Water Treatment Processing Rubber by Bio-Filter Technology

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Abstract:
The paper overviewed the situation of rubber production and processing in Vietnam. At the same time, it also introduces methods to treat wastewater from the process of processing rubber latex in Vietnamese rubber processing factories. Methods of treating rubber wastewater such as: mechanical methods, physical and chemical methods and finally biological methods. Biological - membrane in particular is a new way to protect the environment and develop sustainably

Keywords: *Rubber, treat wastewater, Biological – membrane, chemical methods, Vietnam.*

1. Introduction

Sustainable socio-economic development is the goal of most countries today. In which environmental issues and issues related to the environment is the topic discussed in depth in the sustainable development plan of any country in the world. Environmental pollution is becoming a global problem. In our country, in the past, environmental pollution mainly occurred in some areas such as densely populated urban areas, some mining areas, etc. But now pollution occurs popularly everywhere and on every environment. earth, water, and air field. The rubber latex processing industry is one of the leading industries in our country and the growth potential of this industry is enormous. According to the general development trend of the world, the demand for rubber is increasing. Rubber is used in almost everything from daily needs to industrial fuel and export. By 1997, the area of rubber trees in our country reached nearly 300,000 hectares with an output of 185,000 tons. According to the master plan with loans from the World Bank, by 2010, the area of rubber trees will reach 700,000 ha and an output of 300,000 tons. In our country, annual rubber processing industry is estimated to produce about 5 million cubic meters of wastewater. This wastewater has a very high concentration of easily decomposable organic substances such as acetic acid, sugar, protein, fat COD content reaches 2,500 - 35,000 mg / L, BOD from 1,500 to 12,000 mg / L occurs. receiving sources that have not been completely treated severely affect aquatic organisms in the water. In addition, the odor problem arises due to anaerobic decomposition of organic matter, forming mercaptan and H_2S affecting the surrounding air environment.

2. Overview

2.1. General introduction about the world rubber production situation and Vietnam

The world rubber industry is divided into 2 groups including natural rubber and artificial rubber. Natural rubber is composed of rubber latex extracted from rubber trees, while artificial rubber is derived from petroleum. Currently, the demand for natural rubber accounts for about 40 - 45% of the total global rubber demand.

Vietnam's rubber output has increased rapidly following the increase in area. Due to improved varieties and advanced techniques, productivity has also increased continuously since 1980, at about 700 kg / ha / year in the 1980s to average 1,700 kg / ha / year in the period of 2009 - 2017. Vietnam has now become one of the leading countries in productivity in Asia. Average output has grown by 9.5% per year over the past decades, from 41,100 tons in 1980 to 1,094,500 tons in 2017, an increase of 26.6 times. With this output, Vietnam is the third country in the world in terms of natural rubber supply, accounting for about 8.1% of the total world rubber output, after Thailand (33.2% of the world market share). gender) and Indonesia (27.2%) (Association of Natural Rubber Producing Countries, ANRPC 2018).

2.2. Latex

Rubber latex processing In 2017, Vietnam had a total of 196 processing plants, with a design capacity of over 1.3 million tons of dry latex per year. In 2014, there were 164 rubber processing factories in the whole country with a total designed capacity of 1,218,100 tons, 25.1% higher than the production of 973,700 tons in 2014 and 20% compared with the output of 1,017,000. ton 2015. In the Southeast, there were 106 factories with a capacity exceeding 36.8%. In this year, the Central Highlands has 19 factories and the capacity is lower than the output, so a number of rubber exploited from this region is put to preliminary processing in the Southeast. The Central region has a lower rubber output but the number of factories is 36, with a total capacity of 19.8% higher than the source of raw materials (Department of Agro-forestry Processing and Salt Industry, 2015). By 2017, the number of newly established factories is about 35 compared to the number of factories in 2014. By the end of 2017, the North has no latex preliminary processing factories, some provinces with rubber production have moved to the Central provinces to record. preparations. The plant capacity in the Central Highlands is lower than the output, so the natural rubber produced in this region is transferred to the Southeast for preliminary processing.

According to the Department of Agro-forestry Processing and Commercial Salt Industry (2015), out of 164 rubber processing factories in 2014, the number of factories of private enterprises accounted for over 70%, the rest were factories of State-owned enterprises (enterprises of the Rubber Group, enterprises managed by local governments, defense enterprises (27.4%), some cooperatives and FDI enterprises (2.6%).

Rubber products are diverse, including products such as tires, shoe soles, conveyors, gloves, rubber thread and many other types of products. Producing these products requires a much higher technological level, machinery and workmanship than processing raw products (rubber latex).

In 2017, about 80.4% of natural rubber production in Vietnam was used for export; the remainder (19.6%) is used domestically for the rubber product processing industry. In 2017, Vietnam was the third largest natural rubber supplier in the world, after only Thailand and Indonesia. Supply from Vietnam accounts for about 11.7% of total natural rubber supply in the world. In 2017, about 19.6% of Vietnam's rubber production was used for domestic consumption. Vietnam is the 11th largest consumer of natural rubber in the world with a relatively high growth rate of 7.6% / year in the last 5 years. However, the volume of natural rubber consumed domestically is only about 214,000 tons, accounting for 1.6% of the total natural rubber consumed in the world (13.22 million tons). Domestic natural rubber consumption rate is on the rise, from 16, 3% of Vietnam's total natural rubber in 2013 to 19.6% in 2017 (VRA, 2018b).

3. Origin, composition and nature of wastewater processing rubber industry

Waste water from rubber processing factories has a very high level of pollution, greatly affecting the environmental sanitation conditions. Waste water from factories in large quantities seriously pollutes residential areas, affecting the health and life of people in the area. Toxic odors, chemicals used in processing technology also directly affect people's lives and the development of plants and animals around the factory. Besides the development of the rubber industry is the environmental pollution problem caused by waste water of this industry. Annually, the rubber processing industry generates about 10 million cubic meters of wastewater, on average, the amount of wastewater generated is about 25 m3 / ton of product (calculated on the dry weight) produced from latex, 35 m3 / ton of production. products made from latex and 18 m3 / ton of products made from centrifugal rubber (Vietnam Rubber Corporation, 2004).

In the process of processing rubber latex, wastewater is generated mainly from the following production stages:

* Centrifugal latex processing line: Waste water is generated from the centrifugal process of latex, washing machines, equipment and cleaning factories.

* Pus processing line: Waste water comes from the process of freezing, from rolling to rolling, rolling to creating sheets and chopping nuggets. In addition, wastewater also arises due to the process of washing machinery, equipment and cleaning the factory.

* Latex processing line: This is the most water consuming production line in the latex processing lines. Wastewater generated from the process of soaking, washing rubber pus, from the process of rolling, rolling, sheet forming, shredding, washing machines, equipment and cleaning factories, ... carrying latex and living.

In dry rubber processing, waste water is generated at the mixing, freezing and mechanical processing stages. Discharged from the stirrer tank is the wash basin and utensils, which contain a little latex. Wastewater from coagulation ditches is most important because it contains mostly serums that are separated from pus during the coagulation process. Wastewater from the processing stage is similar in nature but thinner, this is washing water that is sprayed on rubber blocks during mechanical processing to continue removing serum and dirt.

In the production of centrifugal rubber, rubber after mixing is put into rotating centrifugal pots at a speed of about 7000 rpm. At this rate, the centrifugal force is large enough to separate the rubber particles from the serum, based on the difference in their specific gravity. After the concentrated rubber latex has been separated, the remaining liquid is serum, which still contains about 5% of rubber, will be frozen with acid H2SO4 to process into solid rubber with a similar process. common rubber. Processing of centrifugal latex also creates three sources of wastewater. Machine wash water and tanks, serums from skim coagulation ditches, and wash water from mechanical machines. Of these skim pus serum is the highest concentration of pollutants.

Freezing wastewater has the highest concentration of contaminants, mainly serums that are left in the waste water after removing latex, including some typical chemicals such as CH3COOH acetic acid, protein, sugar, rubber; a large amount of pus has not coagulated, so a large amount of rubber is left in the form of glue; pH is low about 5-5.5. Wastewater in other stages (rolling, chopping, ...) has a low organic content, the content of uncoordinated rubber is almost negligible.

4. A number of methods are applied to treat rubber latex waste water

4.1. Mechanical method

In wastewater often contains insoluble substances in suspended form. To separate these substances from waste water, mechanical methods such as filtering through trash screens or screens are deposited under centrifugal gravitation and filtration. Depending on the size of physical and chemical properties, concentration of suspended substances, sewage flow and the level to be cleaned, select the appropriate treatment technology.

Song trash

Waste water leading into the treatment system must first pass through trash rack. Here the large-sized components: leaves, plastic bags, garbage ... are kept. Thereby avoiding clogging of pipes and channels. This is an important step to ensure the safety of the wastewater treatment system. But trash rack made of metal, placed in glass doors and windows, tilted at an angle of 45 - 60o if manual cleaning or inclined at an angle of 75 - 85 o if cleaned by machine. The speed of passing through trash rack is limited to 0.6 - 1 m / s. The minimum velocity is 0.4 m / s, the maximum velocity ranges from 0.75 - 1 m / s.

Clarifier

The task of settling suspended particles is available in sewage or sludge generated from flocculation or biological treatment (settling tanks 2). In horizontal sedimentation tanks, the water flows horizontally across the tank at a speed not greater than 0.01 m / s and the retention time is from 1.5 to 2.5 hours.

4.2. Chemical and physical methods

4.2.1. Neutralization method

Wastewater containing inorganic or alkaline acids should be neutralized to about 6.5 to 8.5 before being discharged into the receiving water or used for subsequent technology. To neutralize sewage containing acid, it is possible to use: NaOH, KOH, Na_2CO_3, dolomite ($CaCO_3.MgCO_3$), ... The selection of neutralization method depends on the volume and concentration of wastewater, regime Waste water and chemical costs.

4.2.2. The method of flocculation

In wastewater treatment, flocculation is a combination of chemical and physical methods. The purpose of this method is to remove difficult-to-settle solid particles or improve the settling performance of the clarifier. In the waste water, a part of the particles usually exists in the form of dispersed fine colloidal particles, the size of the particles usually ranges from 0.1 to 10 µm. These particles do not float nor separate, so it is relatively difficult to remove. As a rule, small particles in the water tend to coagulate due to the Vander waals attraction between particles. Collisions due to Brown motion and due to disturbance. The common flocculants are iron salts and aluminum salts such as $FeCl_2$, $NaAlO_2$, $Fe_2(SO_4)_3$ ... To increase the efficiency of flocculation process, people often use flocculation auxiliaries.

4.3. Biological methods

Biological methods are applied to treat dissolved organic substances in wastewater based on the activity of microorganisms to decompose polluted organic substances.

4.3.1. Anaerobic treatment method

The anaerobic digestion of organic matter is complex, producing many products and undergoing many intermediate reactions. However, the equation for biochemical reactions under anaerobic conditions can be expressed as follows:

Organic microorganisms --- □ $CH_4 + CO_2 + H_2 + NH_3 + H_2S$ + New cells

Occurs in 4 stages: - Stage 1: hydrolytic hydrolysis of polymers - Stage 2: acidification - Stage 3: acetate - Stage 4: Metabolization Anaerobic treatment process suspended microorganisms such as anaerobic contact process, anaerobic sludge treatment process with bottom-up water flow (Upflow Anaerobic Sludge Blanket - UASB). UASB has the following characteristics:

All 3 processes, decomposition - slurry - air separation, are installed in the same building. Forms particles with very high microbial density and sedimentation rate far surpassing the suspended aerobic activity form.

4.3.2. Biological filtration method - Membrane (Membrane Bioreactor)

MBR technology (Membrane Bioreactor, membrane - biofilter) is a wastewater treatment technology that combines the filtration process (such as microfiltration or ultrafiltration, mainly polymer films) with suspended biological growth.

Biofilter means a device with a buffer arrangement and a distribution structure of wastewater and air. In biofilter - the sewage membrane is filtered through a layer of material covered by a microbiological membrane.

Biofilter structure: MBR is a combination of a series of filters such as microfiltration (mini). Its application is to separate suspended solids from insoluble substances. Microfiltration membranes are those with limited pore diameter, small size from 0.1 to 10 µm will retain the sludge, dirt, microorganisms of larger size in the membrane, only allow sewage to pass through, because that will save money, no need to build sedimentation tanks and rear disinfection tanks. The final part of the membrane is protozoa and some other microorganisms.

Factors influencing treatment efficiency in biofilter - membranes are the nature of pollutant organic matter, oxidation velocity, retention time, structure of the reaction tank, viscosity of liquids ...

The principle of membrane biofilter is based on the operation of biofilms developed on the surface of the media. Biofilm is a collection of aerobic microorganisms (in the outer layer of the biofilm) and anaerobic and anaerobic microorganisms (in the inner layer of the biofilm). Organic matter and nitrogen are first oxidized by aerobic microorganisms, then further metabolized by anaerobic and anaerobic microorganisms in the inner layer of the biofilm. Therefore, the aerobic biological filtration method can simultaneously handle organic and nitrogen components.

Membrane biofilter is an improved form of conventional aerobic biofilter, in which the air supply process is not a continuous process but is carried out in the aeration-stopping cycle. . In such a manner, the aerobic and anoxic stages are generated alternately in the same device, so that the method of simultaneous organic and nitrogen treatment of the method will be improved. However, also due to aerobic and anoxic processes are carried out alternately in the same device. Therefore, the cycle time of aerating - stopping aeration will be an important factor that greatly affects the efficiency of T-N treatment of the method.

Biological processes take place in biofilter – membranes

• Oxidation of organic substances:

$$C_xH_yO_z + (x+y/4 - z/2)\ O_2 \rightarrow x\ CO_2 + y/2\ H_2O$$

• Synthesis of cell biomass:

$$n\ (C_xH_yO_z) + n\ NH_3 + n(x+y/4 - z/2-5)\ O_2 \rightarrow (C_5H_7NO_2)_n + n(x-5)\ CO_2 + + n(y-4)/2\ H_2O$$

• Self-oxidation of cellular material (intracellular decomposition):

$$(C_5H_7NO_2)_n + 5n\ O_2 \rightarrow 5n\ CO_2 + 2n\ H_2O + n\ NH_3$$

• Nitrification process:

$$2\ NH_4^+ + 3\ O_2 \rightarrow 2\ NO_2^- + 4\ H^+ + 2\ H_2O \text{ (VK Nitrosomonas)}$$

$$2\ NO_2^- + O_2 \rightarrow 2\ NO_3^- \text{ (VK Nitrobacter)}$$

Total ammonium oxidation reaction:

$$NH_4^+ + 2\ O_2 \rightarrow NO_3^- + 2\ H^+ + 2\ H_2O$$

• Denitrification process:

$$NO_3^- \rightarrow NO_2^- \rightarrow N_2$$

5. Conclusion

Advantages of the biofilter - membrane method

The main advantages are water quality after treatment, small plant area, little residual sludge, in addition, MBR technology also has the ability to disinfect limit the smell generated. - Compact system size - Low speed of mud formation - Save cost of good disinfection ability

Disadvantages of biofilter - membrane method

- The phenomenon of clogging the membrane increases the resistance and pressure to penetrate the membrane, thereby reducing the filtration rate according to the operating time. - Membrane filter cost was formerly high.

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