Application Note to the Field	Common Fluid – Pumping Sodium Hydroxide with Liquiflo Gear Pumps
Application Note Number: 0101-1	**Date:** Jan. 18, 2001; Revised Sept. 2022

Sodium hydroxide is one of the most commonly used industrial chemicals. It is the third most produced chemical in the U.S. and is often used in conjunction with sulfuric acid.

Sodium hydroxide (NaOH), or lye, is used in paper mills, water treatment plants, and any number of a variety of other places. It is very often used for pH control (to raise it) as it is very alkaline, or basic. It is often known as caustic soda or simply "caustic."

The most common concentration of NaOH is 50%, although it can range from trace to about 70%. At ambient temperature and up to 70% concentration, 316 SS has an "A" rating and can be used for the pump housings, shafts and drive gear. For temperatures up to 212°F (100°C) and concentrations up to 20%, 316 SS is acceptable. For the rare case of 20-70% concentration and temperatures above 170°F (76°C), Alloy-C becomes a requirement. The maximum practical temperature that a Liquiflo gear pump can be used on this product is about 248°F (120°C). 316 SS can stress-crack at 50% caustic, so if the pump in question is being operated near the edge of its performance envelope, it might be good to go to an Alloy-C drive gear, shafts and keys.

One thing to watch out for, especially at lower concentrations, is that the viscosity does not fall too low when the temperature rises. For example, 50% NaOH has a viscosity of ~ 87 cP at 77°F (25°C), but this drops to only 3 cP at 212°F (100°C). At caustic concentrations below 10%, the viscosity vs. temperature characteristic is close to that of water (see table on next page). Low viscosity could cause excessive slip and wear, especially with higher differential pressures. (Consult Liquiflo to determine if the application is feasible based on the conditions of service.)

Since sodium hydroxide does not attack or cause swelling of carbon or any plastic offered by Liquiflo, choices can be made based solely on mechanical considerations. However, to achieve the best performance and durability, Liquiflo highly suggests using bearing grade PEEK for the idler gear, Carbon for the bearings and wear plates, and Tungsten Carbide coated shafts.

For concentrations below 10%, a single mechanical seal can be used successfully; however, above this it is necessary to use either a properly supported double mechanical seal or a mag-drive pump. The reason for this is that caustic will tend to crystallize as it crosses into the air and the resultant pieces of salt will destroy the seal faces rather quickly, causing the seal to leak. A mag-drive pump is the safest and simplest solution and should be considered first. If a double seal must be used, at ambient temperature, a simple dead-ended water flush is usually all that is required. Make sure that the pressure is adequate for your application and the source is reliable. If the flush fails, caustic will enter the area between the seals, causing both to wear and leak, as well as possibly contaminating the flush system.

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Sodium hydroxide freezes at moderate ambient temperatures (varies by concentration; see table below for melting point at 50%). This may be a concern where supply tanks, pipes or the pump itself is located outdoors. If freezing begins to occur, solids will become a problem. If this may be the case, heat trace the equipment in question and/or use a suitable heat jacket (on the pump) and properly insulate everything.

Because of the flexibility afforded by our gear pumps for the above reasons, we are able to pump this chemical across a wide flow and differential pressure range quite reliably. We can go from running the H1/31/41 at low RPMs (about 0.1 GPM) to running the H14/314 at 1150 RPM (about 58 GPM).

As usual, if there is any doubt about what to use, contact the factory.

Viscosity vs. Temperature for Various NaOH Concentrations in Water (@ 1 atm)

Temperature		Viscosity (cP) at Concentration of Aqueous NaOH						
(°C)	(°F)	0% (H_2O)	5%	10%	20%	30%	40%	50%
0	32	1.79	–	–	–	–	–	–
10	50	1.31	–	–	–	–	–	–
12 *	53.6 *	1.24	–	–	–	–	–	169
20	68	1.00	1.31	1.86	4.4	12.6	38.1	112
25	77	0.89	–	–	–	–	–	86.5
30	86	0.80	1.03	1.43	3.2	8.4	21.8	67.4
40	104	0.65	0.83	1.14	2.4	6.0	13.5	41.4
50	122	0.55	0.69	0.93	1.9	4.4	9.0	25.9
60	140	0.47	0.58	0.78	1.6	3.3	6.4	16.4
70	158	0.40	0.50	0.66	1.3	2.5	4.8	10.5
80	176	0.35	0.43	0.55	1.0	2.0	3.7	6.8
90	194	0.31	0.38	0.47	0.84	1.6	2.9	4.5
100	212	0.28	0.33	0.40	0.68	1.3	2.3	3.0
110	230	–	–	–	–	–	–	2.0
120	248	–	–	–	–	–	–	1.4
130	266	–	–	–	–	–	–	0.94
140 **	284 **	–	–	–	–	–	–	0.65

* Melting Point of 50% NaOH   ** Boiling Point of 50% NaOH