Technology for Treating Wastewater from Rubber Latex Processing

Author's Details:
[(1)]**Thi Thu Hoai Pham, PHD-**University of Economic and Technical Industries [(2)]**Thi Thu Hien Phan, PHD-** University of Economic and Technical Industries **Correspondence**: Thi Thu Hien Phan No. 296/61/12 Linh Nam Street, Hoang Mai District, Hanoi, Vietnam. E: ptthien.kt@uneti.edu.vn; T: +(84) 0914 915 926

Abstract:

The article analyzed the status and nature of waste from rubber latex processing. After that, the situation of treatment of rubber latex processing is analyzed through stages. In general, the rubber processing industry is an industry that has a lot of impacts on the environment, but waste treatment technology is getting better and better with better technology to improve the negative impact on the environment

Keywords: *Wastewater, rubber latex processing, Vietnam*

1. Introduction

Rubber is always a key export industry in Vietnam. At the same time, WTO accession has brought positive effects and created favorable conditions for the export of Vietnam's rubber products. In the current situation, rubber planting is still attractive because the added value of rubber is still higher than some other crops. Increasing the area of new rubber plantations, of course, is to plant rubber in new ecological areas with more difficulties in terms of conditions leading to rubber latex processing plants being developed throughout the provinces. Large rubber cultivation level. The leading rubber processing companies in Vietnam: Vietnam Rubber Industry Group VRG, Phu Rieng One Member Corporation.

Besides, the discharge of waste from rubber processing is not really effective seriously affecting the environment, ecosystems around factories, ... the face of many environmental challenges requires the application of waste treatment technologies on the processing of rubber latex are actually necessary.

Statistics of the Ministry of Agriculture and Rural Development, in 2018, the total area of rubber trees reached more than 900 thousand hectares, an increase of nearly 10% compared to 2017.

Rubber plantation area is mainly concentrated in the Southeast (64%), followed by the Central Highlands (24.5%) and Central Coast (10%). The area of rubber trees in the Northwest region is only about 10,200 ha (accounting for 1.5%).

Binh Phuoc is considered the capital of rubber trees, with an area of about 170,000 ha, of which 7 state-owned companies (4 of Vietnam Rubber Industry Group and 3 of the province) are managing, exploiting an area of nearly 90,000 ha. With a large area of planting and processing rubber latex, it is necessary to have a process of efficient production and treatment of wastewater to minimize the level of water pollution.

2. Composition and properties of wastewater

Wastewater from rubber latex is formed mainly from mixing, freezing, mechanical processing and washing machine and tank water.

Rubber processing wastewater has a low pH, between 4.2 and 5.2 due to the use of acid to coagulate rubber latex.

Rubber particles exist in water in the form of suspension with very high concentration. These suspended particles are rubber particles that have been coagulated but not yet formed into a large array, which arises during the crepation and rolling phase. If the wastewater is stored for a long time and there is no disturbance of the stream, these suspensions will float themselves and become large pieces on the water surface.

Figure 1: Wastewater from rubber latex

Rubber particles exist in emulsions and glues arising in the process of washing tanks, washing grease cups, water separated from centrifugal latex and even during the wintering period.

In the wastewater also contains a large amount of soluble protein, foomic acid (used during the freezing process), and N-NH3 (used during the antifreeze). COD content in wastewater is quite high, up to 15,000 mg / l.

Latex is a mixture of rubber constituents suspended in a solution called saliva or serium. Spherical rubber granules with a diameter of d <0.5 µm are turbulent in solution. Usually, 1 gram of latex has about 7.4.1012 rubber particles, surrounding these particles are proteins that keep latex in a stable state.

Rubber: 35-40%; Protein: 2%; Quebrachilol: 1%; Soap, fatty acids: 1%; Inorganic substances: 0.5%; Water: 50-60%. BOD / COD ratio of wastewater is 0.60 - 0.88, suitable for biological treatment.

3. Technological process of treating wastewater from rubber latex processing

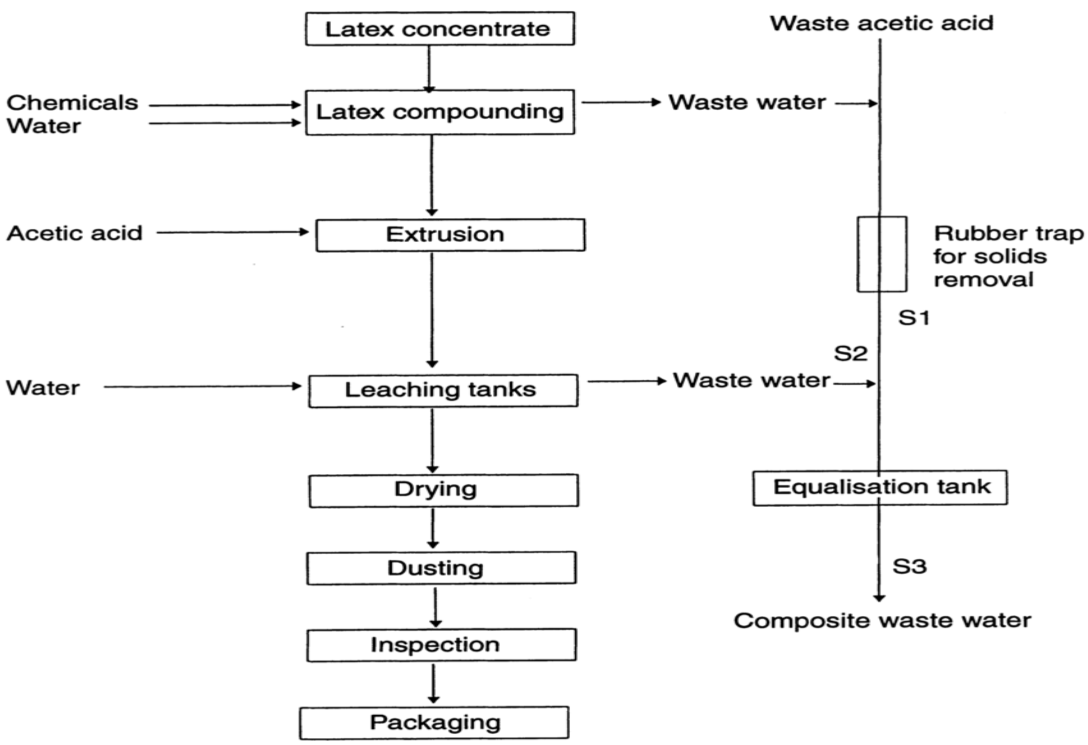

Figure 2: Process of processing waste from rubber latex processing

Wastewater treatment of rubber latex should pay attention to the treatment of polluting indicators such as COD, ammonium, and phosphorus. The concentration of N-NH3 in high wastewater is mainly due to the use of ammonia as an antifreeze during latex harvest, transport, and storage, especially in centrifugal latex processing. Besides, phosphorus content in wastewater is also very high 88.1-109.9mg / l. A particularly important issue is the recovery of rubber latex in wastewater.

Figure 3: Storage tank

Production wastewater is collected to collection ditches. After separating large sized garbage and latex, wastewater is pumped through the storage tank. From the reservoir, the wastewater is pumped to the latex septic tank.

Figure 4: Latex septic tank

At the colloidal latex pool, physicochemistry of pus flocculation is applied with a certain dose. In the tank, the paddle system with a large speed will mix quickly and evenly with the input wastewater. Self-flowing water from the flocculation tank to the separating cap tank, the cap is concentrated at the bottom of the tank, the water in the selfflows through the conditioning tank.

Figure 5: Conditioner tank

The air conditioner has the function of regulating the flow and concentration of wastewater. At the same time, the tank also has the function of supporting the anaerobic treatment and nitrogen treatment works of the rear works. Wastewater from the conditioning tank is pumped to the reaction tank. Coagulant chemicals and environmental correction chemicals are applied to the tank with a certain dose and strictly controlled by a pH machine. Under the effect of the paddle system with a large speed installed in the tank, flocculation chemicals, and environmental correction chemicals are quickly and evenly mixed into the wastewater. In favorable environmental conditions for flocculation, flocculation and contaminants in wastewater are exposed, interacting with each other, forming tiny flakes throughout the area and tank volume. This wastewater mixture flows through the flocculation flocculation tank. At the flocculation flocculation tank, the flocculation chemical is applied to the tank with a certain dose. Under the effect of this chemical and the slow-moving rotor system, the tiny flakes from the reaction tank will move, collide, bind and form residues in the flocculation flocculation tank. The size and volume are many times larger than the original sediments, creating favorable conditions for settling in settling tanks. Useful mixes of water and flakes flow into settling tanks.

The sludge is retained at the bottom of the settling tank and discharged into the sludge tank, the water after treatment at the gravity tank to the UASB tank.

Figure 6: UASB tank

Wastewater from the sedimentation tank flowing through UASB tank - is an anaerobic biological treatment facility. With the advantage of not using oxygen, anaerobic tanks are capable of receiving wastewater with very high concentrations. Highly polluted wastewater will come into contact with anaerobic sludge and all biochemical processes will take place in this mud layer, including hydrolysis, acidification, acetate, and methane formation, and other final products. However, after passing the anaerobic digester, the concentration of organic substances and other substances is still higher than the receiving standard according to the current regulations of the law, so the wastewater will continue to be treated at a biological level. higher order**.**

Figure 7: Aerotank tank

Figure 8: Anoxic tank

Wastewater from UASB tank flows into the anoxic tank - aero tank. This is an aerobic activated sludge tank combined with denitrification, synthetic treatment of pollutants in the water: reducing BOD, nitrifying NH_4^+ and reducing NO_3^- to N_2, disinfecting wastewater without using disinfectant chemicals. With the selection of a combination of activated sludge treatment tank as above and not only utilize the amount of carbon when reducing BOD, therefore, there is no need to supply additional carbon from outside when deoxidizing NO_3, saving 50% of oxygen when NH_4^+ reducing nitrification due to the utilization of oxygen from the NO_3^- reduction process, but also reducing the area of land used.

The concentration of activated sludge in the tank ranged from 1,000-5,000 mgMLSS/L. The higher the activated sludge concentration, the greater the organic load and the greater the treatment efficiency of the tank. Oxygen (air) is provided by air blowers and a highly efficient air distribution system with air bubble size less than 10 µm. The amount of gas supplied to the tank with the purpose of (1) providing oxygen for aerobic microorganisms to convert organic matter dissolved into water and carbonic, organic nitrogen and ammonium into nitrate NO_3^-, (2) mix well wastewater and activated sludge facilitate microorganisms in good contact with the substrate to be treated. The organic load of aerobic tanks usually ranges from 0.32-0.64 kg BOD / m3 day and night.

- Oxidation and synthesis:

COHNS (organic matter) + O_2 + Nutrients + aerobic bacteria ----> CO_2 +

H_2O + NH_3 + C_5H_7ON (New bacterial cells) + other products

Intracellular respiration

$$C_5H_7O_2N \text{ (cell)} + 5O_2 + \text{bacteria} \text{ ----> } 5CO_2 + 2H_2O + NH_3 + E$$

- Besides the conversion of organic substances into carbonic (CO2) and water (H2O), aerobic bacteria Nitrisomonas and Nitrobacter also oxidize ammonia (NH3) to nitrite (NO2-) and finally nitrate (NO3-).
- Bacteria Nitrisomonas:

$$2NH_4^+ + 3O_2 \text{ ----> } 2NO_2^- + 4H^+ + 2H_2O$$

- Bacteria Nitrobacter:

$$2NO_2^- + O_2 \text{ ----> } 2\,NO_3^-$$

- Synthesis of 2 equations above:

$$NH_4+ + 2O_2 \text{ ---> } NO_3^- + 2H^+ + H_2O$$

The amount of oxygen O2 needed to fully oxidize ammonium (NH4 +) is equal to 4.57g O2 / gN with 3.43g O2 / g used for nitrite process and 1.14g O2 / g NO2- oxidized. Based on the following general equations:

$$NH_4^+ + 1{,}731O_2 + 1{,}962\,(HCO_3)^- \text{----> } 0{,}038\,C_5H_7O_2N + 0{,}962\,NO_3^- + 1{,}077\,H_2O + 1{,}769\,H^+$$

The above equation shows that every 1g of nitrogen-ammonia nitrogen (N-NH3) is converted, 3,96g of O2 oxygen is used, 0.31g of new cell (C5H7O2N) is formed, 7.01g of CaCO3 alkaline is separated Out and 0.16g of inorganic carbon is used to form new cells.

The denitrification process from nitrate NO3- to nitrogen gas form N2 ensures the nitrogen concentration in the outlet water meets environmental standards. Nitrogen reduction is related to the biological oxidation of many organic substances in wastewater using Nitrate or nitrite as an electronic receiver instead of oxygen. In the absence of DO or below DO concentration limited to mg 2 mg O2 / L (anoxic conditions). This condition is created in the anoxic tank with a submerged mixer.

$$C_{10}H_{19}O_3N + 10NO_3^- \text{ ----> } 5N_2 + 10CO_2 + 3H_2O + NH_3 + 100H^+$$

This metabolism is carried out by nitrate-reducing bacteria, which accounts for about 10-80% of the bacterial mass (mud). The special denitrification rate ranges from 0.04 to 0.42 g of N-NO3- / g MLVSS on a day, the higher the F / M ratio the greater the reduction rate. After treatment in the anoxic tank - aerotank tank, wastewater flows automatically through lamella tank.

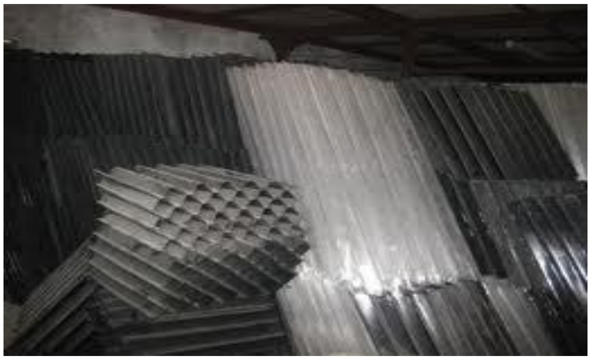

Figure 9: Lamella sedimentation plate

Wastewater from the anoxic tank - the aero tank is distributed into the water distribution area of lamella sedimentation tank. The sedimentation efficiency is significantly enhanced by the use of a lamella sedimentation system. Lamella sedimentation tank is divided into three basic areas:

- Water distribution area;

- Settling zone;

- Concentrated area and residue.

Residual water and flakes move through the water distribution zone into the sedimentation zone of the lamella sedimentation system, with thin layers arranged in a consistent sequence and distance. When the mixture of water and flakes passes through this system, the mudflakes collide with each other, forming a sludge that is much larger in size and mass than the original mud. The mudflakes glide along with the lamella plates and are gathered in the sediment storage area. Clean water is collected at the top of the settling tank and taken to the intermediate tank.

The intermediate tank is the place to transfer water from lamella sedimentation tank to dry type nano tank. Water is pumped from settling tank through dry type nano tank.

The suspended solids, bacteria, and color left in the wastewater will be removed at the dry form nano. Rubber latex wastewater after passing dry nano-tanks meets the permitted waste discharge standards according to the provisions of law

In summary, based on the above-mentioned characteristics of wastewater, rubber wastewater treatment technology is proposed as follows:

Input sewage -> SCR crude -> Receiving tank -> SCR concentrate -> Air conditioner tank (Adjust pH, Compressed air) -> Decanter tank (latex residue) -> UASB tank (Waste sludge, Biogas) -> Aerobic biological tank (Refined sludge) -> Sedimentation tank 2 (Residual sludge) -> Disinfection tank (Chlorine) -> Outlet wastewater.

4. Conclusion

With the above technology of processing rubber latex, the following achievements have been achieved:

- Wastewater treatment is required.

- Simple operation, low chemical consumption.

- Easy to install, easy to maintain.

- Use the physicochemical treatment system before entering a biological treatment system, help avoid load shock.

- Flexibility in the operating mechanism will help the wastewater treatment system meet the requirements of safe handling but still save when it is possible to adjust the different running modes: chemical, non-chemical ...

- Works that limit the occurrence of bad odors compared to other technologies, ensuring environmental safety. Post-treatment sludge is used as fertilizer.

- BioFAS-MBBR / ABR + technology is the latest technology today, processing most types of wastewater with high organic pollution components. Increase in processing efficiency, save costs.

References

i. *Ea H'Leo Rubber Co., Ltd (2012), Environmental monitoring report for the first period of 2012, the project of expanding the latex processing line of Ea Khal rubber processing factory with capacity of 3,500 tons / year, Dak Lak.*

ii. *Department of Waste Management and Environmental Improvement (2011), entitled "Summarizing, assessing the situation of solid waste generation (industrial, hazardous, urban activities) of Dak Lak province in recent years Here (2005 - 2010) ", Hanoi.*

iii. *Tran Trung Dung, Trinh Van Tuyen, Tuyet Hoa Niêđam, Nguyen Hoang Phuong (2014), Some results of investigation and assessment of solid waste status in the Central Highlands provinces, Collection of midterm preliminary conference reports Tay Nguyen 3 program, Hanoi, page 221-231.*

iv. *Vietnam Rubber Industry Group (2011), open-door rubber forum, http://www.rubbergroup.vn/diendan/index.php/introduction*

v. *Ho Chi Minh City Agriculture and Forestry University (2007), Rubber Technology Curriculum, Ho Chi Minh City.*