



Gulf Coast Environmental Systems

CASE STUDY

WET SCRUBBER CHEMICAL INJECTION & LIQUOR CONCENTRATOR
LIGHTING COMPANY: AUGUST 2018

LIGHTING COMPANY

Employees: 9000
Sector: Industrials
Industry: Electrical Equipment
Sub-Industry: Commercial & Residential Building Equipment & Systems
Project Type: Equipment Proposal

EXECUTIVE SUMMARY:

To determine the feasibility and estimates to convert the existing wet scrubber units to chemical injection for creation of a sellable byproduct of ammonia sulfate.

CLIENT OVERVIEW:

This client is a global leader in LED and automotive lighting technology. The develop and manufacture a wide range of LED lighting products, across several industries. Considered a pioneer in the lighting industry, this client has a rich history of technology “firsts”, which has positioned them as a world leader in their field. Based out of California, the company has roughly 9,000 employees, with an average annual revenue of roughly $420 million.

PROJECT OVERVIEW:

Gulf Coast Environmental Systems was asked to perform a feasibility project, by a lighting company that manufactures light-emitting diode (LED) components. With a large amount of ammonia and hydrogen being released from the reactors during the process performed at their facility, they would need specialized equipment. The hydrogen is treated in an Incineration system (NOx created) with the remaining ammonia being...





PROJECT OVERVIEW CONTINUED:

removed using water only in the packed tower scrubbers. The blowdown (Ammonium Hydroxide) from the scrubbers is treated in an Acid Neutralization Systems (ANS) (converts to Ammonium Sulfate) before being discharged into the wastewater system. Waste surcharges apply based on the ammonium (NH4+) content in the wastewater.

The goal of this feasibility study was to determine the required steps and costs involved in using Sulfuric Acid in the scrubbers to get a controlled blowdown liquor that could create a viable revenue stream from an existing liability waste procedure. In addition, the need for the ANS system is hopefully eliminated along with the additional costs of discharging the uncontrolled wastewater.

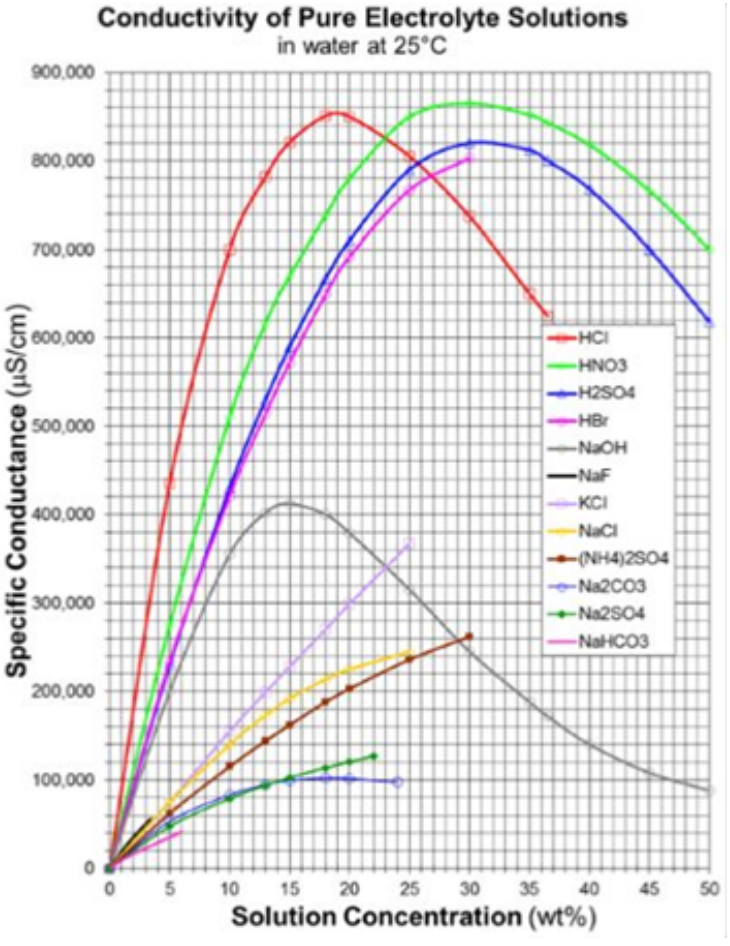
SOLUTION:

Scrubber System Design and Ammonia Sulfate Production:

Scrubbers can be designed to produce ammonium salt solutions suitable for use as fertilizer. This should be considered whenever the amount of ammonia removed from air is substantial. This is because scrubber effluent, containing lots of ammonia nitrogen, can't be discharged without causing nutrient pollution in receiving waters, or overloading the tertiary treatment capacity of a sewage treatment plant.

There are three common disposal options for ammonia scrubber blowdown: send it to a fertilizer plant as crude feedstock to be concentrated and purified to produce commercial products; use it as crude fertilizer (by applying it to range land or for local farmers); or spray it onto dried compost, in order to increase its nitrogen content.

For any of those options, it's desirable to produce a concentrated ammonium salt solution.



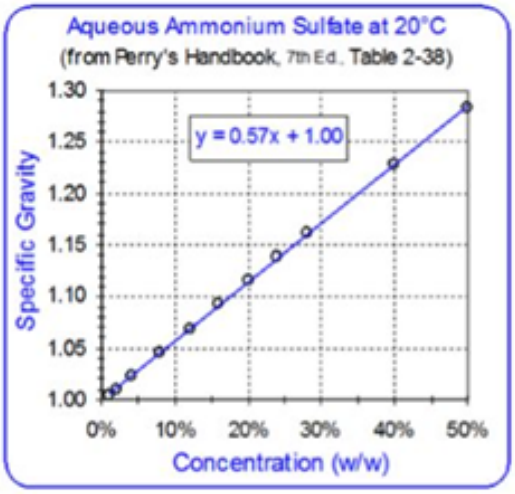




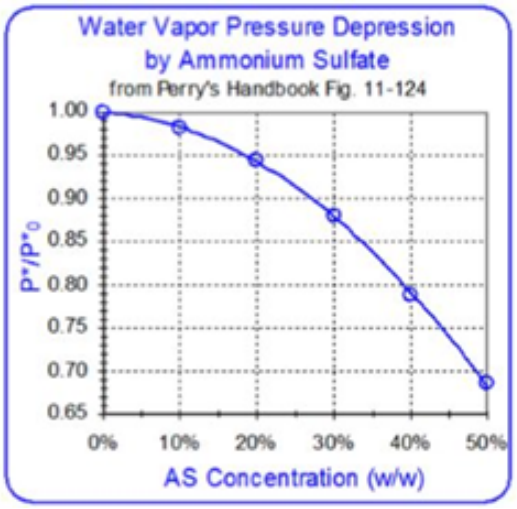
The concentration of the solution circulating in a scrubber can be monitored in real time by measuring its conductivity or density. The relationship of conductivity to concentration for ammonium sulfate solutions is shown in the chart on this page. Conductivity data for concentrations over 30% is not available, but it is known that density is a more reliable indicator than conductivity in the 30~45% range, since the conductivity curve levels off. Real-time density monitors are considerably more expensive, though.

A scrubber's blowdown rate can be adjusted automatically using the signal from a conductivity or density sensor in the sump or the recirculation piping. When the solution conductivity or density reaches an upper set point (indicating that the desired concentration has been reached), a blowdown pump is activated to send some of the solution to a holding tank. Fresh water (added to maintain the liquid level in the scrubber sump) dilutes the remaining solution until its conductivity or density falls to a lower set point, at which time the blowdown pump shuts off.

In this way, the scrubber generates a small volume of consistently concentrated byproduct despite widely varying air flows or ammonia loadings.



If airborne ammonia concentrations are low, or if the gas being scrubbed is hot and humid, it may not be possible to obtain a 40% solution of the byproduct ammonium salt. Concentrated salt solutions have lower vapor pressures than pure water, so they can absorb moisture from saturated air. An ammonia scrubber treating very humid air at a low blowdown rate will be removing both NH3 and H2O, diluting the byproduct salt solution even if no make-up water is added to the scrubber.



Nitric acid or hydrochloric acid can be used for pH control in ammonia scrubbers, but they have two drawbacks. They're volatile acids, which can emit HNO3 or HCl gas to the air if they don't get diluted adequately before the scrubbing solution is sprayed onto the packing. Acid gases released to the air will react with ammonia to form ammonium salt aerosols that a scrubber can't remove, and appear as a dense white smoke plume at the scrubber stack. Also, those monoprotic acids have no buffering capacity, so for consistently higher removal efficiency a scrubber using HNO3 or HCl needs to operate at a lower pH set point (pH 0.5~1.5, depending on the airborne NH3 concentration and the operating temperature).





The resulting byproduct solution is too acidic to be used directly as fertilizer, although it would be partly neutralized by mixing it with urea.

Due to the operational and situational factors experienced, using sulfuric acid as a neutralizing agent is the most reasonable approach. Assuming an ammonia loading of 36.8 lb/hr in 35,000 SCFM of waste gas corresponds to an inlet concentration of about 400 ppmv. This concentration was used for the purposes of this assessment. It is expected that the concentration will vary.

It is possible to adjust the concentration of the ammonium sulfate byproduct solution just by varying the average blowdown rate. If the ammonia content of the gas becomes much lower, then it may or may not be possible to produce a certain concentrated byproduct. Saturated gas will contain water vapor and some of that will also get absorbed by a concentrated salt solution whose vapor pressure is lower than the vapor pressure of pure water. If the solution absorbs too much H2O and too little NH3, the byproduct ammonium sulfate concentration may remain lower than the target even if the scrubber is operated with no make-up water.

The pH set points are subject to adjustment by operators. If the ammonia content of the gas is lower than 400 ppmv and fairly constant, the scrubber may show consistently high removal efficiency at a higher pH set point (3.0 or a bit higher), producing a less acidic byproduct. However, if the ammonia loading fluctuates sharply, it may be necessary to use a lower pH set point (2.0~2.5) in order to leave enough excess acid in the water to neutralize sudden “spikes” of ammonia. Specific plant experience will show what set point works best.





Scrubber System Design and Ammonia Sulfate Production:

Ammonium Sulfate solution is designed to increase herbicide performance through increased absorption into a plant's phloem through the leaf cuticle and decreased antagonism due to calcium ion mineralization. It is used as a fertilizer. Through local conversations with potential users / buyers, sale pricing per gallon of solution appears to range between $0 to $0.25 per gallon pending transportation and chemical quality of the solution. The most common concentration is 34% Ammonium Sulfate meeting a guaranteed analysis of 7- 0-0, 8% sulfur. It is expected many final chemical product manufacturers will have to do additional processing to meet sellable requirements.

This project was completed with the assistance of Lantec Products Inc., a global technological leader in ceramic heat recovery media for RTOs and plastic tower packing media for pollution control equipment.