Environmental Pollution By Tire Manufacturing Industry

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Abstract: The tire industry is an essential industry for the world as it is the primary requirement producer for transportation in the world. In this industry, the raw material used for it is the rubber, which is an elastomeric material. In this review article, the process of tire manufacturing is discussed to give knowledge about the materials and manufacturing methods used separately in producing tires. As well as this indicates waste generating methods, waste management, and how these industries are affected for environmental pollution. Finally, the suggestions for the environmental impact and the development of the country is explained.

Index Terms: Tire manufacturing industry, Environmental pollution, Vulcanization, Carcass, Volatile organic compounds.

1 Introduction

Different industries in various ways contribute their maximum with the help of existing natural resources for the development of the country. Among them, rubber holds a valuable position from all crops which affects to the several sectors in the country, especially in the economic area. As an example, in our country, Rs. 3316 million was earned in 2016 against the Rs 2671 million in 2015 up to September through raw rubber exports [1]. Rubber industries have influenced not only for the economic sector but also for the environment. But the important thing is the impact of the rubber industry in the environmental area is not as good as the impact on the economic sector. The primary raw material which is latex and other ingredients either separately or after combined with each other lead to form gasses and fumes during several stages in production process [2]. The waste management is considered as one of the main issue in those rubber industries. So by considering all these factors, it is essential to identify the types of wastes which generates in the rubber factories.

2 Process Description

In Sri Lanka, several types of rubber products are manufactured in industries. Among these products, tires play a major role in day to day activities because 95% of tires used in transportations and rest of them are used in agricultural purposes [3]. Basically, the tire manufacturing process undergoes several stages. They are chemical mixing, calendaring, extruding, making beads, tire building and curing. These methods can be described further as follows. *Preparation of raw material.* Compounding and mixing In this process, the primary raw material which is used to produce tire is natural rubber. The rubber trees, Hevea Brasiliensis, is used to tap the Latex, and it is called the natural rubber [2]. In here the Latex is a mixture of several ingredients, and mainly it is a water emulsion of a polymer called polyisoprene.

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The compounding process is using to fulfill the requirement of the tire as well as it is the primary process of adding constituents for the vulcanization. Other than the natural rubber, additives include fillers also used in this process. Fillers are used to enhancing the mechanical properties of the rubber and carbon black is the mainly reinforcing filler used in the production of tires as it helps to protect the tire from ultraviolet radiation. At the same time, there are some additives used to produce tire, they are antioxidants, ozone protective chemicals, coloring pigments, plasticizers and softening oils, blowing agents, and mold release compounds. To that, filaments are also used in tire manufacturing. Shaping. The shaping process can be categorized into several processes like extrusion, calendaring, coating, and molding. For the extrusion of rubber, the majority of the industries are mainly used screw extruders. Mostly the extrusion is done to reduce the highly plastic condition of the polymer as it is not yet vulcanized. Next, the calendaring process is done to reduce the thickness of the rubber sheet by using rotating rolls. So in inner layer calendaring, it can make inner layers of tubeless tires. In automobile tires, a coating which is used to substrate fabric is also a necessary process again, and it has several operations including calendaring, skimming, dipping and spraying. In skimming a concentrated solution, which is a rubber compound in an organic solvent is laid on the fabric. Then the dipping process is done to temporary immersed the fabric into a solution of rubber. Molding is an essential fact to consider, especially in tire production. And it is used to get the required foam of the tire. In here compression molding is used to manufacture tires. Vulcanization Finally, the vulcanization is performed by adding sulfur at 140 °C temperature to achieve the cross-linking of molecules of elastomers [2]. Then it leads to becoming stiffer and stronger. Sometimes various chemicals are also added to speed up the reaction like zinc oxide and stearic acid. *Production of tire.* The internal structure of the tire is known as carcass. It is mostly made from the rubber of reinforced rubber. It consists of several different components. So these components with the performing process to fabricate them are as follows. Bead coil - A rubber coated continuous steel wire, cut, coiled and the ends are joined. Plies – Produced in calendaring process which is rubber coated fabric and cut to required shape.Inner lining- It is calendared into the innermost ply in tube tires. Belts – It is cut in different angles for better reinforcement and made in to a belt of multi ply. Tread – A strip made from extrusion and assembled to belts. Sidewall – Cut to required size after extruded as continuous strip. Building the carcass In this situation, a building drum is used to assemble the carcass. Then the precut strips are built

up around the cylindrical arbor. After that two bead coils are used anchored the layered plies on the rim's opposite sides. Moreover, other components are also fixed by using plies and bead coils. After the required piles are placed, the belts are applied. Molding and curing Tire molds are considered as split molds. The one half of the mold is attached to the upper platen and another half to the lower platen. Next, the uncured tire is directed to the mold halves after placed on the expandable diaphragm. Then the press is closed, and soft rubber press against the mold cavity. Then tread pattern is transmitted to the rubber. The outside mold is heated while the same time inside of the diaphragm is also heated by using high-pressure steam. It takes about minutes to cure a tire. After the curing process, the tire placed for the cooling process, and finally, the removed from the press.

3 WASTE GENERATION

Waste can be defined as the materials that are not prime products for which initial user or generator has no further use [4]. From the beginning to the end, there are considerable waste generating methods in the process of manufacturing the tires. There are mainly three methods for generating wastes in the tire industry. They are the waste generating by solid, liquid, and gas.

Solid waste

From the tire manufacturing process huge amount of solid waste is generating from different sources. They can be categorized as, Rubber – Tires rejected in experimental tests and quality control as well as the molding waste. Metal – From wire bead, steel cord and belt processing. Textiles – Components in reject tires like fabric cord and belt. Rubbish– Containers of contaminated raw material. Plastic or polythene – Packing and finishing.

Gaseous waste

Mainly volatile organic compounds (VOC) are emitted during the manufacturing of the tire. So the VOC emission take place in following situations [4]. In compounding VOC emission happens due to curing agents, accelerators, antioxidants and in mixing process. In calendaring operation. From green tire spraying.

Liquid waste

This type of waste is generated in different situations with the participation of contaminants like anti-tack agents, oil and grease and rubber fines. Floor and other components washed water in different units. Water contaminating by leakages. The water overflowed by anti-tack water tank. Other miscellaneous water [5].

waste treatment:

In tire manufacturing industry the solid wastes are currently disposed by different methods. Some of them are disposed to sanitary land filled, by shipment to reclaiming operations or recycle to use as a low quality goods. When considering waste water management, at present the industries have selected waste water treatment plant to treat the waste water. Rather than above wastes, gaseous waste are managed through the use of capture or control systems. The assessment of environmental impact is greatly required for the environmental protection. Environmental pollution can be happen in tire manufacturing industry due to several reason. That can be explained as follows, Air pollution impact Air pollution can be happen due to primary and secondary air pollutants. Primary pollutants (CO_2, CO, SO_2, NO_X, particulate matter) are formed from directly by the emissions from the rubber industry plants. Secondary pollutants like SO_3, NO_2, ozone incomplete combustion products are detect by the use of pollution control equipment. So these air pollutants mainly affects for the fog, smog formation and acid rain. Then it leads to unbalance the eco- systems by killing the terrestrial plants and animals. Waste water Wastewater which contains pollutant, discharge to water bodies will lead to losing the thousands of lives of aquatic animals and plants. Also, it contributes to eutrophication-the acids used in latex coagulation cause to vary the pH level of the water body Solid waste The solid waste disposal is one of the main reason for the ground water pollution. It is necessary to reduce the ways to generate wastes rather than the waste management. Then it will greatly contribute to decrease the environmental pollution. So some suggestions for it are as follows. Sulfur less material – reduce the amount of sulfur add in vulcanization process while maintain the strength of the elastomers. VOC emission reduction systems (capture & control) Insulation of VOC Direct flame afterburners Catalytic afterburners Heat recovery Absorption of VOC Absorbents used in here are activated alumina, silica gel, activated carbon. Low VOC content materials Water based green tire sprays, Use bio degradable plastics- It will minimize the enviro nmental pollution as it takes short time to decompose than plastics. Reduce the packaging- Minimize the use of polythene to wrap the tires. Rules and regulation – Introducing new rule and regulations for the waste disposal, treatment and management to minimize waste generation and environmental impact.

5 Conclusion

In this article, there are few suggestions to prevent environmental pollution. As well as it makes an opportunity to develop the tire industry by considering the manufacturing process and waste management's. So by considering these factors, if these industries are subjected to above suggestions it will be a great opportunity to save the thousands of lives of fauna and flora which are considered as living things on earth.

References

[1] Rubber research institute of Sri Lanka: Annual review 2016.

[2] Mikell P. Groover, Fundamentals of modern manufacturing, materials, processes and systems, 5th edition.

[3] Don R. Goodwin, Rubber tire manufacturing industry, July 1981.

[4] United nations, Glossary of Environment Statistics, United Nations Publications, 1997

[5] S.C. Jagadale, Kasilingam Rajkumar, R.P.Chavan, D.N.Shinde, C.L.Patil. Environmental concern of pollution in rubber industry, internationals Journal of Research in Engineering and Technology November 2015.