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 ($Ca(OH)_2$).
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 (Na_2CO_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 ($CaCO_3$), brine (saturated $NaCl_{(aq)}$), ammonia (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 $CaO_{(s)}$ (used in a final step) and $CO_{2(g)}$ which is mixed with the ammoniated brine in a carbonation tower to form ammonium bicarbonate ($(NH_4)HCO_3$). This intermediate can easily degrade on its own, but in the presence of the brine solution it reacts further to create NH_4Cl (ammonium chloride) and $NaHCO_3$ (sodium bicarbonate). The sodium bicarbonate is then removed by filtration and heated to produce the final product: soda ash (Na_2CO_3). The $CaO_{(s)}$ (left over from heating the limestone) is mixed with water (slaking) to form $Ca(OH)_2$, which is used to recover NH_3 by reacting with the NH_4Cl solution. Ammonia is then recycled within the process (Figure 1).

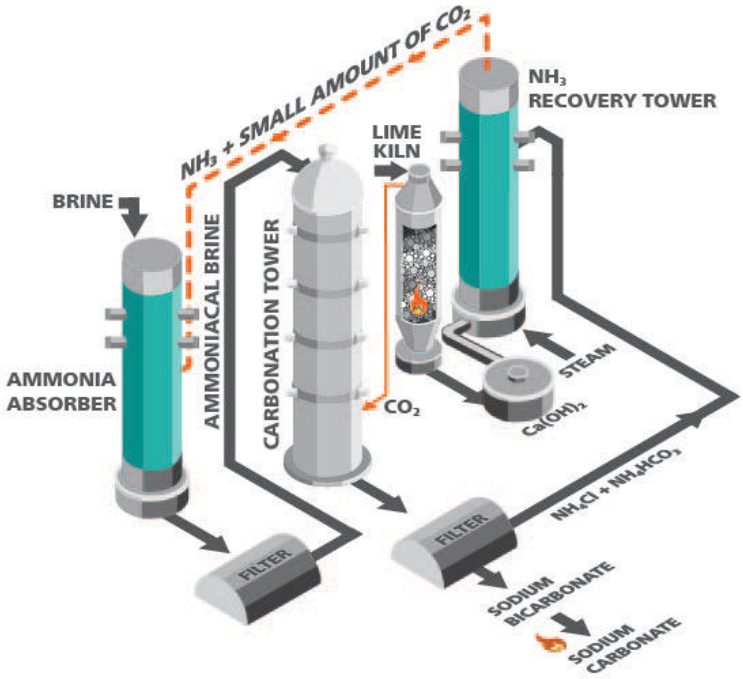

Figure 1. Illustration of the Solvay process used to manufacture sodium carbonate when mining for ore is not economically feasible.

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_4^+	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.

CONTACT

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CONFIGURATION

2035 Process Analyzer - Potentiometric

2035 フロセスアナライサーては、電位差滴定およびイオン選択性測定において特別な滴定試薬および電極を使用します。2035 フロセスアナライサーのこの装置のハリエーションは、その上、メトロームの高性能電極によるイオン選択性分析に適しています。この精確な標準添加物の方法は、難しいサンフル物質の分析に理想的てす。

分析装置の電位差測定におけるこの装置のハリエーションは、市場て提供されている測定方法の中ても最も精確な結果を出します。1000を超える既製のアフリケーションにより、滴定も、ほほ全ての産業分野において最も頻繁に使用される数百の成分の分析方法の一つに数えられ、酸塩基分析から電気めっき浴の金属濃度測定に至るまて幅広く提供されています。

滴定は、今日使用されている中ても最も一般的てある、完全な化学メソットの一つてす。その方法はシンフルて、キャリフレーションも不要てす。

このコンフィクレーションに含まれる滴定の種類:

- 電位差滴定
- 光ファイハー技術による比色滴定
- カールフィッシャー滴定メソットによる水分測定