TECHNOLOGY SHEET

AMMONIA REMOVAL (PRD-AMS PROCESS)

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The discharge of ammonia from wastewater treatment plants and industrial processes has become a challenging issue through the United States. Pursuant to EPA's 1999 water quality criteria, nearly half of all states – 24 states plus the District of Columbia have adopted new rules addressing total ammonia concentrations to protect aquatic life. Many concentrated wastewater streams produced in food and agro-industry are treated using sludge digestion, and effluents from this process frequently contain ammonia in high concentrations (up to 2 kg/m3). Typically, 40-5-% of the total nitrogen in a municipal treatment plant is found as ammonia in the centrate or filtrate streams. Ammonia is widely used in the chemical industry in the production of fertilizers, plastics and explosive, resulting in large quantities of wastewater containing ammonia.

The target, treated-level of ammonia depends on the application. Aquaculture water requires ammonia levels of less than 1 mg/L, whereas in municipal wastewater treatment, discharge levels may be up to ten times higher. In industrial wastewater treatment, discharge levels of ammonia may exceed 100 mg/L.

Ammonia can be separated from water using a variety of processes, which includes:

- **Ion Exchange**: Uses clinoptilolite, a naturally occurring zeolite, which has a classical alumino-silicate cage-like structure, with significant macroporosity. Some ion exchange systems can be regenerated using sulfuric acid, forming ammonium sulfate, which can be concentrated and sold as fertilizer;
- **Biological Nitrification to nitrate**: Uses two different types of aerobic autotrophic bacteria that oxidize ammonia to nitrite (*nitrosomonas*) and then oxidize nitrite to nitrate (*nitrobacter*). Both types of these bacteria require proper biomass concentration (mixed liquor suspended solids), temperature, pH, alkalinity, dissolved oxygen levels and sufficient residence time than is required for just treatment of organics. Nitrification requires over four times the amount of oxygen than is required for biological organics removal. In most cases, additional alkalinity has to be added to achieve biological nitrification. Recently, using an integrated fixed film system (IFAS), utilizing moving media, both organics removal and nitrification is achieved in the same basin;
- **Flash Vacuum Distillation**: These systems use a lower operating pressure and a higher operating temperature (140 – 180 deg F) to flash the ammonia and some water vapor, which is then absorbed in sulfuric acid to form dilute ammonium sulfate; this dilute ammonium sulfate is then concentrated by evaporation to form usable fertilizer. When the wastewater has high bicarbonate alkalinity, carbon dioxide is flashed off with ammonia to form ammonium carbonate, which contaminates the product. Typically, to prevent fouling of heat transfer surface and nozzles, some pretreatment is needed to reduce bicarbonate alkalinity;
- **Membrane Separation**: A porous membrane separates the flow of wastewater from the countercurrent flow of sulfuric acid solution, with the ammonium ion crossing through the membrane pores to form ammonium sulfate solution, which is sold as a fertilizer.
- **Adsorption**: Phosphoric acid impregnated activated carbon adsorbs ammonia from a gas stream, and when this carbon is saturated with ammonium phosphate, the carbon is sent for regeneration or discarded. This process can be used to remove low ammonia concentrations from a gas stream;
- **Air Stripping**: Ammonia exists in water as unionized ammonia and ammonium ion ($NH4^+$). At pH 9.25 half of the ammonia will be un-ionized (NH3) and half will be ionized ($NH4^+$). At pH 8.25 and 7.25, 90, and 99% of the ammonia will be ionized, respectively. Hence, as pH increases, the volatility of ammonia increases, and this property can be utilized to air strip ammonia out of water at a high pH.

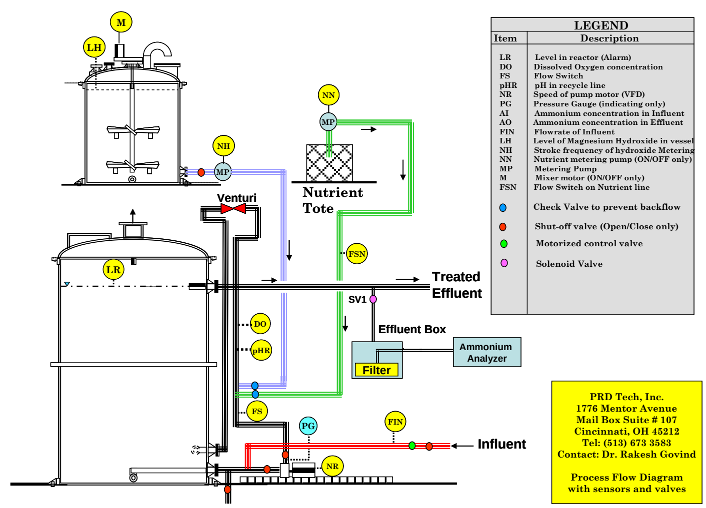
Major issues with each of the above separation/treatment methods are summarized below:

Issue	Ion Exch.	Biological	Flash Distillation	Membrane	Adsorption	Air Stripping
Cost	High	Medium	Medium	High	Medium	Medium
Rates	High	Low	High	Medium	High	Medium
Size	Medium	Large	Medium	Small	Small	Small
Treatment	No	Yes	No	No	No	No
Efficiency	High	Medium	Medium	Medium	High	High

PRD Tech, Inc. has developed and tested at full-scale a combined biological, fixed-film and adsorption process (PRD-AMS) that achieves high ammonia removal rates and extends the following benefits:

- Small liquid residence time in the bioreactor that uses a special, high surface area biomedia to effectively increase biofilm capacity and reaction rates;
- Economical, with low cost of treatment
- Effective: Can reduce ammonia concentrations from several hundred ppms to less than 10 ppm;
- Low Operating Cost: Typically uses an agent to increase alkalinity, if there is insufficient alkalinity in the feed water;
- Combines the advantages of adsorption with biological treatment capability, requiring no change of biomedia;
- Compact: The equipment can be skid-mounted, and has a small footprint;
- Tested: Has performed at full-scale at a sludge treatment facility

The figure below shows a schematic of the PRD-AMS process, in which the wastewater enters the bioreactor which has a specially, designed biomedia, moving inside the water. Air is injected using a venturi system that provides the needed oxygen and alkalinity is maintained by adding magnesium hydroxide slurry. Treated water overflows from the bioreactor, and the ammonia level is measured continuously in the effluent.



The PRD-AMS process has been operating wherein it achieves a high treatment efficiency, with influent ammonia levels ranging from 300-700 mg/L.

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