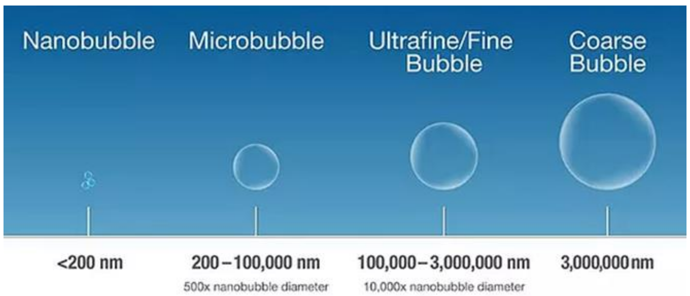
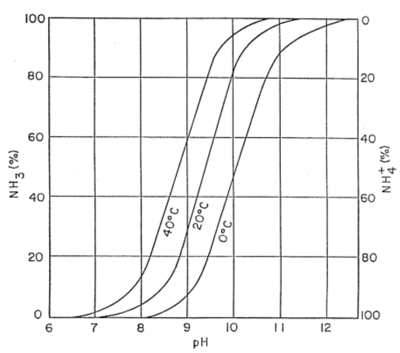
TECHNOLOGY SHEET

SEPARATION OF VOLATILE CHEMICALS FROM WATER

Separation of volatile chemicals, such as ammonia, hydrogen sulfide, low boiling point organics, such as ethyl acetate, require efficient contact between the aqueous phase and the stripping gas. Traditionally this has been accomplished using a packed or tray tower, in which the gas phase is contacted with the aqueous phase, spread as a thin film on a high surface area packing material, or the gas phase is bubbled through the liquid. In both of these processes, the mass transfer rates of the chemical from the aqueous phase into the gas phase is limited by the interfacial area between the two phases. Furthermore, packed towers suffer from fouling due to either suspended solids in the liquid phase and/or biological growth, especially in the case of ammonia where nitrogen compounds serve as nutrients for biological growth.



PRD Tech, Inc. has pioneered a unique gas stripping technology entitled "Controlled Nanobubble Stripping (CNS) process in which the stripping gas is dispersed in the aqueous phase, contaminated with the volatile chemical, in the form of nanobubbles, less than a micron in diameter. The interfacial surface area of nanobubbles is 400 times higher than for a 400 nm microbubble.



Certain volatile compounds such as ammonia exist as ionized species in the aqueous phase and are converted into neutral species based on the pH of the water. The graphs below show the ionization and interconversion into neutral ammonia gas as a function of pH. As the pH increases from 6 to 12, the ammonium ion is interconverted into neutral ammonia gas, dissolved in water. Only neutral gases dissolved in water can be stripped using air or another water-insoluble gas.

Typical design and operating factors for conventional stripping towers are shown in the table. For ammonia stripping the air to liquid ratio ranges from 2000 – 6000, which results in a very high air flow and hence a low ammonia concentration in the exit air. This reduces the reaction rate when ammonia in the air phase is reacted with sulfuric acid to convert the ammonia gas to ammonium sulfate. High gas to liquid ratio also results in high operating and investment costs for the air stripping and ammonia absorption columns.

parameters	unit	VOC compounds removal	ammonia removal
falling liquid ratio	$L{\cdot}m^2/min$	600–1800	40–80
gas to liquid ratio (G/L)	m^3/m^3	20–60:1	2000–6000:1
stripping ratio (S)		1.5–5	1.5–5
permitted pressure drop (ΔP)	$(N/m^2)/m$	100–400	100–400
height to diameter ratio (Z/D)	m/m	max 10	max 10
packing height (Z)	M	1–6	2–6
safety factor (SF)	D %	20–50	20–50
pH		5.5–8.5	10.8–11.5

Controlled Nanobubble Stripping process uses a gas to liquid ratio of 20-60, which is 100 times less than conventional air stripping technologies. Equilibrium data for the ammonia-water system shows that the equilibrium constant for ammonia is in the range of 6.8 – 10.0 when the temperature is in the 30-80^{o}C range. A schematic of the Controlled Nanobubble Stripping system for separating ammonia from wastewater is shown in the following figure.

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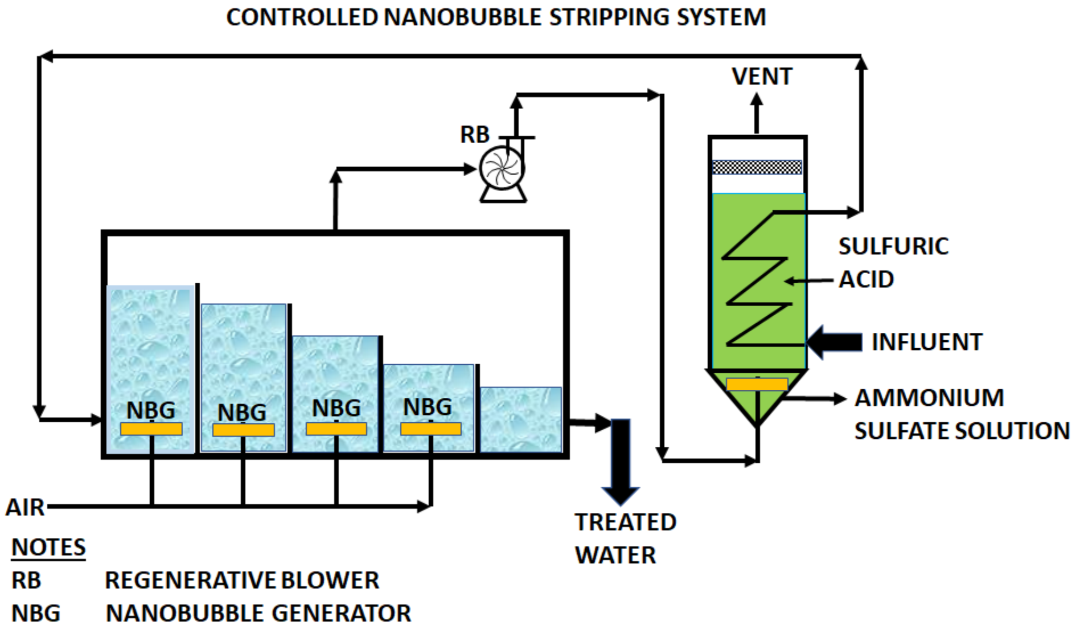

Influent wastewater containing ammonia at a pH of about 10.5 is heated in the Absorber section, where the ammonia gas is reacted with sulfuric acid to form ammonium sulfate solution. This is an exothermic reaction and this heat of reaction is used to preheat the influent wastewater to the desired temperature. Heated wastewater is then sparged with nanobubbles of air, generated by a proprietary nanobubble generator (NBG). The wastewater flows sequentially through several stripping sections before exiting as treated water. Air rich in ammonia gas is drawn out of the stripping sections by a regenerative blower (RB) and then bubbled as nanobubbles in sulfuric acid in the absorber section. As ammonium sulfate is formed, the pH of the sulfuric acid will increase until attaining the pH of the final ammonium sulfate solution.

ECONOMIC COMPARISON

The yearly costs for Ammonia recovery from wastewater using the standard stripping and absorption process is in the range of $2.0 - $2.50 per lb of N recovered. Investment costs vary depending on the air/water ratio used in the stripping tower, especially since the air/liquid ratio is in the wide range of 2,000 – 6,000:1. In comparison, with the nanobubble generation striping and absorption process, the operating costs are about 40-50% lower, i.e., in the range of $0.80 - $1.25/lb N recovered. The chemical costs are very similar since the pH has to be increased in both the standard air stripping process as well as in the Nanobubble stripping process.

For More Information on the Nanobubble Stripping and absorption process contact the following:

Dr. Rakesh Govind
PRD Tech, Inc.
1776 Mentor Avenue; STE 413
Cincinnati, OH 45212
Cell: (513) 673 3583
Email: rgovind837@aol.com