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Ammonia removal from skim latex using air bubbles

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Abstract

Skim rubber is produced by adding sulfuric acid into skim latex for rubber coagulation. The amount of sulfuric acid used, however, depends on the concentration of ammonia containing in the skim latex which is used as a preservative agent. Two techniques are currently used for the ammonia removal including stirring in an open tank and flowing pass a horizontal open channel. Both techniques, nevertheless, require large areas, high operating cost and time consuming. Moreover, the evaporated ammonia produced during the removal process causes a harmful effect on the health. In this research, therefore, air bubbles at different sizes of diffusers (10-16μm, 16-40μm, and 40-100μm) and air flow rates (300 cc/min,500 cc/min,700 cc/min) were used instead to remove ammonia in skim latex. The results show that the smallest size of bubbles with highest air flow rate provided the highest removal rate of ammonia. Using bubbling technique, can not only overcome those drawbacks suffering from the conventional processes but also minimize the amounts of sulfuric used and wastewater produced. Also, ammonia in air stream can be treated before purging to the environment.

Keywords: Ammonia removal, Skim Latex, Air bubbles

Introduction

Many countries currently produce natural rubber such as Thailand, Vietnam, Indonesia, India and Malaysia. It can be used as raw material for various products i.e., tires, glove and so on. Thailand is the top three countries producing large amount of natural rubber. This is because the weather and soil are suitable for planting rubber trees. In 2018, Natural rubber was producing over 1.5 Mton/year. Some of them are exported to overseas and the rest is domestic used [1]. Natural latex is a cloudy, white liquid that can be collected by cutting thin strips of bark from the rubber trees [2]. After collecting, ammonia is then added to natural latex for preservation. The natural latex is concentrated by a centrifugal technique forming concentrated latex (over 60% dry rubber content, total solid content) and skim latex (4-8% dry rubber content, total solid content). Skim latex can be used to produce skim block, skim crepe and coagulated latex [3]. Before producing such products, ammonia has to be removed in order to reduce sulfuric acid used during processes. Due to low sulfuric acid used, it results in small amount of waste water produced [4].

There are several techniques for ammonia removal in Thailand e.g. stirring latex in the open tank and flowing latex through the horizontal open channel. However, these techniques can remove ammonia but they need long time and large area. In addition, ammonia evaporates as a pollutant to the environment [5]. Therefore, this paper is interest in air bubbles to remove ammonia. The advantages of this proposed technique are require less space, less operating time compared with the conventional processes. Also, it is a simple and cost effective way [6].

The objective of this research is to find relationship between pore size of diffusers, air flow rate and operating time for ammonia removal in the bubble column. Although this method cannot solve air pollution problems, it helps to minimize the amount of wastewater and sulfuric acid used.

Materials and methods

Materials

Concentrated latex (60% TSC) with ammonia concentration of 0.7 wt% was purchased from Rubberland Product co., Ltd. Ammonia solution (28 wt%) , hydrocholric acid (38%), and methyl red (ACS reagent grade) were obtained from Sigma-Aldrich.

Methods

Skim latex (4% TSC) was prepared by adding distilled water into concentrated latex. Initial ammonia concentration was controlled at 0.5 wt% , thus ammonium solution was then added into skim latex. The experimental setup is shown in Figure 1. The bubble column has a diameter of 50 mm assembled with a diffuser connected to stainless tubes, a flow meter and an air pump. Bubbles were generated while air was flowed through the column. Bubble-sizes were varied depending on the diffuser used. Here, the diffusers are porous-glass discs with a diameter of 50 mm and have different ranges of pore sizes; P2 (40-100 µm), P3 (16-40 µm) and P4 (10-16 µm) as represented in Table 1. The skim latex (0.5 wt% of NH_3) of 50 mL was loaded into the bubble column. Air was then flowed from the air pump with different flowrates of 300, 500 and 700 cc/min through the diffuser and the latex containing in the column. Samples were collected every 10 minutes for 1 hour. The concentration of ammonia in skim latex was analyzed using the tritration technique. The reduction of ammonia concentration in the bubble column with time was recorded in related to bubble-sizes and flowrates.

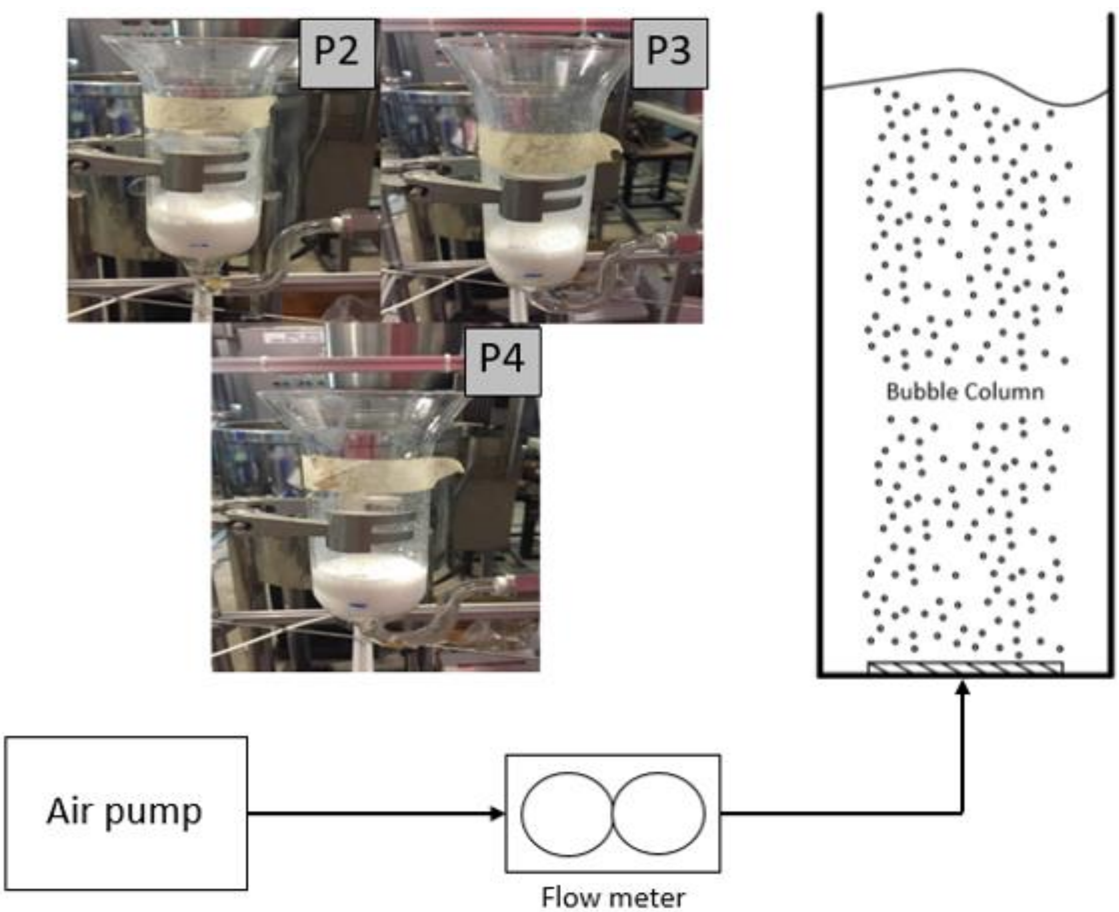
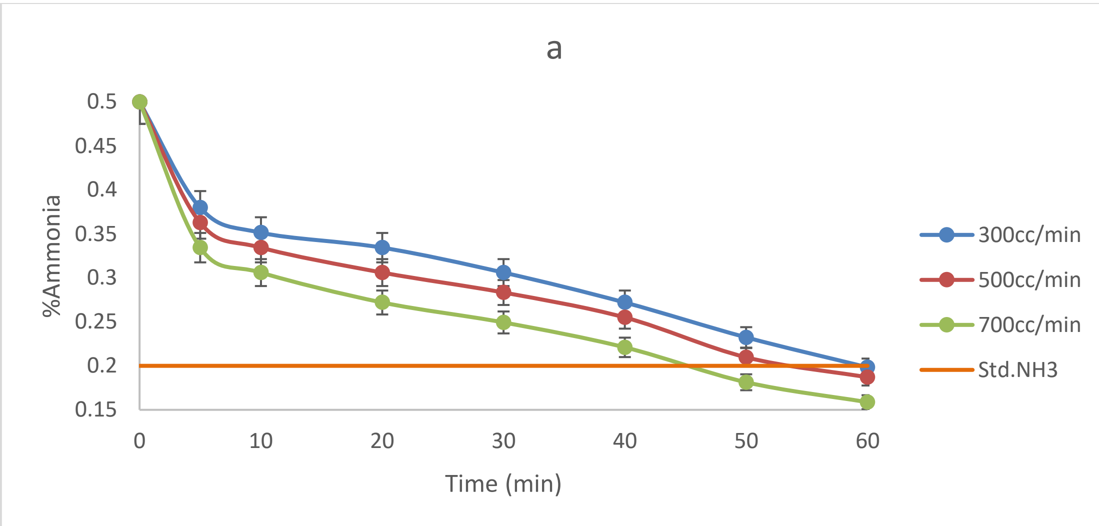


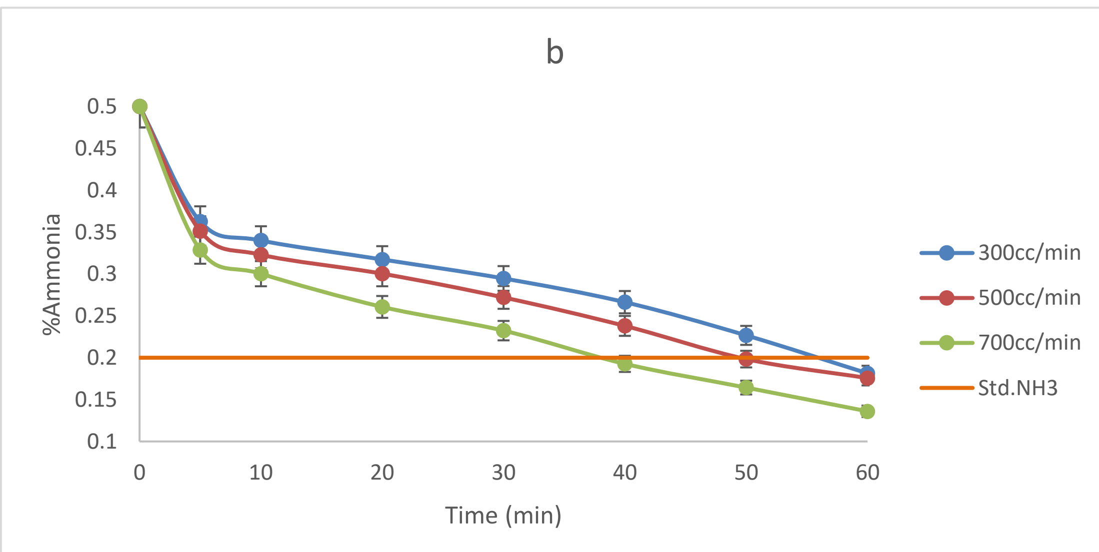
Figure 1 Experimental setup for ammonia removal via bubbles .The inset is a photograph of the bubble column while flowing air with a flow rate 300 cc/min through a diffuser P2, P3, and P4.

Table 1 Sizes of the diffusers used in the experiment

Diffuser	Pore size(µm)
P2	40-100
P3	16-40
P4	10-16

Results and discussion





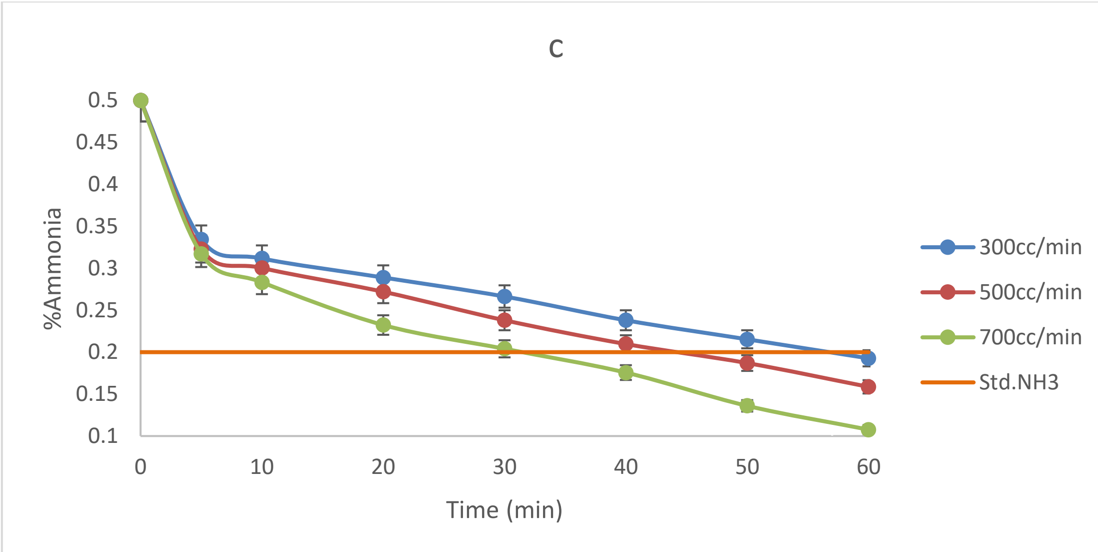


Figure 2 The remaining NH_3 content (wt%) after flowing of air for 60 minute through diffusers P2(a), P3(b), and P4(c) at air flow rates of 300, 500 and 700 cc/min.

A simple and inexpensive technique for ammonia removal via air bubbles presented in Figure 1. The inlet temperature of air was set room temperature. After bubbles formed, they float from the bottom to top of the bubble column. Ammonia dissolved in skim latex evaporates simultaneously into bubbles leading to the reduction of such substance.

The amount of ammonia remaining in skim latex with various bubbling times are shown in Figure 2. Overall, the concentration of ammonia decreases rapidly in the first 5 minutes. It was noticed in all flow rate and diffusers. At air flow rate of 700 cc/min represented in Figure 2a, concentration of ammonia decreases from 0.5% to 0.2% (the standard concentration before feeding to next process) within 45 minutes, while longer bubbling time required at lower air flow rate. These characteristics were observed when the diffuser P3 and P4 were used as shown in Figure 2b and Figure 2c, respectively. At flow rate of 700 cc/min represented in Figure 2b, concentration of ammonia decreases from 0.5% to 0.2% within 40 minutes, whereas diffuser P4 represented in Figure 2c reached that target within 30 minutes. This means that small pore size can reduce more amount of ammonia than large pore size at the same air flow rate according to the work done by Zimmerman and Rees study [7]. In other words, smaller bubble size reduces more amount of ammonia than large bubble size, because the small bubbles provided high surface area [8].
Moreover, at the same air flow rate, the highest removal rate of ammonia was observed at the highest air flow rate as shown in Figure 2 a-c. This means that the amount of ammonia transferred into air bubbles is proportional to air flow rate.

Conclusion

This research successfully performs a simple and practical technique for ammonia removal from skim latex using air bubbles. Bubble size and air flow rate are the main parameters that affect the rate of ammonia removal. Higher ammonia removal rate was observed when both smaller bubbles were formed and higher flow rate was set. In addition, the amount of ammonia in skim latex is less than 0.2% within 30 minutes for the diffuser (P4) and flow rate (700 cc/min).

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