The Application of Electrolysis Method to Reduce Ammonia Content in Liquid Waste of Tofu

by Nurlaili Nurlaili

The Application of Electrolysis Method to Reduce Ammonia Content in Liquid Waste of Tofu

To cite this article: S Prabowo *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **144** 012046

View the article online for updates and enhancements.

Related content

- Electrolytes and electrolysis
  R W Gurney

- Surface Enhanced Raman Scattering on Self-assembled Nano Silver Film Prepared by Electrolysis Method
  Yi-pu Kang, Ren-ming Liu and Min-zhen Si

- Electrochemical disinfection of coliform and *Escherichia coli* for drinking water treatment by electrolysis method using carbon as an electrode
  Riyanto and W A Agustiningsih

The Application of Electrolysis Method to Reduce Ammonia Content in Liquid Waste of Tofu

S Prabowo[*1]**, Nurlaili**[2]**, Muflihah**[2]**, R A Tindangen**[2]**, Sukemi**[2,3]

[1] Faculty of Agriculture, Mulawarman University, Samarinda, Indonesia
[2] Chemical Education Department, Faculty of Teacher Training and Education, Mulawarman University, Samarinda, Indonesia
[3] SMA N 2 Samarinda, Samarinda, Indonesia

*Corresponding Author: sprabowo@faperta.unmul.ac.id

Abstract. Ammonia (NH_3) is known as an important chemical in industrial sector. It is also known as harmful pollutant. Ammonia is a weak base, a gas in room temperature and has 330^oC of BP. The aims of research were to investigate the effect of voltage (4 to 12 volt), time (1 to 30 min.), concentration of ammonia (0.01 to 0.05 M) and potassium hydroxide concentration on the ammonia content in aqueous solution by using electrolysis method with platinum as electrodes. The ammonia content was analysed by using UV-Vis spectrophotometer. The result showed that an increment in the voltage, time and potassium hydroxide concentration could increase the amount of converted ammonia. The optimum condition to reduce the ammonia content by using electrolysis method was 10 V of electrical voltage, 25 min. of electrolysis time and 0.04 M of potassium hydroxide concentration. At the optimum condition, the electrolysis method could decrease 81.13% of ammonia content in liquid waste of tofu.

1. Introduction

Environmental pollution is a crucial issue in efforts to establish a healthy environment. One of the sources of environmental pollution is waste from industrial activities. Based on observation and interview, it is known that some industries in Samarinda dispose waste to river. One of industries that continuously dispose the waste to river is tofu industry. Tofu industry produce solid and liquid wastes and they are usually disposed to river. The liquid waste of tofu contains protein.Decomposition of the protein in the river producesammonia.

Liquid waste of tofu has ammonia content around 2.21 – 16.00 mg/l. It exceeds the minimum content of the ammonia; 0.50 mg/l. Ammonia can increase the oxygen demand in gill and damaged tissue of fish and decrease ability of blood to transfer oxygen. In chronic condition an increment of ammonia content cause illness and decrease growth.

Many ways have been done to handle the tofu's liquid waste such as an aerobe process and convert the waste to biogas and fertilizer. Another way is application of electrolysis on the treatment of the waste. Electrolysis is a decomposition process of chemicals by using electrical energy. Electron flows from and to electrical source, but is not between the electrodes. Cation goes to cathode and is neutralized with the addition of electron at cathode. Anion goes to anode and release electron to be a

neutral. The application of electrolysis on the waste treatment is depend on the potential electrode. By using electrolysis method, the ammonia in liquid waste can be decomposed and the ammonia content can be decreased [4, 5, 6].

Some researches on the application of electrolysis methods to reduce the ammonia content have been done, especially at developed countries. The usage of electrolysis methodis not only focus on the decrement of the ammonia content, but also focus on the usage of hydrogen as the result of ammonia decomposition as fuel. Some studies have been done on the application of electrolysis to decompose ammonia. An increment in electrical voltage that used in the electrolysis of aqueous ammonia solution increase the amount of converted ammonia solution. On the other hand, anincrement of potassium hydroxide concentration in the electrolysis of aqueous ammonia solution decreases the ammonia content in the solution [7,8,9].

According to the reasons above, this research was created to find the optimum condition; electrical voltage, time, potassium hydroxide concentration and electrode types on the treatment of tofu's liquid waste.

2. Methods

2.1. Sample and Chemicals
Sample on this research was the liquid waste of tofu. The waste was collected from home industry that is located in Samarinda city, East Kalimantan, Indonesia. The waste was centrifuged for 10 min. Then the mixture was separated and the clear part of the waste was collected and used as the sample. All the chemicals that used in this research were analytical grade.

2.2. Electrolysis procedure
20 ml of certain concentration sample was loaded in the electrolysis container (beaker glass). 3 drops of certain concentration of KOH was added. After the electrodes were loaded in the solution, the electrolysis was started for certain time and at the certain voltage.

Determination of the optimum electrical voltage was done at the conditions; 100 ppm of initial ammonia concentration, 2 min. of electrolysis time, 0.02 M of potassium hydroxide concentration and 4, 6, 8, 10 and 12 volt of electrical voltages.

Determination of the optimum timewas done atthe conditions; 100 ppm of initial ammonia concentration, 0.02 M of potassium hydroxide concentration, 10 volt of electrical voltage, and 10, 20, 25 and 30 min. of electrolysis time.

Determination of the optimum potassium hydroxide concentrationwas done at the conditions; 100 ppm of initial ammonia concentration, 25 min. of electrolysis time, 10 volt of electrical voltage, and 0.01, 0.02, 0.03 and 0.04 potassium hydroxide concentration.

2.3. Determination of ammonia concentration
The sample was loaded into 50 ml beaker glass. 1 ml Nessler reagent was added. The mixture was homogenized and leaving for 10 min. Then the absorbance of the mixture was measured by using UV-Vis spectrophotometer at 495 nm of wavelength. The ammonia concentration was calculated by plotted the absorbance data to the regression linear of standard curve. Series standards of ammonia were made by using aqueous ammonia solution.

3. Result and discussion

3.1 Determination of optimum electrical voltage
The effect of electrical voltage on the remaining ammonia concentration in the solution by using the electrolysis process is shown in table 1.

Table 1. Remaining concentration of ammonia in the solution after treated by using electrolysis method (initial ammonia concentration = 100 ppm, electrolysis time = 2 min., concentration of KOH = 0.02 M)

Electrical voltage (Volt)	Ammonia concentration (ppm)	
	Initial	Remaining
4	100	23.81
6	100	19.96
8	100	15.15
10	100	11.31
12	100	11.98

According to table 1, it can be stated that an increment on the electrical voltage decreases the remaining concentration of ammonia; increases the converted ammonia content. This phenomenon is caused by an increment on the electrical voltage increases electric current, an increment on the electric current increases electric charge and an increment on electric charge in electrolysis process increases mass of electrolysis product.This result is in accordance with previous research. Riwayati (2010) found that an increment on electric current density decreases the remaining ammonia concentration; increases the converted ammonia content [10]. On the other hand, and increment the electric current density increases the electric current. It means an increment on the electrical voltage decreases the remaining ammonia concentration; increases the converted ammonia content. It seems that the optimum electrical voltage was 10 volt.

3.2 Determination of optimum time
The effect of time process on the remaining ammonia concentration in the solution by using the electrolysis process is shown in table 2.

Table 2. Remaining concentration of ammonia in the solution after treated by using electrolysis method (initial ammonia concentration = 100 ppm, concentration of KOH = 0.02 M, electrical voltage = 10 volt)

Time (min.)	Ammonia concentration (ppm)	
	Initial	Remaining
10	100	30.19
15	100	26.92
20	100	24.31
25	100	20.27
30	100	20.81

Table 2shows that an increment on the time process of electrolysis decreases the remaining concentration of ammonia; increases the converted ammonia content. This phenomenon is in accordance with Faraday's Law; an increment on the time process increases mass of electrolysis product[11]. When the mass of the product increases, the mass of reactant decreases; the concentration of the reactant decreases. The optimum electrolysis time process was 25 min.

3.3 Determination the optimum potassium hydroxide concentration
The effect of concentration of KOH on the remaining ammonia concentration in the solution by using the electrolysis process is shown in table 3.

Table 3. Remaining concentration of ammonia in the solution after treated by using electrolysis method (initial ammonia concentration = 100 ppm, electrolysis time = 25 min., electrical voltage = 10 volt)

Concentration of KOH (M)	Ammonia concentration (ppm)	
	Initial	Remaining
0.01	100	13.35
0.02	100	13.19
0.03	100	12.88
0.04	100	12.42

From table 3it can be concluded that an increment on the concentration of potassium hydroxide insignificantly decreases the remaining concentration of ammonia; insignificantly increases the converted ammonia content.The KOH generates alkaline environment of ammonia electrolysis. An increment on the alkalinity decreases the ammonia oxidation overpotential, shifts the ammonia oxidation potential negatively.This study is in accordance with previous study conducted by Yao and Cheng (2007), Zhou and Cheng (2008) and Riwayati (2010) [10,12,13].

The optimum conditions (10 volt of electrical voltage, 25 min. of electrolysis time, and 0.04 M of KOH concentration) were applied on the electrolysis of the real liquid waste of tofu.The method was applicable to decrease ammonia content in liquid waste of tofu and decrease 81.13% of the ammonia content.

4. Conclusion

We have investigated the optimum conditions of electrolysis process to reduce the ammonia content in the aqueous solutions. The optimum conditions were 10 V of electrical voltage, 25 min. of electrolysis time and 0.04 M of potassium hydroxide concentration. The electrolysis method was applicable to decrease ammonia content in liquid waste of tofu. 81.13% of ammonia content in the real sample could be reduced by using electrolysis method at the optimum condition.

Acknowledgment

References

[1]   Husni H and Esmiralda 2010, Uji Toksisitas Akut Limbah Cair Industri Tahu Terhadap Ikan Mas (*Cyprinus carpio* Lin), Studi Kasus: Limbah Cair Industri Tahu "SUPER", Padang), *Thesis* (Padang: Faculty of Enginering of Andalas University) Available at http://repo.unand.ac.id/3005/

[2]   Meade JW 1985, Allowable Ammonia for Fish Culture, *The Progressive Fish-Culturist*, **47** p 135

[3]   Snieszko SF 1974, Fhe Effects of Environmental Stresson Outbreaks of Infectious Diseases of Fishes, *J. Fish Biol.*, **6** p 197

[4]   Yasin NHM, Mumtaz T, Hassan MA, and Rahman NAA2013, Food waste and food processing waste for biohydrogen production: A review, *J. Environ. Manage.***130** p 375

[5]   Levina E 2016, Biogas from Tofu Waste for Combating Fuel Crisis and Environmental Damage in Indonesia, *APEC Youth Scientist Journal*, **8** p 16

[6]   Putnarubun C, Rettob M, Gunam IBW, and Balubun SK 2015, Utilization of Tofu Waste As a Cultivation Media for *Tetraselmis sp* Microalgae in Preliminary Study of Biodiesel Production, *International Journal of Basic & Applied Sciences*, **15** p 13

[7]   Bonnin EP, Biddinger EJ, and Botte GG 2008, Effect of Catalyst on Electrolysis of Ammonia Effluents, *Journal of Power Sources*,**182** p 284

[8]   Muflihah, Tindangen RA, and Noor 2015. Penentuan Kadar Ammonia Pada Berbagai Variasi Tegangan Dengan Menggunakan Elektroda Grafit.*Book Research* (Samarinda: Faculty of Teacher Training and Education of Mulawarman University)

[9]   Noor and Nurlaili2015,Penentuan Kadar Ammonia Pada Berbagai Variasi Waktu Dengan Menggunakan Elektroda Grafit,*Book Research* (Samarinda: Faculty of Teacher Training and Education of Mulawarman University)

[10] Riwayati I 2010. Waste To Energy: Recoverydan Elektrolisa Amoniadari Limbah Pabrik Pupuk Untuk Menghasilkan Gas Hidrogen.*Momentum*.**6** p 27

[11] Ratnawati, Sumarno, and Nugroho A 2010, Konversi Elektrokimia Amonia Menjadi Hidrogen, *Teknik*, **31**98

[12] Yao K and Cheng YF 2007, Electrodeposited Ni–Pt Binary Alloys as Electrocatalysts for Oxidation of Ammonia, *Journal of Power Sources*,**173** p 96

[13] Zhou 1 and Cheng YF 2008, Catalytic Electrolysis of Ammonia on Platinum in Alkaline Solution for Hydrogen Generation,*International Journal of Hydrogen Energy*, **33** p 5897

The Application of Electrolysis Method to Reduce Ammonia Content in Liquid Waste of Tofu