# Phytoremediation of Ammoniacal Nitrogen Wastewater using Water Hyacinth (*Eichhornia Crassipes*)

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***Abstract***
*Ammoniacal nitrogen (AN) is present in both domestic and industrial wastewater which is one of the main contributors of eutrophication. Phytoremediation is recommended as an alternative solution to treat wastewater with high AN content due to its cost-effective, environmental friendly and sustainable characteristics. In this study, one-factor-at-a-time (OFAT) study was conducted on the parameters influencing the AN removal using water hyacinth.*

*The variables involved pH (4-10), retention time (2-14 days), initial AN concentration (10-70 mg/L), macrophytes density (5-30 g/L) and salinity (1-5 g NaCl/L) which influenced the AN removal significantly. The highest AN removal of 98.85% was obtained at pH 9, 99.18% at retention time of 14 days, 90.46% at initial AN concentration of 40 mg/L, 84.91% at macrophyte density of 30 g /L and 70.13% at salinity of 1 g NaCl/L respectively. Overall, water hyacinth has demonstrated high potential as the macrophyte for phytoremediation of AN in semiconductor effluent.*

**Keywords:** Phytoremediation, ammoniacal nitrogen, wastewater treatment, water hyacinth, green technology.

## Introduction

Increasing global demand of electronic products has led to the fast growing of semiconductor industry especially in North America, Europe, Asia and Australia[3]. During semiconductor manufacturing process, a large amount of ultrapure water is consumed for cleaning and rinsing wafers, thus generating a significant volume of wastewater contaminated with varying pollutants[4]. Ammoniacal nitrogen (AN) is one of the major pollutants present in semiconductor effluent[2]. AN is categorized as a type of inorganic pollutants which acts as main contributor to eutrophication phenomenon[5]. Eutrophication is a serious environmental issue that needs attention since it causes aquatic macrophytes' spread, algal blooms, dissolved oxygen reduction and aquatic species loss[26]. As the protective measure, wastewater with high AN content must be treated before its final discharge into waterbodies. In Malaysia, AN contaminated wastewater must be treated to achieve AN concentration below 20 mg/L as enforced by the Environmental Quality (Industrial Effluent) Regulations 2009.

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In general, conventional AN removal technologies can be categorized into physiochemical and biological means. Physiochemical technology for AN removal comprises of ammonia stripping and distillation, ammonia precipitation as struvite, ion exchange, adsorption, chemical oxidation, breakpoint chlorination and advanced oxidation processes[8,23,34]. Meanwhile, the biological means for AN removal are performed by bacteria under very specific environmental conditions such as nitrification/denitrification, simultaneous nitrification and denitrification (SND), autotrophic denitrification, anaerobic ammonium oxidation (Anammox) process, partial nitrification/Anammox process and completely autotrophic nitrogen removal over nitrite (CANON) process[6,30]. However, these conventional technologies for AN removal are not cost effective since chemical reagents or complementary facilities are required[8].

It has been reported that the semiconductor effluent commonly contains AN concentration ranging from 40 to 250 mg/L and the existing technologies are insufficient to achieve the permissible discharge standard[2]. As the alternative solution, phytoremediation is recommended for AN removal in semiconductor wastewater.

Phytoremediation is defined as the treatment process making use of plant (phyto) to clean up (remediate) polluted soil or water[20]. It is recognized as the new emerging green technology for wastewater treatment and has gained keen interest among the researchers to employ this technology for both organic and inorganic pollutants removal due to its advantages such as high community acceptance, cost effective, sustainable, easy operation and maintenance[36]. The selection of suitable macrophyte is essential to ensure an effective phytoremediation system.

According to Rezania et al[39], macrophytes used for phytoremediation process should be accomplished with characteristics of ease control, high pollutants uptake capacity, fast growth rate and adaptability to wastewater. *Eichhornia crassipes*, commonly known as water hyacinth, is the worst invasive weed in the world. However, due to its characteristics of fast growth rate, high nutrient uptake capacity and adaptability to a wide range of environmental conditions, water hyacinth is widely applied for phytoremediation process for various wastewater treatment such as domestic wastewater[31,46], agriculture wastewater[49], mines wastewater[42], palm oil mill effluent (POME)[10], eutrophic lake and river water[29,48].