

Inline sodium hydroxide (NaOH) concentration measurement on the example of naval closed loop scrubbers

Relevant for: Naval Architecture, Energy Sector, Chemical Industry

An accurate control of the right sodium hydroxide concentration is an essential quality parameter for the efficiency of scrubbers. Anton Paar offers inline concentration measurement solutions by using the sound velocity sensor L-Sonic 5100 Version MON or the density sensor L-Dens 7400 Version INC.

1 NaOH Measurement

Sodium hydroxide solutions are applied in various industries and shades of dilution. Determining the concentration is an essential factor for the quality and effectiveness of different processes including the production of soaps, detergents, pulp, or in the alumina ore process.

Furthermore, sodium hydroxide plays an important role in the treatment of waste gas, where scrubbers are used to comply with the further enforced air pollution regulation. Aqueous NaOH solutions are used in the closed-loop scrubber to wash SO_x contaminations out of the flue gas.

Anton Paar offers a wide range of measurement units to control the NaOH concentration during the dosage process, securing a safe operation of the scrubber. For continuous concentration measurements, Anton Paar's L-Sonic 5100 Version MON and L-Dens 7400 Version INC provide a reliable solution.

2 Anton Paar's application solution

2.1 Flue Gas Scrubbers

Scrubbers for the treatment of flue gas make use of the rapid solubility of SO_x in alkaline solutions. Sodium hydroxide is especially applicable in naval settings working on a closed-loop principle because 50 wt.% NaOH solutions can be stored space-saving on board and be diluted without the need of mechanical mixers. Diluting the lye to the desired concentration before induction in the main line is essential to ensure stability and avoid overdosing while (re-)filling. This is where Anton Paar's measurement solutions allow detailed insights into the process.

In the wash water cycle (Figure 1) the circulation tank is filled with a 5-20 wt.% solution of sodium hydroxide. The desired concentration depends on various process factors, such as the structural shape of the scrubber or the fuel's sulfur content. Before entering the scrubber,

the wash water is cooled to ensure optimal process conditions. Afterwards, the wash water is sprayed in the scrubber and brought in contact with the flue gas. In the scrubber, the SO₂ gets dissolved in the alkaline solution. Also, the contained SO₃ is dissolved and reacts with the sodium hydroxide.

The proportion of each result of the reaction depends on the available oxygen and on the pH value in the solution. Deviating concentrations of sodium hydroxide will limit the conversion of toxic components significantly.

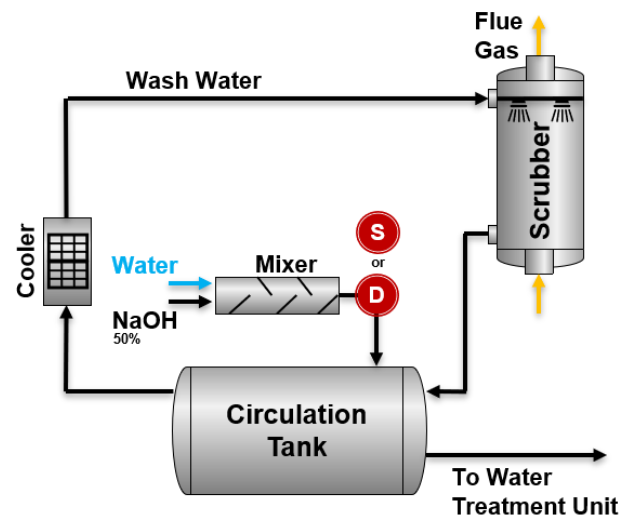


Figure 1: Illustration of a closed loop SO_x scrubbing system

After cleaning the flue gas, the contaminated wash water flows back to the circulation tank. Depending on the structural form, a portion of the wash water is renewed before passing through the process again.

To ensure a constant sodium hydroxide concentration at the inflow, Anton Paar provides a wide range of measurement solutions to precisely monitor and analyze the aimed fluid concentration. Anton Paar helps to ensure an optimal utilization of raw material, which is especially important in space-limited naval applications.

3 Measurement setups

3.1 Overview

The strong alkaline nature of NaOH solutions requires special materials and instruments. Anton Paar offers two setups that have been especially designed for the inline concentration measurement of NaOH solutions.

3.2 L-Sonic 5100 Version MON

The sound velocity of NaOH solutions is measured with the L-Sonic 5100 Version MON with wetted parts made of Monel 400 (Figure 2). Anton Paar's L-Sonic is especially applicable for concentration ranges from 0 to 34 wt.% and can be integrated directly in the tank or line.



Figure 2: L-Sonic 5100 Version MON sound velocity sensor

3.3 L-Dens 7400 Version INC

Continuous density measurement of NaOH solutions is performed with the L-Dens 7400 Version INC density sensor with wetted parts made of Incoloy. The L-Dens delivers highly accurate and reliable results over the full concentration range of NaOH. The integration in the line or tank is conducted with a bypass.

All sensors can be equipped with Anton Paar's powerful transmitter Pico 3000. This transmitter can be integrated into the electronics housing of the sensor or into a remote-control housing. Different interfaces are offered for direct communication with the plant. An HMI is also available as an option.

3.4 Specifications of NaOH measurement

Sensor Type	Concentration [%]	Temperature [°C]	Accuracy [%]
L-Dens 7400 Version INC	0... 50	0... 100	0.05
L-Sonic 5100 Version MON	0... 34	10... 80	0.1

Table 1: Sensor specifications

Aqueous NaOH solutions correlate excellently between concentration and density or sound velocity values, making both density and sound velocity measurement ideal for accurate concentration measurements (Figure 3).

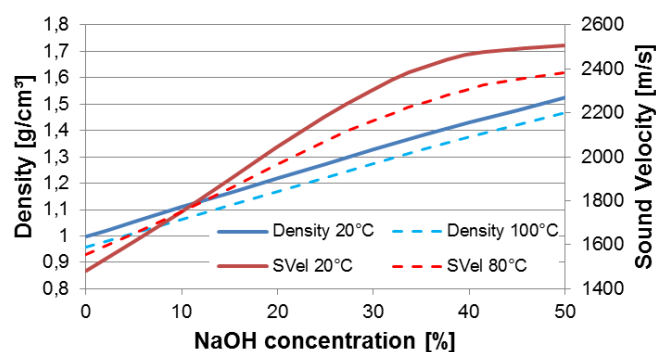


Figure 3: Relation between density / sound velocity values and the concentration of an aqueous NaOH solution

4 Benefits

- Linear correlation between NaOH concentration and density or sound velocity:
 - Conductivity shows a reversal point at approx. 15 % NaOH
 - One highly reliable measuring system for the whole concentration range
- Optimal use of resources in space-limited environments like the naval transportation
- Compliance with emission limits by accurate NaOH dosing and data recording
- Fully integrable measuring system
- Easy to use, maintenance-free

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