What every operator should know about sodium hypochlorite

Rob Baur

Knowledge	Principle	A practical consideration
Sodium hypochlorite	Sodium hypochlorite is chlorine gas dissolved in sodium hydroxide. This is essentially household bleach.	Sodium hypochlorite is a disinfectant that is liquid at room temperature and can be dosed with chemical feed pumps.
Hypochlorite chemistry	$Na^+ OCl^- + H_2O \rightarrow H^+ OCl^- + Na^+ OH^-$	Hypochlorite (OCl^-) is the disinfecting ion in this compound. The hydroxyl ion (OH^-) increases the solution's overall pH.
Sodium hydroxide	Sodium hydroxide (NaOH) is often called caustic soda.	This compound has an extremely high pH when dissolved in water.
Sodium hypochlorite strength	Common hypochlorite sold in stores (household bleach) is 5.25% chlorine since lower concentrations are more stable. Industrial hypochlorite is 12 to 15 trade percent chlorine.	Industrial strength hypochlorite concentration typically is measured in "trade percent." A 15 trade percent has specific gravity of 1.206, 150 g/L available chlorine, 1.25 lb of chlorine per gallon, a density of 10.06 lb/gal, and is 12.44% by weight available chlorine.
Gasification	Hypochlorite decomposes to oxygen gas and sodium chloride. ($NaOCl + NaOCl \rightarrow O_2 + 2\ NaCl$) Decomposition occurs faster at higher temperatures and concentrations and with metal contamination. If hypochlorite is exposed to acid, chlorine gas will be released.	Chlorine gas production can damage ball valves, isolated pipe sections, and pumps as well as result in loss of prime and "air locking" of pumps. To prevent gasification problems, use vented ball valves and high point air relief valves and flush lines when not in use. Pumps equipped with dosing monitors can sound alarms when they lose prime and activate vents to re-prime automatically.
Scaling	The high pH of hypochlorite causes calcium and magnesium in dilution water to precipitate as carbonate scale.	To avoid scaling, deliver hypochlorite neat (undiluted) to the point of application. If dilution water is required and calcium levels are significant, using softened water can eliminate scale.
PVC pipe	Polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) pipes both are resistant to damage from hypochlorite. CPVC has a higher temperature rating.	PVC is the cheaper alternative and is readily available.
PVC glue	Normal glue uses fumed silica (finely ground glass) for thickening. The high pH of the hypochlorite solution can dissolve the silica, leaving the glue joint porous and susceptible to leaks.	Use only glues rated for hypochlorite service, such as IPS 724 or equivalent. Follow gluing instructions exactly. Bevel pipe end, apply primer to socket, pipe, and then socket again. Apply glue to pipe, socket, and socket again. Assemble pipe pieces with a 1/4-turn twist.

Knowledge	Principle	A practical consideration
Threaded fittings	Avoid threaded fittings when using hypochlorite. Use flanged fittings instead.	Hypochlorite will leak through threaded fittings even when Teflon® tape is used to seal the joint.
Corrosion	The high pH of hypochlorite will attack metals. It will generate hydrogen gas when in contact with aluminum.	Pipe leaks can emit chlorine gas and cause corrosion on nearby metal. Use only plastic, fiberglass, or stainless steel materials nearby.
Decomposition	Metal contact causes catalytic decomposition of hypochlorite to oxygen gas and sodium chloride.	Do not use any metallic parts in contact with hypochlorite.
Safety	Unless flushed, drained, or vented, off-line equipment may generate significant pressure from gasification that may be released explosively. Splashes, spills, and leaks may occur. Hypochlorite contact with clothing will result in holes and bleaching.	Flush or drain off-line equipment. Be aware of potential pressurization. Flush equipment prior to maintenance. Always wear appropriate personal protective equipment.
Design	Anticipate gasification and pressure buildup potential. Design with safety in mind.	Avoid pipe sections that can be isolated with valves and trap gas buildup. Provide flushing connections so equipment can be maintained without contact with hypochlorite.
Mixing	Rapid mixing provides good contact and prevents localized breakpoint reactions.	Flash mixers enable rapid mixing without adding dilution water that could lead to scale. An air gap between the flash mixer suction and the hypochlorite supply pipe is needed to prevent mixer suction from boiling hypochlorite in the delivery line at low pressure.
Chemical interactions	Mixing anything with hypochlorite can be extremely dangerous. Contact between hypochlorite and other treatment plant chemicals such as alum, ferric, or sodium bisulfate, can cause an uncontrolled explosive release of energy, heat, and chlorine gas.	A mistake in chemical delivery can be disastrous. Delivery points should include locks, stringent procedures, and double-checks to prevent delivery into the wrong tank.
Onsite generation (low strength)	This process uses salt and electricity to generate hypochlorite at a 0.8% solution. Hypochlorite is very stable at such low concentrations.	This process requires a significant capital cost for installation as well as large volumes of onsite storage.
Onsite generation (high strength)	This process uses salt and electricity to generate chlorine gas and caustic soda. These compounds can be recombined to make 15% hypochlorite. Alternately, the chlorine gas can be used for disinfection and the caustic put to another use.	This process can use existing chlorine gas equipment and makes chlorine on-demand so only a few pounds of chlorine are in the system at any time. But it has a high capital cost and is a fairly complex system.
Storage	Hypochlorite attacks all tank materials except titanium.	Fiberglass tanks often are used, but they must be made of the proper resin and be cleaned and inspected every 3 to 5 years to monitor deterioration and repair damage. Tank replacement should be included in building design. Tanks should be as cool as possible to preserve hypochlorite and extend tank life. Polyethylene tanks also have a limited life span.

Rob Baur *is senior operations analyst at Clean Water Services (Hillsboro, Ore.).*