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# ICTAFF 2018

## International Conference on Tropical Agrifood, Feed, and Fuel

Sustainability of Food, Feed, and Fuel Tropical Resources for Quality Future

# PROCEEDING

Samarinda, 13-14 November 2018
MESRA Bussines Hotel

# PROCEEDING

## INTERNATIONAL CONFERENCE ON TROPICAL AGRIFOOD, FEED, AND FUEL (ICTAFF) : SUSTAINABILITY OF FOOD, FEED, AND FUEL TROPICAL RESOURCES FOR QUALITY FUTURE

**Samarinda, 13-14 November 2018**

**Publisher**

**Department of Agricultural Products Technology**
**Agriculture Faculty, Mulawarman University**
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# PREFACE

The greatest regards should be expressed only to God the Almighty, Allah SWT. We have finished the Proceeding book of International Conference on Tropical Agrifood, Feed, and Fuel (ICTAFF) after the conference which was held on 13-14 November 2018 in Mesra bussines Hotel Samarinda.

The conference takes "Sustainability of Tropical Food, Feed, and Fuel Tropical Resources for Quality Future" as the main theme.This international conference is aimed at resolving problems and bringing together scientists, researchers, professionals, and students from multidisciplinary agriculture-related fields to share the latest findings or ongoing research activities.

There are 6 sub themes emphasized in the ICTAFF 2018, including halal, safe, and healthy food, improving quality food and nutrition, security and sustainability food and agriculture, innovation in feed technology to increase animal production, sustainable and renewable fuels based on tropical resources, and empowering of agribusiness based on community.

We would like to thank all keynote speakers for their contributions to the Conference, they are Asst. Prof. Dr. Somsak Maneepong from Walailak University Thailand, Prof. Xuming Huang from South China Agricultural University, Prof. Irwandi Jaswir from International Islamic University Malaysia (IIUM), Prof. Ali Agus from Gadjah Mada University, Dr. Dadan Rohdiana from Research Institute of Tea and Cinchona Indonesia, and Widi Sunaryo, Ph.D from Mulawarman University Indonesia.

Finally, we would like to thanks all of the proceeding team who have dedicated their constant supports and countless time to bring these scratches into a book. The ICTAFF 2018 proceeding is a credit to a large group of people, and everyone should be proud of the outcome.

Editors

# Welcome Speech

## Welcome Note From ICTAFF 2018 Committee

*Assalamu'alaikum Warahmatullah Wabarakatuh*

I would like to express the greatest regard to the Almighty God, Allah Subhanallahi Wa Ta'ala, for the Successful of International Conference of Food, Feed and Fuel 2018. I also would like to welcome all the audiences to Samarinda Kota Tepian.

Food security is very important to strengthen and support sustainable development in agriculture. Food, not only from plant but also from animal, should be available for all resident of Indonesia. It is urgent to provide quality feed to support food animal development to fulfill people needs of nutrition.

We would like to report that about sixty participants are attending the conference. Researcher and lecturer from some universities and research institutions will disseminate their research in this conference.This number is beyond our expectation when we were arranging the conference.

This conference will present international speakers from Wailailak University, Associate Professor Somsak Maneepong, Prof. Irwandi Jaswir from International Islamic University of Malaysia, Prof Xuming Huang from South China Agricultural University, Prof Ali Agus from Gadjah Mada University, Dr. Dadan Rohdiana from Research Institute of Tea and Cinchona Indonesia, and last but not least, Widi Sunaryo, Ph.D from Mulawarman University.

The morning session is designed to keynote speeches and the afternoon session is for parallel sessions. The parallel sessions will be focused into six topics: Halal, safe and healthy food; Security and sustainability of food and agriculture; Innovation in feed technology to increase animal production; Sustainable and Renewable fuel based on tropical resources; and Empowering of agribusiness based on community.

Faculty of Agriculture as conference organizer would like to thank Agrivita, the Journal of Agricultural Science on an agreement for publication of the selected papers from ICTAFF participants, and special thank Dr. Haviludin for helping our communication to the agreement. I also would like to thank to STIPER Kutai Timur, especially Prof. Juraemi, for cooperation in organizing and special thanks to PT. Kaltim Prima Coal and PT. Pupuk Kaltim for strong support to this conference.

We hope you will enjoy the tropical climate as long as staying in Samarinda. Thank you

*Wassalamu'alaikum Warahmatullah Wabarakatuh*

Committee,

Aswita Emmawati
Chairman

# CONTENTS



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# A PLAIN DESIGN OF ELECTROLYSIS APPARATUS TO REDUCE AMMONIA CONTENT IN EFFLUENT FROM TOFU INDUSTRY

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## ABSTRACT

One of the environmental problems the tofu industries encounter the presence of an unpleasant odor due to the production of ammonia ($NH_3$) gas from wastewater they produce. Several previous studies have proven that electrolysis methods can breakdown thisharmful gas into more environmentally friendly compounds. As the results of literature reviews and some comprehensive research, this paper comes up with a plain design apparatus useful to reduce ammonia content in wastewater using the electrolysis method.

*Keywords : ammonia, electrolysis, tofu industries, waste*

## INTRODUCTION

One of the most crucial environmental pollution problems in Indonesia is effluent discharge from home-based industries. It is because of that almost all home industries do not practice proper wastewater treatment; instead, the effluent is frequently disposed of in free water bodies which leads to environmental detriment.

Among the real case of wastewater, discharge into waters is what occurs to some tofu industries in the city of Samarinda, Kalimantan. Initially, the effluent of tofu production processes generated in the washing process, boiling to pressing which is commonly discharged into the surrounding water bodies without proper treatment. This practice eventually causes pollution to the water by tofu liquid waste. This environmental pollution is indicated with the presence of a strong odor of ammonia gas resulting from protein decomposition of tofu liquid waste.

A number of studies have been conducted to reduce ammonia levels in liquid waste, one of which is considered rather effective is to apply the electrolysis process (Vitse et al., 2005). Electrolysis is the process of decomposition of chemical compounds by means of the electric current. Electrons flow from and to the power supply, but not between the two electrodes. Meanwhile, the cation will flow to the cathode and be neutralized by the addition of electrons (reduction) at the cathode, whereas the anion will flow to the anode and release electrons (oxidation) to become neutral. The application of electrolysis methods in wastewater treatment is unique because it depends on the reduction potential; hence, the electrolysis process can decompose various substances. Furthermore, based on a number of research results, it is not only focused on reducing ammonia levels, but it also has come to the further stage to utilize the hydrogen gas resulting from ammonia electrolysis for the purpose of renewable fuels (Vitse et al., 2005; Hanada et al., 2010).

On the same topic, Li et al. (2014) conducted research on ammonia electrolysis using zeolite electrodes. A total of 6 – 100 mg of N/L ammonia was able to be removed within 1 – 7 hours under study conditions. Furthermore, the application of electrolysis in a wastewater treatment plant has succeeded in reducing ammonia levels from 27.8 mg N/L to 0.5 mg N/L after 1.5 hours of electrolysis. Likewise, Riwayati and Ratnawati (2010) also conducted research and came to the conclusion that electrolysis techniques are very likely to be commercially applied in reducing ammonia levels. Yet, various variables have to be taken into accounts, such as the type of electrode, pH, catalyst and electric current being used. Muflihah and Tindangen (2015) found that the voltage used in the pure ammonia electrolysis process is linearly proportional to the conversion of pure ammonia. Meanwhile, Noor and Nurlaili (2015) also revealed that increasing KOH concentration as a catalyst in pure ammonia electrolysis was directly proportional to the increase in pure ammonia conversion.

Using the same principle, the application of electrolysis methods in the treatment of liquid waste generated from tofu production is expected to reduce ammonia content; thus, the levels are safer for the environment. In their study, Muflihah et al. (2015) revealed that electrolysis can reduce ammonia levels in tofu liquid waste by a conversion rate of up to 82.60%.

However, one of the constraints of the above studies is that they still utilize commercial sources of electricity, resulting in high total cost in the wastewater treatment process. Therefore, this present study is aimed at finding the more economical electrolysis method in wastewater treatment by using more affordable sources of electricity. Instead of using commercial sources, the electrolysis process is designed to utilize electricity generated by solar panels to overcome the high operational cost. This plain design of the prototype is expected to be used as a model in processing tofu industrial wastewater at a laboratory scale.

## LITERATURES REVIEW

Tofu production always generatestofu sludge as solid waste and a considerable amount of liquid waste. While a solid waste of tofu (sludge) is usually used as a source of other processed food or animal feed, it is not for the liquid waste generated through the process of washing, boiling, pressing and tofu molding. Most part of the liquid waste is immediately discharged into the river without going through proper wastewater treatment. It is certainly hazardous for the environment since the liquid contains a number of harmful chem

icals, one of which is ammonia or $NH_3$), as well as other hazardous substances, such as organic matter which causes high BOD and COD. In addition, the temperature of liquid waste is considered quite high compared to the free water bodies' temperature.

In a thesis containing study report conducted by Sani (2006), she revealed that most of the sources of liquid waste generated by tofu-making industries are thick liquids which are separated from lumps of tofu called 'whey'. This liquid waste is often disposed of directly without proper treatment prior to discharge; thus, in time it will produce a foul odor and pollute the river water. Furthermore, still in the same reference, she presented the characteristics of liquid waste as shown in Table 1.

In addition to the parameters listed in the table above, it is found that there is also a considerable amount of ammonia in the tofu liquid waste. Husni and Esmiralda (2016) in their study on tofu wastewater found that industrial wastewater of tofu production contains ammonia for up to 2.21 – 16 mg/L. Similarly, research's finding of Christin (2015) also found the figure of 5.29 mg/L of ammonia content. Given this value, it is very far exceeding the ideal level as stated in Government Regulation of the Republic of Indonesia Number 82 the Year 2001 about the Management of Water Quality and Control of Water Pollution, in which, it is stipulated that maximum limit of ammonia is 0.5 mg/L. In fact, for some species of fish, the ammonia content should not even be more than 1 mg/L for their sustainable living.

**Table 1**. Characteristics of industrial effluent of tofu.

| Parameter | Maximum value | Maximum permissible limit |
|---|---|---|
| Temperature | 38°C | - |
| BOD | 150 | 3 |
| COD | 275 | 5.5 |
| TSS | 100 | 2 |
| pH | | 6.0 – 9.0 |

*Source: Sani, 2006*

Given the fact that the tofu wastewater produced is directly discharged into the river, it becomes a great concern for the environment. Furthermore, the dumping location is also very close to the settlement, particularly to the residents around Karang Mumus River. When used for domestic purposes, the polluted river water cause a great impact on health since the content of the pollutants exceed the value of the maximum permissible level. During dry season, the decrease in water discharge turns the water black and gives off unpleasant odors to the surrounding. This foul air can be caused by ammonia evaporation which the river water contains since its concentration may reach 4.56 mg/L.

Albeit ammonia is a hazardous substance for life, it has the potential of being used as a renewable energy source. This is due to the fact that ammonia consists of hydrogen atoms which are known to be very environmentally friendly fuels. As such, when the hydrogen-based fuels are combusted, it will decompose into the water as a byproduct. The utilization of ammonia as a new renewable energy source has been carried out by some researchers, such Botte from Russ College of Engineering and Technology (Vitse et al., 2005). In his research, Botte used an electrolysis process to produce Hydrogen gas fuel cells from wastewater containing ammonia.

Likewise, in Indonesia, electrolysis of wastewater containing ammonia has also been carried out by some researchers. However, the process ends up to the decomposition of ammonia to Nitrogen and Hydrogen gas with the aim of reducing wastewaterharmful effect without taking advantages from the components decomposition

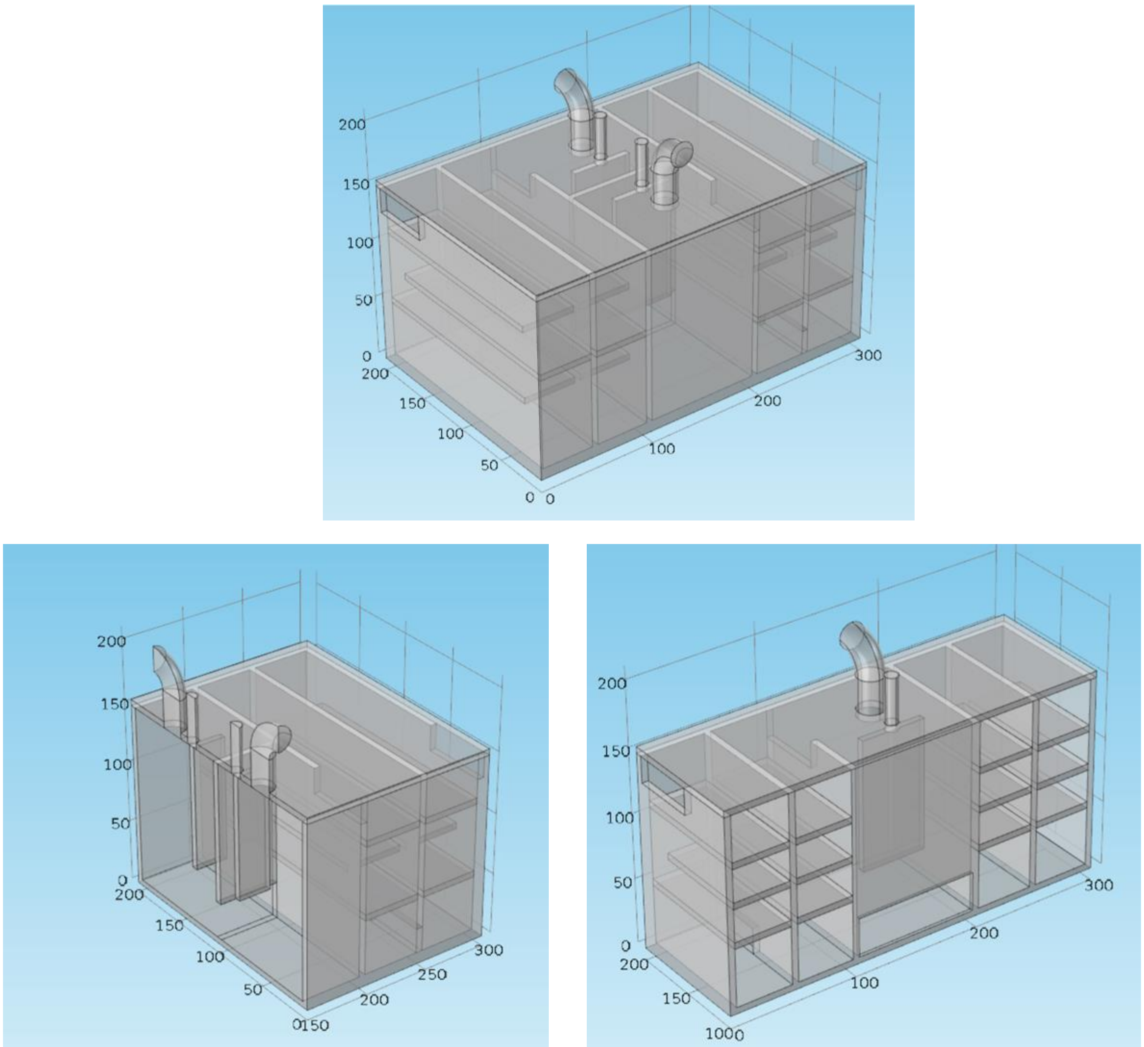


**Figure 1.** Laboratory scale design of ammonia wastewater treatment apparatus

of wastewater. On the other hand, the process of electrolysis has been carried out to produce Hydrogen gas from ammonia. Yet, the ammonia being used is in high purity, rather than decomposed materials from wastewater treatment which contains ammonia.

Similar research has also been carried out by Muflihah et al. (2015) to determine the effect of different voltages on pure ammonia concentration. It comes to the conclusion that the decrease in ammonia levels in the liquids linearly proportional to the voltage used in the electrolysis process. In other words, it can be inferred that the higher the voltage used, the more pure ammonia is converted. A study on the same topic was conducted by Nurlaili and Noor which showed that the use of different concentration of KOH as a catalyst in the electrolysis process also affected pure ammonia levels it produced. Using a higher concentration of KOH, the more pure ammonia was yielded. When applied to liquid waste, the electrolysis method can convert ammonia to 73.66% (Muflihah et al., 2015).

## DESIGN OF AMMONIA WASTEWATER TREATMENT APPARATUS

One of the methods of ammonia wastewater treatment being developed in this present study is based on the process of electrolysis. The design of the apparatus is presented in the following figure (Figure 1). The plain design of apparatus consists of tubs arranged in series which can be added according to the results of ammonia removal in each tub.

The process of ammonia reduction can be carried out through a continuous or batch system. In this study, the wastewater which contains ammonia flows into tub I. Each tub consists of three compartments. The first and third compartments are labyrinths that function to stir the liquid which flows in. The second compartment is an electrolysis cell which is made airtight but can be opened for cleaning and electrode replacement purposes. At the top of each electrode is facilitated with an exhaust channel for gases produced during the electrolysis process. The liquid flow from the electrolysis cell will be drained out to the next tub and will undergo repeated processes as in the first bath. In the batch system process, the liquid flow from the last tub is pumped back into the first tub until the ammonia level reaches a safe limit and can be released into free water. On the other hand, a continuous process can be carried out by modifying the variables which affect the rate of electrolysis, for instance, by increasing the number of tubs and optimizing the variable of electrodes, voltage source, temperature or other variables.

Finally, the electrode cells are connected to a power source of electricity generated by solar panels. Electrolysis is the process of converting electrical energy into chemical energy with the aim of converting chemical substances by oxidation or reduction; thus, the desired products are formed. Through the electrolysis process, ammonia in wastewater can be reduced by converting the ammonia into Nitrogen and Hydrogen gas.

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