when unloading is completed. Allow the air to blow through the transfer lines to the storage tank for 3 to 4 minutes to clear the lines. Shut off the air to the tank car and allow the pressure to relieve to the storage tank. If pump unloading, shut off the pump when the car is empty (product level is visible through the fill hatch). Note that it is advisable to equip the pump motor with a "low-amp" cut out to avoid/minimize potential damage to the pump sealing mechanism or magnetically driven pump components, if equipped.
10. Close the tank car unloading ball valve and appropriate unloading line valves. Disconnect the unloading line and allow it to drain to an appropriately contained area. When disconnecting the hose, always assume caustic potash is present and under pressure until you are certain this is not the case.
11. Install the plugs on all tank car valves (air inlet and outlet ball valves) making sure they are wrench tight and that all valves are fully closed (DOT requirement).
12. Wash the tank car exterior and unloading station of any incidental product drippage and collect rinse water in the containment system.
13. Perform a mechanical inspection of the tank car consistent with 49 CFR 173.31 (d).
14. Secure the dome housings with pins and seals.
15. It is important to keep all equipment, tools, and PPE clean. After use, wash all valves, hoses, wrenches, PPE, and any other items used during the unloading process to remove oil, dirt, grit, and caustic potash residues.
16. **As the legal "shipper of record," you are responsible for ensuring the tank car is prepared for safe return shipment before release to the carrier. Failure to adequately prepare the tank car may result in you accruing regulatory fines or citations.**

Steaming Procedures

Because of the relative high freezing point (50 % KOH = 39 °F or 3.9 °C), caustic potash is shipped in heavily insulated tank cars. Tank cars almost always arrive at the user's site with the bulk of their contents liquid. However, in cold weather, the outlet valves and the bottom of the eduction pipe are often plugged by a small amount of frozen caustic potash that can be thawed by placement of a steam lance around the outlet valve. Many tank cars are equipped with a steam chamber enveloping the bottom outlet valve assembly which can be heated by applying steam via the coil connectors. A steam lance will be required to thaw top-located outlet valves, if frozen.

Occasionally, the bulk of the caustic potash in the tank car may be frozen on arrival, especially for 50 % caustic potash. This condition might be caused by extremely cold weather or very long delays in delivery time. To accommodate these circumstances, Olin has a portion of its fleet equipped with external steam coils to provide a means for thawing the entire contents of a frozen car.

Maximum permissible pressure of the heating steam is stenciled on tank cars. Higher pressure must be avoided. Temperatures from steam at higher pressures may damage linings and result in contamination of the caustic potash.

The guidelines below are applicable to either top or bottom unloading of caustic potash cars:

1. Inspect tank cars for evidence of freezing before unloading in cold temperatures. This should be done when the fill hatch is initially opened and samples are taken. The need for steam application will depend on the solution strength of the tank car and ambient weather conditions. General steaming guidelines can be found on the following page. Be sure to wear the appropriate personal protective equipment when taking the sample from the tank car.

Unloading Caustic Potash Solutions

General Steaming Guidelines

Solution Strength	Temperature	Action
50 % KOH	Above 80 °F (26.7 °C)	Steaming is not required
50 % KOH	Below 80 °F (26.7 °C)	Apply steam
45 % KOH	60 °F (15.6 °C) or higher	Steaming is not needed
45 % KOH	10 °F (-12.2 °C) or lower	Apply steam

2. In addition to product temperature, the decision on when to steam tank car contents should consider factors such as the presence of heated pipelines, pipeline length, and desired transfer time. Consult the viscosity data in the Technical Data section of this manual.
3. Tank car valves and their attachment points are not insulated and therefore will typically be the first points to freeze, if any caustic potash residue is inside the valve cavity. Despite confirming product inside the tank car is adequately warm, an application of low pressure (15 psig max.) steam to the external body of the valve(s) may need to be provided whenever ambient temperatures approach the freeze points of either 50 % or 45 % KOH, respectively. For tank cars without a steam chamber enveloping the bottom outlet valve assembly, heat can be provided via a steam lance (typically made of an L-shaped piece of metallic tubing) connected to low pressure steam and applied to the exterior of the 2-inch auxiliary valve for about 30 minutes to melt any frozen product. Once thawed, it may be necessary to insert the steam lance up through the opened 2-inch auxiliary outlet valve to adequately thaw the internal valve. Never attempt to open the internal valve while applying steam to this valve. Confirm the tank car is connected to the unloading system before opening the internal valve. Apply steam to the internal valve for at least 30 minutes. Steaming work should be performed over catch pans or containment for environmental protection. Always use low pressure (15 psig max.) steam. Never use gas fired cutting or blow torches to heat tank car valves.
4. If the weather is very cold or the car has been in transit for an extended period, it may require significantly longer steaming to liquefy the contents of the car. If the car is equipped with an external heating coil/jacket, steam pressure should be limited to a maximum pressure of 15 psig (104 kPa gauge). Contact your Olin representative for additional information.
5. Never steam partially full tank cars. Steaming application to less-than-full tank cars may result in damage of the protective tank liner.
6. To avoid pressure buildup during steaming, the tank car must be vented by opening the vent valve or fill hatch.
7. Never inject steam or water directly into the tank car through the fill hatch.
8. Electrical tracing used on caustic potash piping and equipment must be thermally rated to withstand a 300 °F (148.9 °C) pipe wall temperature to allow steaming without damaging the tracing (see Equipment section).
9. On most tank cars, either of the steam fittings can be used as inlet or outlet. Cars with other requirements will be marked to show limitations. A pressure control valve and a pressure relief valve (15 psig [103kPa] maximum) should be installed in the steam line that supplies steam to the heating coils.
10. Use of a steam trap on the discharge of the steam heating connections helps melt solidified caustic potash and is more effective than a throttling valve or any other device on the condensate discharge. Also, using a steam trap saves labor since it requires little attention from operating personnel. Discontinue steaming as soon as product is melted and ready to be unloaded. Adequate steaming is achieved when the product has reached a temperature corresponding to the General Steaming Guidelines. Caustic potash should not be heated any higher than 120 °F (48.9 °C) in the tank car. Avoid excessive steaming of tank cars and never steam partially empty tank cars. Steaming partially empty tank cars can damage the protective interior lining very rapidly. Excessively hot caustic potash can also cause rapid corrosion of carbon steel and even stainless steel piping systems (caustic potash temperatures >170 °F or 76.7 °C).
11. Remove the steam trap when steaming is completed. In cold weather, condensate should be blown out of the coils to prevent damage from freezing. Caps should be left off the steam fittings to allow drainage in transit.

Additional information on steaming caustic potash tank cars can be found in **The Chlorine Institute** *Pamphlet 87, Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Tank Cars* at www.chlorineinstitute.org.

Tank Trailer Unloading

Unloading Facilities

Tank trailer unloading stations should be laid out to provide easy access to the receiving pipeline connection. Wherever possible, drive-through unloading stations are preferred over backing of the tank truck into the unloading station. In-plant street access should be designed to accommodate tractor/trailer combinations and incorporate wide intersections. Reinforced concrete unloading pads sloped to a containment device such as a dedicated sump or French drain provide a hard surface for trailer parking. This unloading pad concept can also collect potential drips and leaks that may occur during the delivery process. Where multiple chemicals are received in the same area as caustic potash, engineering and/or procedural provisions should be incorporated to avoid mixing of incompatible materials.

Rapid delivery typically makes steaming of the trailer unnecessary. However, steam should be available at the unloading site to thaw the trailer's valve, which may have frozen product in cold climates. Additional utilities such as water to rinse unloading equipment and containment, as well as lighting for night-time unloading should also be provided.

The user should provide an appropriate pipeline for product receiving that includes:

1. A 2-inch male quick connect hose connector of stainless steel construction. Connectors located at approximately thigh-to-hip height are preferred for ergonomic reasons.

Unloading Caustic Potash Solutions

2. A block valve installed directly behind the hose connector to prevent loss of contents from pipeline backflow.
3. A drain valve located near the transfer hose connection point and directed to containment to relieve hose pressure or collect pre-unloading samples.
4. A clearly identified delivery hose connection point using text such as “45 % Caustic Potash,” “Potassium Hydroxide,” or “Potassium Hydroxide UN 1814,” to avoid wrong tank – wrong product events.

Trailers can be provided with air compressors for unloading if the facility does not have a compressed air source. Most carriers do not offer unloading pumps. Check availability with Olin before scheduling your delivery. Customer-supplied compressed air must be regulated to a maximum of 25 psig and include an oil and particulate filter to eliminate introduction of the contaminants into the shipping container and product being received. A Chicago-style connector is standard for attaching the air supply line to the tank trailer.

The receiver of the inbound delivery is responsible for checking and accepting the caustic potash before unloading. Procedures should be established and followed to be certain the product is acceptable before unloading.

Typical Tank Trailer Connections

All tank trailers are equipped with an internal foot valve (1), an auxiliary product valve (2), a two- or three-inch quick-connect fitting for unloading hose attachment (3), and a rear emergency shut-off device (4) as depicted in Figure 7. Each tank trailer is also equipped with a one inch Chicago-style connector (not shown) for pneumatic product transfer.

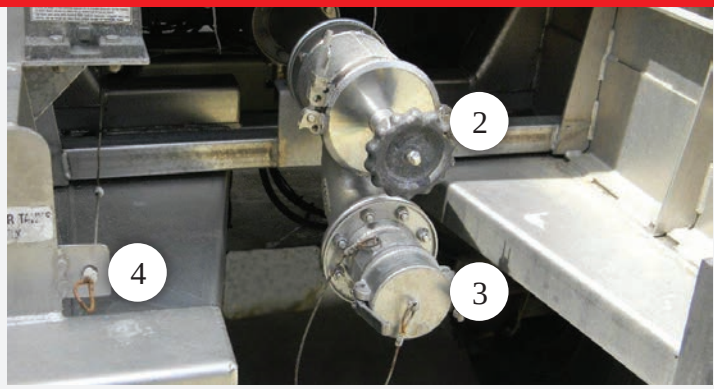
Unloading Procedures

Detailed information on tank trailer unloading facilities and procedures is available from **The Chlorine Institute,** *Pamphlet 88, Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Cargo Tanks* at www.chlorineinstitute.org.

The delivery driver normally unloads tank trailers. 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.

A plant representative should accompany the driver during the high-risk part of the unloading activities, such as when the tank trailer is being connected and when the connections are broken after unloading has been completed. The DOT 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 caustic potash hose connection points, they should 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. All tank trailers are equipped with an emergency shut-off device located at the driver’s side front and rear of the tank trailer. See Figure 7 and 8.

Figure 7: Typical Tank Trailer Connections



1. Internal Foot Valve Actuator

2. Auxiliary Valve Hand Wheel

3. 2" Auxiliary Outlet With Dust Cap

4. Rear Emergency Shut-Off Device

Unloading Caustic Potash Solutions

Figure 8: Typical Emergency Shut-Off Device

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. The steps used in unloading should follow this general sequence:

1. Spot the tank trailer. Set the brakes and chock the wheels (if necessary) to prevent accidental movement. Place warning signs and/or barricades around the unloading area. Locate and inspect PPE and any portable containment devices which may be used. Locate and check the eyewash and safety showers to be certain they are operating properly.
2. Unless the truck's compressor is being used for unloading, turn off the engine and remove the keys to ensure the truck will not be moved prematurely.
3. While wearing full PPE and using fall protection, relieve any pressure or vacuum in the tank trailer by opening the air vent valve, making sure that the valve discharge is pointed away from all personnel. Open the fill hatch cover by first loosening, but not removing, all the bolts. Lift the cover slightly with the opening away from all personnel to ensure there is no pressure, spray, or other problems. Take any necessary samples, and confirm that the contents are suitable for unloading.
4. Secure the fill hatch to prevent any air leaks if air pad unloading or open the fill hatch as a vent for pump or gravity unloading. Fill hatch securement bolts should be evenly torqued using a star pattern when tightening.
5. Make sure the storage tank is adequately vented to handle the air pressure surge (air pad unloading) that occurs when the tank trailer is empty and depressured.
6. Verify the internal foot valve and auxiliary valve are closed and that the bonnet on the auxiliary valve is tight *before* removing the valve cap. The unloader should position his/her body and open the cap as if there were caustic potash in the unloading line, just in case some material may have leaked through the valve(s) during transit.
7. During cool ambient temperatures, it may be necessary to thaw frozen chemical residue inside the valve cavity before unloading begins. Tank trailer outlet valves are not insulated and are often the first areas to exhibit frozen chemical during cold weather events. Application of low pressure steam (15 psig or less) to the exterior of the outlet valve for a few minutes is generally effective at thawing frozen valves. See general steaming guidance in the Tank Car General Steaming Guidelines section of this manual.
8. Attach the transfer hose to the tank trailer and to the facility's receiving pipeline connector. Lock or strap the "ears" on all quick connect fittings to ensure that they do not accidentally open during the unloading operation. **If pump unloading, make sure the fill hatch is open to vent the tank trailer and prevent damage and possible collapse.** If air pad unloading, connect the air lines and be sure to use safety pins on all quick couple fittings.
9. Open the valves on the unloading lines. Open the auxiliary, then internal valves, on the tank trailer. Start the unloading pump or open the compressed air line depending on the unloading system. Monitor the tank pressure in the air pad unloading system, keeping it below 25 psig.
10. When the caustic potash transfer is complete, shut off the pump or air pad. The level in the tank trailer can be seen through the open fill hatch with pump unloading. If air pad unloading, the hose will jump or surge when the tank trailer is empty. Continue unloading for 3 to 4 minutes after this starts to ensure the hose and piping are empty. Shut off the air flow source and allow the tank trailer pressure to bleed down through the caustic potash unloading hose; disconnect the air hose.
11. Once the unloading hose and piping are empty, close the internal valve on the caustic potash tank trailer, the auxiliary valve, and finally the valve on the receiving piping. Make sure any pressure in the hose is bled off, using the drain valve located on the receiving pipeline prior to closing pipeline valves. Disconnect the hose first at the unloading line and then from the tank trailer. Drain any caustic potash residue into an appropriate caustic potash containment area.
12. Wash down the trailer, hose, other equipment, and the containment area to remove any caustic potash residue or other materials. Make sure all wash water and any spilled material is collected and handled appropriately. Verify all tank trailer valves are closed. Close and secure the fill hatch lid if it was opened. Properly stow unloading hoses. Verify the pipe cap or plug is secured in place on the tank trailer outlet valve and receiving pipeline.

Barge Unloading

While there are many similarities between barge unloading and tank car unloading, barge operations involve different regulatory agencies and potential hazards associated with the waterways. Detailed information on caustic potash barges, barge handling facilities and procedures, and the regulatory agencies involved is available from **The Chlorine Institute** *Pamphlet 80, Recommended Practices for Handling Sodium Hydroxide and Potassium Hydroxide Solution (Caustic) Barges* at www.chlorineinstitute.org.

General Information

Receipt of caustic potash by barge requires careful coordination between supplier, user, and various authorities having jurisdiction over the

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facilities. In the U.S., the Army Corps of Engineers has responsibility for maintaining navigation channels while the Coast Guard enforces the DOT regulations governing vessels, waterfront facilities (up to the first valve within containment), and unloading personnel. Other authorities may also be involved. Canadian barge customers should seek guidance from Transport Canada for applicable regulations.

The U.S. Coast Guard requires that a designated Person-In-Charge of the facilities (PIC-facilities) and a Person-In-Charge of the vessel (PIC-vessel) be assigned and present during the entire unloading operation. There are specific requirements that must be met to qualify as the Person-In-Charge. Contact the Coast Guard or your federal regulatory agency, e.g., Transport Canada for Canadian facilities, if there are any questions about these qualifications.

Prior to unloading, various items should be checked including:

- Documentation, labels, and markings.
- Barge equipment including pumps, piping, connections, mooring lines, transfer hoses.
- Barge void spaces for the presence of water.
- Emergency equipment, navigation aids and containment devices.
- Testing and certification information. The Coast Guard requires that the hose and lines up to the first valve within the containment be tested regularly and that the pressure indicator be calibrated at least yearly.
- Certifications for all Persons-in-Charge are current.

Unloading Facilities

Special care must be given to the design of barge unloading facilities. In particular, it is essential to prevent the accidental discharge of caustic potash into the waterways. This especially applies to the contents of transfer lines at the end of the unloading procedure.

Unloading Procedures

Personnel safety and protection of the environment is of utmost importance when unloading caustic potash barges. The following items should be included in all barge unloading procedures:

- Use all applicable personal protective equipment (see Personal Protection section).
- The emergency shutdown system is tested and in good working order before unloading starts.
- Cargo line connections are secured with the correct bolts and properly sized drip pans placed under each connection.
- After a joint inspection, the PICs complete a Declaration of Inspection.
- The unloading operation is monitored at all times for leaks and is carried out to ensure that the vessel does not list (tilt) excessively in the water. Listing can lead to broken mooring ropes, stopping the unloading flow before the barge is empty (starving the pump suction), and in extreme cases, submerging of deck areas.
- Secure the piping and cargo tanks after the barge is unloaded. It is particularly important to make sure any product residues are properly cleaned from the barge and that barge manifold piping is drained to prevent any caustic potash from freezing in the lines.
- A final inspection of barge and unloading facilities is required before the barge is released. A written format is advisable for follow up and record keeping. **As the legal "shipper of record," you are responsible for ensuring the barge is prepared for safe return shipment before release to the carrier. Failure to adequately prepare the barge may result in you accruing regulatory fines determined by the U.S. Coast Guard or Transport Canada.**

Technical Data

Caustic potash is produced from a purified salt water solution (undissolved chicklets shown above) using the electrochemical process.

If the technical information you need is not included in this manual, please contact your Olin representative.

Tables

Charts

Sampling

Careful sampling is essential for accurate analysis of caustic potash. Exposure of samples to air must be minimized, since caustic potash rapidly absorbs water and carbon dioxide.

When shipping container samples are required, top-sampling of tank trailers and tank cars is preferred and should incorporate the use of an elevated platform with fall protection provisions. Sample collection and testing should be performed by wearing proper PPE as determined by a qualified safety or industrial hygiene professional. To ensure the most representative sample, the shipping container should be profiled using a sample thief, which will allow all levels of the vessel to be evaluated. If shipping containers must be sampled from the bottom, the first material withdrawn should be discarded. Minor amounts of scale and other foreign material may be present in the shipping container piping, but will not be representative of delivery. Since frozen caustic potash will have different product and impurity concentrations, it should be thoroughly thawed before sampling.

Caustic potash samples should be transferred to clean, dry polyethylene sample bottles. Glass containers should not be used, as caustic potash will tend to etch the glass.

Table 1: Physical Constants of Pure Potassium Hydroxide (KOH)*

Molecular Weight	56.106
Boiling Point, 1 atm	
K	1,600
°C	1,327
°F	2,421
Freezing Point (Melting Point)	
K	633
°C	360
°F	680
Latent Heat of Fusion (ΔH_{fus})	
Cal/mol	2,000
Heat of Formation ($\Delta H°$)	
kcal/mol	(-102)
Heat of Vaporization	
Cal/mol	30,850
Specific Gravity (25 °C/4 °C)[7]	2.04

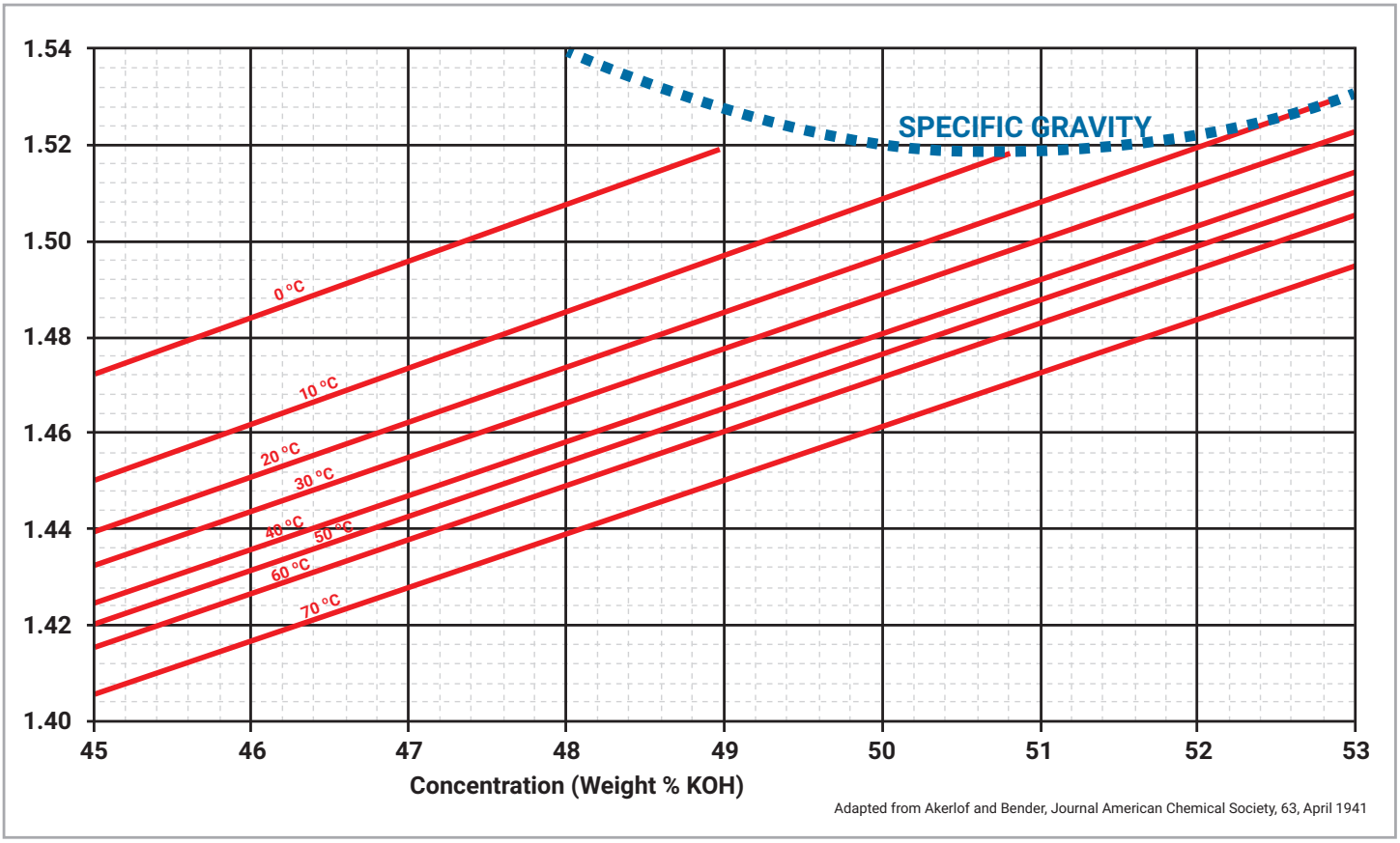
*Perry's Chemical Engineer's Handbook, 8th Ed.

Methods of Analysis

Olin recommends the ASTM methods of analysis for caustic potash. These are published as E 291 (Vol. 22) "Chemical Analysis of Caustic Potash and Caustic Soda (Sodium Hydroxide and Potassium Hydroxide)."

E 291 gives methods for Total Alkalinity, Carbonate, Chloride, Iron, and Sulfate. The methods are such that almost any well-equipped laboratory can perform these analyses. These methods are adequate and suitable for most quality control and process purposes. If other methods are required, contact your Olin representative.

Chart 1: Specific Gravity of KOH Solutions at Various Temperatures



Adapted from Akerlof and Bender, Journal American Chemical Society, 63, April 1941

Table 2: Density Chart for KOH Solutions - SI Units (kg solution/m^3 solution)

wt% KOH	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C
44.0	1460.3	1450.5	1439.8	1432.7	1424.9	1420.7	1415.9	1406.0
44.1	1461.5	1451.6	1440.9	1433.8	1426.0	1421.8	1417.0	1407.1
44.2	1462.6	1452.8	1442.1	1434.9	1427.1	1422.9	1418.1	1408.2
44.3	1463.8	1454.0	1443.2	1436.1	1428.2	1424.0	1419.2	1409.3
44.4	1465.0	1455.1	1444.3	1437.2	1429.3	1425.1	1420.3	1410.4
44.5	1466.2	1456.3	1445.5	1438.3	1430.5	1426.3	1421.5	1411.5
44.6	1467.3	1457.4	1446.6	1439.4	1431.6	1427.4	1422.6	1412.6
44.7	1468.5	1458.6	1447.7	1440.6	1432.7	1428.5	1423.7	1413.7
44.8	1469.7	1459.7	1448.9	1441.7	1433.8	1429.6	1424.8	1414.8
44.9	1470.9	1460.9	1450.0	1442.8	1434.9	1430.7	1425.9	1415.9
45.0	1472.1	1462.1	1451.2	1444.0	1436.1	1431.9	1427.1	1417.1
45.1	1473.2	1463.2	1452.3	1445.1	1437.2	1433.0	1428.2	1418.2
45.2	1474.4	1464.4	1453.4	1446.2	1438.3	1434.1	1429.3	1419.3
45.3	1475.6	1465.5	1454.6	1447.3	1439.4	1435.2	1430.4	1420.4
45.4	1476.8	1466.7	1455.7	1448.5	1440.5	1436.3	1431.5	1421.5
45.5	1478.0	1467.9	1456.9	1449.6	1441.7	1437.5	1432.7	1422.6
45.6	1479.1	1469.0	1458.0	1450.7	1442.8	1438.6	1433.8	1423.7
45.7	1480.3	1470.2	1459.2	1451.9	1443.9	1439.7	1434.9	1424.8
45.8	1481.5	1471.4	1460.3	1453.0	1445.0	1440.8	1436.0	1426.0
45.9	1482.7	1472.5	1461.4	1454.1	1446.2	1442.0	1437.2	1427.1
46.0	1483.9	1473.7	1462.6	1455.3	1447.3	1443.1	1438.3	1428.2
46.1	1485.1	1474.8	1463.7	1456.4	1448.4	1444.2	1439.4	1429.3
46.2	1486.3	1476.0	1464.9	1457.6	1449.5	1445.3	1440.5	1430.4
46.3	1487.4	1477.2	1466.0	1458.7	1450.7	1446.5	1441.7	1431.5
46.4	1488.6	1478.4	1467.2	1459.8	1451.8	1447.6	1442.8	1432.7
46.5	1489.8	1479.5	1468.3	1461.0	1452.9	1448.7	1443.9	1433.8
46.6	1491.0	1480.7	1469.5	1462.1	1454.1	1449.9	1445.1	1434.9
46.7	1492.2	1481.9	1470.6	1463.3	1455.2	1451.0	1446.2	1436.0
46.8	1493.4	1483.0	1471.8	1464.4	1456.3	1452.1	1447.3	1437.1
46.9	1494.6	1484.2	1472.9	1465.5	1457.4	1453.2	1448.4	1438.3
47.0	1495.8	1485.4	1474.1	1466.7	1458.6	1454.4	1449.6	1439.4
47.1	1497.0	1486.5	1475.2	1467.8	1459.7	1455.5	1450.7	1440.5
47.2	1498.2	1487.7	1476.4	1469.0	1460.8	1456.6	1451.8	1441.6
47.3	1499.4	1488.9	1477.5	1470.1	1462.0	1457.8	1453.0	1442.7
47.4	1500.6	1490.1	1478.7	1471.3	1463.1	1458.9	1454.1	1443.9
47.5	1501.7	1491.2	1479.8	1472.4	1464.2	1460.0	1455.2	1445.0
47.6	1502.9	1492.4	1481.0	1473.5	1465.4	1461.2	1456.4	1446.1
47.7	1504.1	1493.6	1482.2	1474.7	1466.5	1462.3	1457.5	1447.2
47.8	1505.3	1494.8	1483.3	1475.8	1467.7	1463.5	1458.7	1448.4
47.9	1506.5	1495.9	1484.5	1477.0	1468.8	1464.6	1459.8	1449.5
48.0	1507.7	1497.1	1485.6	1478.1	1469.9	1465.7	1460.9	1450.6
48.1	1508.9	1498.3	1486.8	1479.3	1471.1	1466.9	1462.1	1451.8
48.2	1510.1	1499.5	1487.9	1480.4	1472.2	1468.0	1463.2	1452.9
48.3	1511.3	1500.7	1489.1	1481.6	1473.3	1469.1	1464.3	1454.0
48.4	1512.5	1501.8	1490.3	1482.7	1474.5	1470.3	1465.5	1455.1
48.5	1513.7	1503.0	1491.4	1483.9	1475.6	1471.4	1466.6	1456.3
48.6	1514.9	1504.2	1492.6	1485.0	1476.8	1472.6	1467.8	1457.4
48.7	1516.1	1505.4	1493.7	1486.2	1477.9	1473.7	1468.9	1458.5
48.8	1517.3	1506.6	1494.9	1487.3	1479.0	1474.8	1470.0	1459.7
48.9	1518.5	1507.7	1496.1	1488.5	1480.2	1476.0	1471.2	1460.8

Table 2: Density Chart for KOH Solutions - SI Units (kg solution/m³ solution) - Continued

wt% KOH	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C
49.0	1519.7	1508.9	1497.2	1489.6	1481.3	1477.1	1472.3	1461.9
49.1	1520.9	1510.1	1498.4	1490.8	1482.5	1478.3	1473.5	1463.1
49.2	1522.1	1511.3	1499.6	1491.9	1483.6	1479.4	1474.6	1464.2
49.3	1523.3	1512.5	1500.7	1493.1	1484.8	1480.6	1475.8	1465.3
49.4	–	1513.7	1501.9	1494.3	1485.9	1481.7	1476.9	1466.5
49.5	–	1514.9	1503.1	1495.4	1487.1	1482.9	1478.1	1467.6
49.6	–	1516.1	1504.2	1496.6	1488.2	1484.0	1479.2	1468.8
49.7	–	1517.2	1505.4	1497.7	1489.4	1485.2	1480.4	1469.9
49.8	–	1518.4	1506.6	1498.9	1490.5	1486.3	1481.5	1471.0
49.9	–	1519.6	1507.7	1500.0	1491.7	1487.5	1482.7	1472.2
50.0	–	1520.8	1508.9	1501.2	1492.8	1488.6	1483.8	1473.3
50.1	–	1522.0	1510.1	1502.4	1494.0	1489.8	1485.0	1474.4
50.2	–	1523.2	1511.2	1503.5	1495.1	1490.9	1486.1	1475.6
50.3	–	1524.4	1512.4	1504.7	1496.3	1492.1	1487.3	1476.7
50.4	–	1525.5	1513.6	1505.9	1497.4	1493.2	1488.4	1477.9
50.5	–	1526.7	1514.8	1507.0	1498.6	1494.4	1489.6	1479.0
50.6	–	1527.9	1515.9	1508.2	1499.7	1495.5	1490.7	1480.2
50.7	–	1529.1	1517.1	1509.3	1500.9	1496.7	1491.9	1481.3
50.8	–	–	1518.3	1510.5	1502.0	1497.8	1493.0	1482.4
50.9	–	–	1519.5	1511.7	1503.2	1499.0	1494.2	1483.6
51.0	–	–	1520.6	1512.8	1504.3	1500.1	1495.3	1484.7
51.1	–	–	1521.8	1514.0	1505.5	1501.3	1496.5	1485.9
51.2	–	–	1523.0	1515.2	1506.6	1502.4	1497.6	1487.0
51.3	–	–	1524.2	1516.3	1507.8	1503.6	1498.8	1488.2
51.4	–	–	1525.3	1517.5	1509.0	1504.8	1500.0	1489.3
51.5	–	–	1526.5	1518.7	1510.1	1505.9	1501.1	1490.5
51.6	–	–	1527.7	1519.8	1511.3	1507.1	1502.3	1491.6
51.7	–	–	1528.9	1521.0	1512.4	1508.2	1503.4	1492.8
51.8	–	–	1530.1	1522.2	1513.6	1509.4	1504.6	1493.9
51.9	–	–	1531.2	1523.4	1514.8	1510.6	1505.8	1495.1
52.0	–	–	1532.4	1524.5	1515.9	1511.7	1506.9	1496.2

Adapted and interpolated from Akerlof and Bender, Journal American Chemical Society, 63, April, 1941.

Technical Data

Table 3: Density Chart for KOH Solutions - English Units (0 to 52 %, English Units)

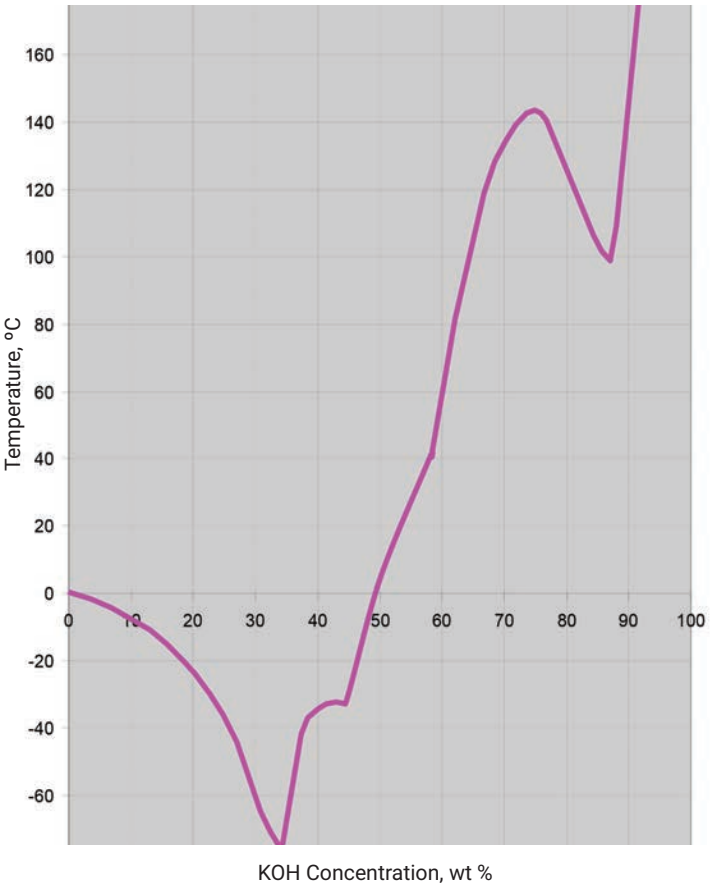
wt % KOH	32 °F		50 °F		68 °F		86 °F		104 °F		122 °F		140 °F		158°F	
	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.	lbs. sol./ gal.	lbs. KOH/ gal.
0	8.3	0.00	8.3	0.00	8.3	0.00	8.3	0.00	8.3	0.00	8.2	0.00	8.2	0.00	8.2	0.00
1	8.4	0.08	8.4	0.08	8.4	0.08	8.4	0.08	8.4	0.08	8.3	0.08	8.3	0.08	8.2	0.08
2	8.5	0.17	8.5	0.17	8.5	0.17	8.5	0.17	8.4	0.17	8.4	0.17	8.4	0.17	8.3	0.17
3	8.6	0.26	8.6	0.26	8.6	0.26	8.5	0.26	8.5	0.26	8.5	0.25	8.4	0.25	8.4	0.25
4	8.7	0.35	8.7	0.35	8.6	0.35	8.6	0.34	8.6	0.34	8.5	0.34	8.5	0.34	8.4	0.34
5	8.7	0.44	8.7	0.44	8.7	0.44	8.7	0.43	8.6	0.43	8.6	0.43	8.6	0.43	8.5	0.43
6	8.8	0.53	8.8	0.53	8.8	0.53	8.8	0.53	8.7	0.52	8.7	0.52	8.6	0.52	8.6	0.52
7	8.9	0.62	8.9	0.62	8.9	0.62	8.8	0.62	8.8	0.62	8.8	0.61	8.7	0.61	8.7	0.61
8	9.0	0.72	9.0	0.72	8.9	0.71	8.9	0.71	8.9	0.71	8.8	0.71	8.8	0.70	8.7	0.70
9	9.1	0.82	9.0	0.81	9.0	0.81	9.0	0.81	8.9	0.80	8.9	0.80	8.9	0.80	8.8	0.79
10	9.1	0.91	9.1	0.91	9.1	0.91	9.1	0.91	9.0	0.90	9.0	0.90	8.9	0.89	8.9	0.89
11	9.2	1.01	9.2	1.01	9.2	1.01	9.1	1.00	9.1	1.00	9.1	1.00	9.0	0.99	9.0	0.99
12	9.3	1.12	9.3	1.11	9.2	1.11	9.2	1.11	9.2	1.10	9.1	1.10	9.1	1.09	9.0	1.08
13	9.4	1.22	9.4	1.22	9.3	1.21	9.3	1.21	9.2	1.20	9.2	1.20	9.2	1.19	9.1	1.19
14	9.5	1.33	9.4	1.32	9.4	1.32	9.4	1.31	9.3	1.31	9.3	1.30	9.3	1.30	9.2	1.29
15	9.6	1.43	9.5	1.43	9.5	1.42	9.4	1.42	9.4	1.41	9.4	1.41	9.3	1.40	9.3	1.39
16	9.6	1.54	9.6	1.54	9.6	1.53	9.5	1.52	9.5	1.52	9.4	1.51	9.4	1.51	9.3	1.50
17	9.7	1.65	9.7	1.65	9.6	1.64	9.6	1.63	9.6	1.63	9.5	1.62	9.5	1.61	9.4	1.60
18	9.8	1.77	9.8	1.76	9.7	1.75	9.7	1.74	9.6	1.74	9.6	1.73	9.6	1.72	9.5	1.71
19	9.9	1.88	9.9	1.87	9.8	1.86	9.8	1.86	9.7	1.85	9.7	1.84	9.6	1.83	9.6	1.82
20	10.0	2.00	9.9	1.99	9.9	1.98	9.8	1.97	9.8	1.96	9.8	1.95	9.7	1.95	9.7	1.93
21	10.1	2.11	10.0	2.10	10.0	2.09	9.9	2.09	9.9	2.08	9.9	2.07	9.8	2.06	9.7	2.05
22	10.2	2.23	10.1	2.22	10.1	2.21	10.0	2.20	10.0	2.19	9.9	2.19	9.9	2.18	9.8	2.16
23	10.2	2.36	10.2	2.34	10.1	2.33	10.1	2.32	10.0	2.31	10.0	2.30	10.0	2.29	9.9	2.28
24	10.3	2.48	10.3	2.47	10.2	2.45	10.2	2.44	10.1	2.43	10.1	2.42	10.1	2.41	10.0	2.40
25	10.4	2.60	10.4	2.59	10.3	2.58	10.3	2.57	10.2	2.55	10.2	2.55	10.1	2.53	10.1	2.52
26	10.5	2.73	10.5	2.72	10.4	2.70	10.3	2.69	10.3	2.68	10.3	2.67	10.2	2.66	10.2	2.64
27	10.6	2.86	10.5	2.85	10.5	2.83	10.4	2.82	10.4	2.80	10.3	2.79	10.3	2.78	10.2	2.76
28	10.7	2.99	10.6	2.98	10.6	2.96	10.5	2.95	10.5	2.93	10.4	2.92	10.4	2.91	10.3	2.89
29	10.8	3.12	10.7	3.11	10.7	3.09	10.6	3.08	10.6	3.06	10.5	3.05	10.5	3.04	10.4	3.02
30	10.9	3.26	10.8	3.24	10.7	3.22	10.7	3.21	10.6	3.19	10.6	3.18	10.6	3.17	10.5	3.15
31	11.0	3.40	10.9	3.38	10.8	3.36	10.8	3.34	10.7	3.32	10.7	3.31	10.6	3.30	10.6	3.28
32	11.0	3.53	11.0	3.52	10.9	3.49	10.9	3.48	10.8	3.46	10.8	3.45	10.7	3.44	10.7	3.41
33	11.1	3.68	11.1	3.65	11.0	3.63	11.0	3.62	10.9	3.60	10.9	3.59	10.8	3.57	10.8	3.55
34	11.2	3.82	11.2	3.80	11.1	3.77	11.0	3.75	11.0	3.74	11.0	3.72	10.9	3.71	10.8	3.68
35	11.3	3.96	11.3	3.94	11.2	3.91	11.1	3.90	11.1	3.88	11.0	3.86	11.0	3.85	10.9	3.82
36	11.4	4.11	11.4	4.09	11.3	4.06	11.2	4.04	11.2	4.02	11.1	4.01	11.1	3.99	11.0	3.96
37	11.5	4.26	11.4	4.23	11.4	4.21	11.3	4.19	11.3	4.16	11.2	4.15	11.2	4.14	11.1	4.11
38	11.6	4.41	11.5	4.38	11.5	4.35	11.4	4.33	11.3	4.31	11.3	4.30	11.3	4.28	11.2	4.25
39	11.7	4.56	11.6	4.54	11.5	4.50	11.5	4.48	11.4	4.46	11.4	4.45	11.4	4.43	11.3	4.40
40	11.8	4.72	11.7	4.69	11.6	4.66	11.6	4.63	11.5	4.61	11.5	4.60	11.4	4.58	11.4	4.55
41	11.9	4.88	11.8	4.85	11.7	4.81	11.7	4.79	11.6	4.76	11.6	4.75	11.5	4.73	11.5	4.70
42	12.0	5.04	11.9	5.00	11.8	4.97	11.8	4.94	11.7	4.92	11.7	4.90	11.6	4.89	11.6	4.85
43	12.1	5.20	12.0	5.16	11.9	5.13	11.9	5.10	11.8	5.07	11.8	5.06	11.7	5.04	11.6	5.01
44	12.2	5.36	12.1	5.33	12.0	5.29	12.0	5.26	11.9	5.23	11.9	5.22	11.8	5.20	11.7	5.16
45	12.3	5.53	12.2	5.49	12.1	5.45	12.1	5.42	12.0	5.39	11.9	5.38	11.9	5.36	11.8	5.32
46	12.4	5.70	12.3	5.66	12.2	5.61	12.1	5.59	12.1	5.56	12.0	5.54	12.0	5.52	11.9	5.48
47	12.5	5.87	12.4	5.83	12.3	5.78	12.2	5.75	12.2	5.72	12.1	5.70	12.1	5.69	12.0	5.65
48	12.6	6.04	12.5	6.00	12.4	5.95	12.3	5.92	12.3	5.89	12.2	5.87	12.2	5.85	12.1	5.81
49	12.7	6.21	12.6	6.17	12.5	6.12	12.4	6.09	12.4	6.06	12.3	6.04	12.3	6.02	12.2	5.98
50			12.7	6.35	12.6	6.30	12.5	6.26	12.5	6.23	12.4	6.21	12.4	6.19	12.3	6.15
51					12.7	6.47	12.6	6.44	12.6	6.40	12.5	6.38	12.5	6.36	12.4	6.32
52					12.8	6.65	12.7	6.62	12.7	6.58	12.6	6.56	12.6	6.54	12.5	6.49

*Adapted from Akerlof and Bender, Journal American Chemical Society, 63, April, 1941.

Caustic Potash Phase Diagram

Caustic potash has two eutectic points. These points, sometimes called minimum freezing points, define the caustic potash concentrations that will not undergo partial freezing as they are cooled. Since caustic potash solutions at these concentrations continue to behave as a liquid instead of a slurry at temperatures down to the actual freezing point, they are generally easier to handle. A 34 % solution of caustic potash freezes at the lowest temperature, -104.8 ºF (-76 ºC). The most prevalent solution strengths have freeze points of negative 22 ºF (- 30 ºC) and 39 ºF (4 ºC), for 45 and 50 % solutions, respectively.

Chart 2: Caustic Potash Freeze Point Curve



Viscosity of Caustic Potash Solutions

Table 4: Viscosity (cps) of Aqueous KOH (wt %) Solutions

Temp. °C	5 %	10 %	15 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
0	1.9	2.1	2.4	2.7	3.2	4.0	5.3	7.5	11.8	19.9
20	1.1	1.2	1.4	1.6	2.0	2.4	3.1	4.1	6.2	8.7
25	0.98	1.1	1.2	1.5	1.8	2.2	2.7	3.6	5.3	7.3
30	0.89	1.0	1.1	1.3	1.6	2.0	2.5	3.2	4.6	6.3
35	0.81	0.91	1.0	1.2	1.5	1.8	2.2	2.8	4.0	5.5
40	0.73	0.83	0.95	1.1	1.3	1.6	2.0	2.5	3.5	4.8
45	0.67	0.77	0.87	1.0	1.2	1.5	1.8	2.3	3.1	4.2
50	0.62	0.71	0.81	0.94	1.1	1.4	1.7	2.1	2.8	3.8
55	0.57	0.66	0.75	0.88	1.0	1.3	1.5	1.9	2.5	3.4
60	0.53	0.61	0.70	0.82	0.96	1.2	1.4	1.8	2.2	3.1
65	0.50	0.57	0.66	0.76	0.90	1.1	1.3	1.6	2.0	2.8
70	0.47	0.53	0.62	0.72	0.84	1.0	1.2	1.5	1.9	2.5
75	0.44	0.50	0.58	0.67	0.79	0.94	1.1	1.4	1.7	2.3
80	0.41	0.47	0.55	0.63	0.74	0.88	1.1	1.3	1.6	2.2
85	0.39	0.44	0.52	0.60	0.70	0.83	1.0	1.2	1.5	2.0
90	0.36	0.42	0.49	0.57	0.66	0.78	0.94	1.2	1.4	1.9
100	0.33	0.38	0.44	0.51	0.59	0.70	0.84	1.0	1.2	1.6
110	0.30	0.34	0.40	0.46	0.54	0.63	0.76	0.92	1.1	1.4
120	0.27	0.31	0.36	0.42	0.49	0.58	0.69	0.83	1.0	1.3
130	0.25	0.28	0.33	0.38	0.45	0.53	0.63	0.76	0.93	1.2
140	0.23	0.26	0.30	0.35	0.41	0.49	0.58	0.70	0.86	1.0
150	0.21	0.24	0.28	0.33	0.38	0.45	0.54	0.64	0.79	0.95
160	0.20	0.23	0.26	0.31	0.36	0.42	0.50	0.60	0.73	0.88
170	0.19	0.21	0.25	0.29	0.34	0.39	0.47	0.56	0.68	0.81
180	0.18	0.20	0.23	0.27	0.32	0.37	0.44	0.52	0.63	0.76
190	0.17	0.19	0.22	0.25	0.30	0.35	0.41	0.49	0.59	0.71
200	0.16	0.18	0.21	0.24	0.28	0.33	0.39	0.46	0.55	0.67
210	0.15	0.17	0.20	0.23	0.27	0.31	0.37	0.44	0.52	0.63
220	0.14	0.17	0.19	0.22	0.25	0.30	0.35	0.41	0.49	0.60
230	0.14	0.16	0.18	0.21	0.24	0.28	0.33	0.39	0.47	0.57
240	0.13	0.15	0.17	0.20	0.23	0.27	0.32	0.37	0.45	0.54
250	0.12	0.14	0.17	0.19	0.22	0.26	0.30	0.36	0.43	0.51
260	0.12	0.14	0.16	0.18	0.21	0.25	0.29	0.34	0.41	0.47
270	0.11	0.13	0.15	0.17	0.20	0.23	0.27	0.32	0.37	0.44
275	0.11	0.13	0.15	0.17	0.20	0.23	0.27	0.31	0.36	0.42

- Table generated using data from both Puchkov and Sargaev. Raw data was normalized using Natural Logs.
- The data point at 50% and 0°C is shown only for illustration and interpolation. The solution should be frozen at these conditions.

Technical Data

Table 5a: Dilution of 45 % KOH Solutions

KOH Concentration Desired (Weight %)	To Obtain Indicated Concentrations Add:		Diluted Volume (Value x original KOH Volume)
	kg water per kg 45 % KOH	vol. water per vol. 45 % KOH	
1	43.91	63.85	64.68
2	21.46	31.20	32.06
3	13.97	20.32	21.19
4	10.23	14.87	15.76
5	7.98	11.61	12.50
6	6.49	9.43	10.33
7	5.42	7.88	8.78
8	4.62	6.71	7.61
9	3.99	5.80	6.71
10	3.49	5.08	5.99
11	3.08	4.49	5.40
12	2.74	3.99	4.91
13	2.46	3.57	4.49
14	2.21	3.21	4.13
15	2.00	2.90	3.83
16	1.81	2.63	3.56
17	1.64	2.39	3.32
18	1.50	2.18	3.11
19	1.37	1.99	2.92
20	1.25	1.81	2.75
21	1.14	1.66	2.60
22	1.04	1.52	2.46
23	0.95	1.39	2.33
24	0.87	1.27	2.22
25	0.80	1.16	2.11
26	0.73	1.06	2.02
27	0.67	0.97	1.92
28	0.61	0.88	1.84
29	0.55	0.80	1.76
30	0.50	0.73	1.69
31	0.45	0.66	1.62
32	0.41	0.59	1.56
33	0.36	0.53	1.50
34	0.32	0.47	1.44
35	0.29	0.41	1.39
36	0.25	0.36	1.34
37	0.22	0.31	1.30
38	0.18	0.27	1.25
39	0.15	0.22	1.21
40	0.12	0.18	1.17
41	0.10	0.14	1.13
42	0.07	0.10	1.10
43	0.05	0.07	1.06
44	0.02	0.03	1.03
45	0.00	0.00	1.00

Table 5b: Dilution of 50 % KOH Solutions

KOH Concentration Desired (Weight %)	To Obtain Indicated Concentrations Add:		Diluted Volume (Value x original KOH Volume)
	kg water per kg 50 % KOH	vol. water per vol. 50 % KOH	
1	48.90	73.94	74.73
2	23.95	36.21	37.04
3	15.64	23.64	24.48
4	11.48	17.35	18.20
5	8.98	13.58	14.44
6	7.32	11.07	11.93
7	6.13	9.27	10.14
8	5.24	7.92	8.80
9	4.55	6.87	7.75
10	3.99	6.04	6.92
11	3.54	5.35	6.24
12	3.16	4.78	5.67
13	2.84	4.29	5.19
14	2.57	3.88	4.78
15	2.33	3.52	4.42
16	2.12	3.21	4.11
17	1.94	2.93	3.84
18	1.77	2.68	3.59
19	1.63	2.46	3.38
20	1.50	2.26	3.18
21	1.38	2.08	3.00
22	1.27	1.92	2.84
23	1.17	1.77	2.70
24	1.08	1.63	2.56
25	1.00	1.51	2.44
26	0.92	1.39	2.33
27	0.85	1.29	2.22
28	0.78	1.19	2.13
29	0.72	1.09	2.04
30	0.67	1.01	1.95
31	0.61	0.92	1.87
32	0.56	0.85	1.80
33	0.51	0.78	1.73
34	0.47	0.71	1.67
35	0.43	0.65	1.61
36	0.39	0.59	1.55
37	0.35	0.53	1.50
38	0.32	0.48	1.45
39	0.28	0.43	1.40
40	0.25	0.38	1.35
41	0.22	0.33	1.31
42	0.19	0.29	1.27
43	0.16	0.25	1.23
44	0.14	0.21	1.19
45	0.11	0.17	1.16
46	0.09	0.13	1.12
47	0.06	0.10	1.09
48	0.04	0.06	1.06
49	0.02	0.03	1.03
50	0.00	0.00	1.00

Unit Conversions

Converting English to SI units

Table 6: Conversion to SI Units

Quantity	To Convert From	To	Multiply By
Heat	Btu[a]	joule (J)	1054.35
Enthalpy	Btu[a]/pound-mass	joule/kilogram (J/kg)	2324.444
Viscosity	centipoises (cp)	pascal-second (Pa*s)	0.001
Volume	gallon[b]	cubic meter (m^3)	0.0037854
Length	inch (in)	meter (m)	0.0254
Pressure	pound-force/$inch^2$ (psi)	pascal (Pa)	6894.757
Mass	pound-mass (lbm[c])	kilogram (kg)	0.4536

NOTE: To convert from SI to English system, multiply the SI unit by the reciprocal (1/x) of the factor in Column 4. A more complete table of conversion factors can be found in the Standard Metric Practice Guide (A Guide to the Use of SI – the International System of Units), ASTM E-380.

[a] thermochemical
[b] U.S. liquid
[c] avoirdupois

Temperature Conversions

To convert degree Fahrenheit (ºF) to degree Celsius (ºC):

$$ºC = (ºF - 32) \div 1.8$$

To convert degree Fahrenheit (ºF) to Kelvin (K):

$$K = (ºF + 459.67) \div 1.8$$

To convert degree Celsius (ºC) to degree Fahrenheit (ºF):

$$ºF = (ºC \times 1.8) + 32$$

To convert degree Celsius (ºC) to Kelvin (K):

$$K = 273.15 + ºC$$

Hydrometer Conversions

The following formulas can be used to convert hydrometer readings.

$$\text{Sp. Gr.} = \frac{145}{145 - \text{Bé}}$$

$$\text{Bé} = 145 - \frac{145}{\text{Sp. Gr.}}$$

The Chlorine Institute – Reference Pamphlets

The Chlorine Institute Information

The Chlorine Institute offers a wide variety of safety and technical information associated with Potassium Hydroxide. 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 caustic potash.

Pamphlet 80, "Recommended Practices for Handling Sodium Hydroxide Solution & Potassium Hydroxide Solution (Caustic) Barges" – Offers recommended practices for handling caustic potash barges.

Pamphlet 87, "Recommended Practices for Handling Sodium Hydroxide Solution & Potassium Hydroxide Solution Tank Cars" – Provides recommended practices for handling caustic potash tank cars.

Pamphlet 88, "Recommended Practices for Handling Sodium Hydroxide Solution & Potassium Hydroxide Solution Cargo Tanks" – Discusses recommended practices for handling caustic potash tank trailers.

Pamphlet 94, "Sodium Hydroxide & Potassium Hydroxide Solution (Caustic): Storage Equipment & Piping Systems" – Provides storage and piping guidance for caustic potash storage and pipelines.

Pamphlet 164, "Reactivity and Compatibility of Chlorine and Sodium Hydroxide with Various Materials" – Provides information concerning the compatibility of these two substances with a variety of materials and their reactivity with other chemicals.

In Case of Emergency

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 10 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.

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 caustic potash from spilling onto soil, storm sewers, or into waterways. Since it is a strong alkali with a high pH, caustic potash can threaten the survival of most wildlife, especially in aquatic environments.

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 will perform Response duties, activate the **Emergency Action Plan.**
  - If facility persons will perform Response duties, activate the **Emergency Response Plan.**

Step 2 – Suit Up and Remediate (only trained facility personnel or trained external personnel should perform these functions)

THESE STEPS SHOULD PERFORMED BY TRAINED, KNOWLEDGEABLE PERSONNEL ONLY!

- Suit up with appropriate PPE per SDS and never respond alone.
- Isolate and contain the spill with use of inert materials (ex: sand, dirt, etc.).
- Recover as much chemical as possible for reuse.
- 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 with weak, buffered acids.
- Decontaminate all equipment, PPE, and materials.
- Launder any clothing or jewelry prior to reuse.

Step 3 – Report

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

North America Contact Information

USA: +1 833 370 3737
Canada: +1 877 304 4442
Latin America: +55 115188 4105

Info@olin.com
www.OlinChlorAlkali.com

Emergency Telephone Numbers

(Chemical Incident Only)

USA: +1 800 424 93 00
Canada: +1 613 996 6666

Form No. 102-00559-1220PI