



## Application Note AN-PAN-1025

# Online analysis of ammonia in ammonia-saturated brine

During the Solvay process, ammonium bicarbonate and sodium chloride are converted into sodium bicarbonate and ammonium chloride. Heating the former compound yields sodium carbonate (soda ash), an important raw material used to make several commonly used products. Ammonia is recovered almost completely through the conversion of the ammonium chloride with lime milk ( $\text{Ca}(\text{OH})_2$ ). This Process Application Note describes a

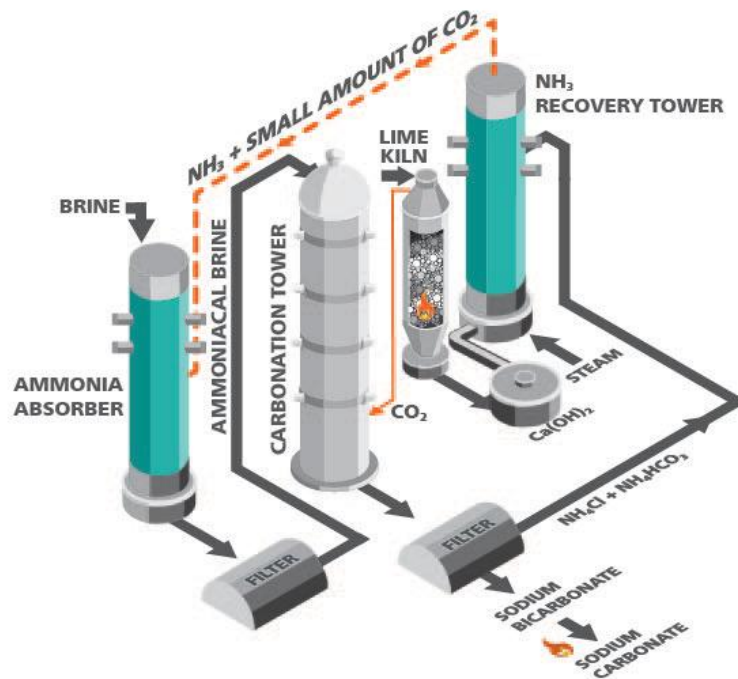
method to continuously monitor the ammonia content online in the saturated sodium chloride brine solution after the absorption tower, thus guaranteeing optimal product yield in the carbonation tower. The 2035 Process Analyzer - Potentiometric from Metrohm Process Analytics is the ideal solution to monitor ammonia and more in the Solvay process (e.g., alkalinity, carbonate, chloride, calcium oxide, and carbon dioxide).

## INTRODUCTION

Soda ash, otherwise known as sodium carbonate ( $\text{Na}_2\text{CO}_3$ ), is a key chemical in the production of many goods, such as glass, soap, and paper, as well as for treating water and scrubbing sulfur compounds from smokestack emissions. There are two ways to manufacture soda ash: the industrial Solvay process or mining from ores (trona and nahcolite). The Solvay process is most commonly used in Europe, where the mining of ores is not economically feasible [1].

The major components necessary for the Solvay process besides water are limestone ( $\text{CaCO}_3$ ), brine (saturated  $\text{NaCl}_{(\text{aq})}$ ), ammonia ( $\text{NH}_3$ , 10–35%), and carbon (coke) for the lime kiln (oven) (Figure 1). First, ammonia gas is absorbed into a concentrated brine solution. The

limestone is heated, producing  $\text{CaO}_{(\text{s})}$  (used in a final step) and  $\text{CO}_{2(\text{g})}$  which is mixed with the ammoniated brine in a carbonation tower to form ammonium bicarbonate ( $(\text{NH}_4)\text{HCO}_3$ ). This intermediate can easily degrade on its own, but in the presence of the brine solution it reacts further to create  $\text{NH}_4\text{Cl}$  (ammonium chloride) and  $\text{NaHCO}_3$  (sodium bicarbonate). The sodium bicarbonate is then removed by filtration and heated to produce the final product: soda ash ( $\text{Na}_2\text{CO}_3$ ). The  $\text{CaO}_{(\text{s})}$  (left over from heating the limestone) is mixed with water (slaking) to form  $\text{Ca}(\text{OH})_2$ , which is used to recover  $\text{NH}_3$  by reacting with the  $\text{NH}_4\text{Cl}$  solution. Ammonia is then recycled within the process (Figure 1).



**Figure 1.** Illustration of the Solvay process used to manufacture sodium carbonate when mining for ore is not economically feasible.

Timely and effective monitoring of brine chemistry is critical for maintaining the efficiency and safety of the ammonia saturation process. Manual analysis of the brine stream is undesirable since the obtained data does not represent the actual process conditions. Metrohm Process Analytics process analyzers are able to monitor the amount of ammonia in

saturated brine after the absorption tower and help to adjust the concentrations to ensure a good product yield in the carbonation tower. Additionally, an alarm indication can be immediately sent to the control room if ammonia concentrations are out of specification.

APPLICATION

Sample acidified with HCl is accurately titrated with a NaOH solution. The endpoint indication is performed with a combined pH electrode, and

the result is calculated as ammonia using a 2035 Process Analyzer - Potentiometric (Figure 2).



Figure 2. 2035 Process Analyzer - Potentiometric for accurate online determination of ammonia in brine streams.

Table 1. Measured parameter in saturated brine streams.

Parameters	Concentration [g/L]
NH <sub>4</sub> <sup>+</sup>	55–135

## REMARKS

Other online applications are available for soda ash manufacturers such as alkalinity, carbonate,

chloride, calcium oxide, carbon dioxide, and hardness.

## CONCLUSION

Metrohm Process Analytics offers automated online process solutions to monitor ammonia in saturated brine around the clock. The 2035 Process Analyzer - Potentiometric can measure

not only ammonia, but it is also suitable for monitoring alkalinity, carbonate, chloride, calcium oxide, carbon dioxide, and hardness to optimize process efficiency.

## RELATED APPLICATION NOTES

[AN-PAN-1005 Online analysis of calcium and magnesium in brine](#)

[AN-PAN-1059 Online analysis of strontium and barium in high purity brine](#)

## BENEFITS FOR ONLINE ANALYSIS IN PROCESS

- Increased final product quality due to constant online monitoring
- Safer working environment with automated sampling and analysis
- Fully automated diagnostics – automatic alarms alert process operators immediately for corrective actions when brine streams are out of set specification parameters



## REFERENCES

1. Jones, T.; Dunwoodie, M.; Boucher-Ferte, V.; Reiff, O. *Chemicals for Beginners*; Vth edition; Deutsche Bank, 2011.

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## CONFIGURATION



### 2035 Process Analyzer Potentiometric

用于位滴定和子性量的 2035 Process Analyzer 程分析,可使用用和滴定行分析。此外,版本的 2035 Process Analyzer 程分析用于使用万通高性能行子性分析。一精的准溶液技是理品基的理想方法。

此位分析款型的分析可提供当前市上所有量技的最精果。滴定法作最常用的分析方法之一,具有超 1000 用可供使用,能分析数百成,从酸/元素直到解池中金属度,可用于几乎任何行。

滴定法是目前使用最广泛的化学方法之一。技易行,无需校准。

可用于此配置的部分滴定:

- 位分析滴定
- 使用光技的比色滴定
- 基于·休滴定法定水