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Pollution Problem Pertaining to Liquid Effluents From Natural Rubber Procesing Factories

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Introduction

Modern civilization is mainly based on the development of agriculture and agro-based industries Most of these industries have inevitable contribution to the environmental pollution. Natural rubber industry with a variety of products is no exception in this regard[1]. Unlike other agricultural crops natural rubber is harvested in the form of liquid called 'latex'. The latex contains 30-40% rubber hydrocarbon, 2-2.5% protein, 1-1.5% sugars, 1-1.6% resins, 0.7-0.9% ash and 55-60% water[2]. The rubber hydrocarbon is separated by acid coagulation for the preparation of ribbed sheets, crepe and crumb. It is also processed in the form of latex concentrate by centrifugation and creaming. In the above processes, large quantity of water is used. The wash water loaded with organic compounds mentioned above and organic and inorganic acids used in the processing go to form the effluent[3].

In India over 1.85 lakhs tonnes of natural rubber was produced and processed during the year 1985-86. On an average 20 litres of effluent is generated for every kilogram of processed rubber. Hence, the effluent generated through rubber processing factories were about 37 lakhs kilolitres during 1985-'86. The rubber processing factories of varying type and capacity are involved in the processing and they are distributed throughout the rubber growing belts in India. The quality and quantity of the effluent vary according to the type of rubber processed and size of the factories. As the rubber processing factories are located near residential areas the pollution due to these factories are serious. This problems will be very serious due to the introduction of more and more centralised rubber processing factories.

Survey of the Rubber Processing Factory Effluents

Pollution load of the effluents varies with the processing techniques[2]. A survey on the pollution load of different rubber processing factory effluent was conducted. Composite samples of the effluent were collected from ribbed sheet factory, crumb rubber factory, crepe rubber factory and latex centrifuging

factory and they were chemically and bacteriologically examined. Nature and extent of pollution by the effluent from these factories are given below.

Ribbed Sheet Factory Effluent

More than 60% natural rubber in our country is processed in the form of ribbed sheets (RS). In this process water is added to the field latex to bring down the dry rubber content (drc) to 12.5%. Either acetic or formic acid is added to the latex and coagulateted in suitable containers. These slabs of coagulum are sheeted through a set of rollers to remove serum which contains non-rubber constituents and residual acid. Water used for dilution and other purposes along with traces of rubber and other organic components of latex and the acid used for the coagulation go to form the effluent. The analytical data of this effluent is given in Tables 1 and 2. Due to undecomposed organic matter the effluent is milky in appearance with high level of total solids. The pH of the effluent varies from 4.5 to 5. The Biochemical Oxygen Demand (BOD) as well as Chemical Oxygen Demand (COD) is very high and on stagnation this effluent causes the production of foul smell and in course of time it becomes dark in colour. The total as well as the coliform bacterial counts are also high. As these types of rubber processing centres are numerous and scattered throughout the rubber growing areas, they cause serious pollution problems.

Crumb Rubber Processing Factory Effluent

Processing of technically specified block rubber in the form of crumb was introduced in India during 1970 s. Due to

TABLE 1 – Quality of the Raw Effluents from Natural Rubber Processing Factories

Effluent source	pH	Dissolved solids	Suspended solids	Total solids	BOD	COD	Total nitrogen	Ammonia nitrogen	Phosphates	Sulphates	Chlorides
Ribbed sheet factory	4.6	3450	750	4200	1400	3260	200	—	—	—	—
Crumb rubber processing factory	6.2	620	1050	1670	310	1200	125	—	8.5	1186	64
Crepe rubber processing factory	6.0	480	925	1400	340	1350	140	—	10.0	950	45
Latex concentrate factory	3.8	6880	1920	8800	3500	10500	1860	1725	200.0	4340	730

TABLE 2 – Results of Bacteriological Analysis of the Raw Effluent from Natural Rubber Processing Factories

Effluent source	Total count/ml	Coliform	*E. coli*	Streptococci
Ribbed sheet rubber factory	45,000	13,400	2, 50	5,500
Crumb rubber factory	75,000	11,500	18,650	22,300
Crepe rubber factory	80,000	15,600	21,450	25,450
Latex concentrate factory	8,000	4,500	250	350

this type of centralised processing, enormous quantity of effluent is being generated causing serious problems of water pollution.

Crumb is made either from latex or from field coagulum called scraps, Scrap rubber is soaked in water tanks for two days to remove the adhering dirt materials. After this rubber is subjected to size reduction by passing through macerators and finally cut into small pieces in hammer mills. Finally the rubber particles are allowed to float in large water tanks and then dried. Large quantity of water is used during all these processes to remove dirt, bark, sand and other foreign matters. So the effluent generated in these factories contain both dissolved and suspended solids. The pH of the effluent ranges from 5 to 6. The effluent formed at the time of processing latex coagulum is more acidic and milky at times. But it is brownish and turbid due to the bark, soil and small rubber particles when scrap rubber is used.

The analytical report given in the table shows that the BOD and COD of the effluent are 310 mg/l and 1200 mg/l respectively. Though the BOD is comparatively low, the volume of effluent is very high and it requires treatment before disposal. Hence, most of the crumb rubber factories adopt one or other effluent treatment technique.

Crepe Rubber Processing Factory effluent

Crepe rubber is prepared from latex as well as from scraps as in the case of crumb rubber. Latex coagulum or soaked scrap rubber is milled into blanket in a series of macerators and creepers in making crepe. As in the processing of crumb, water is used for washing the rubber to remove dirt, sand, bark and other foreign matters. The pollution load is also more or less similar to that of crumb rubber factory effluent.

Latex Concentrate Factory Effluent

More than 90% of the latex concentration is obtained by centrifuging the ammoniated field latex. Latex concentration is to increase the rubber contents of the field latex by centrifuging from initial *drc* of 30–40% to 50–60%. In the centrifuging process, the latex is split into two fractions viz. latex concentrate and skim serum containing 5–10% *drc*. The skim which contains about 0.8% ammonia is generally coagulated with sulphuric acid, creped and dried. The washings of centrifuging machines, the sludge that is collected in tanks and centrifuging machines, the serum of skim coagulation

and washings in skim rubber processing, constitute the effluent.

This effluent is very turbid due to suspended rubber particles. Analysis of this effluent for various parameters of pollution show that it is having a high level of BOD and COD. Unlike effluents from other factories this effluent contains a very high level of nitrogen due to the ammonia used for preserving the field latex. Besides nitrogen it also contains a reasonable amount of phosphates-sulphates and chlorates. Though the effluents contains all the essential nutrients it is resistant to the microbial action during the initial stage due to the low pH. A large amount of hydrogen sulphide is produced by the anaerobic bacteria from this effluent on storing.

Bacteriological Analysis of the Rubber Processing Factory Effluents

The raw materials used for different types of rubber processing and the quantity and quality of water used contribute to the bacterial population of rubber processing factory effluents. In the preparation of crumb and crepe rubber mainly scrap rubber at various stages of purification is used. In both the processing factories enormous quantity of stream water is used. The bacterial analysis showed that maximum total bacterial population is in crepe rubber factory effluent followed by crumb rubber, ribbed sheet rubber and latex centrifuge factory effluents. Similar trend was also observed with regard to the coliform bacterial count. The augmented bacterial population in the former two effluents might be due to the contamination of raw materials and indiscriminate use of stream water. The low population in the latex centrifuge factory effluent may be due to the ammonia in the latex and the high acidity due to the sulphuric acid used for coagulation. (Table. 2)

Treatment systems Followed at Present

In view of the serious pollution problemes by the effluent, the rubber processing factories are prevented from discharging the raw effluent into public sewers or rivers. Some crumb rubber factories and latex centrifuging factories have set up effluent treatment systems. The systems adopted at present in rubber processing factories are the anaerobic/aerobic ponding system and the oxidation ditch system. Both these systems are found to be suitable for the rubber processing factory effluents under Malaysian conditions [4-6]. However, a detailed report on the efficiency of these treatment systems for the natural rubber processing factories under Indian conditions is not available. Having this in mind, Rubber Research Institute of India has initiated detailed investigations on the efficiency of different effluent treatment systems followed at present.

Preliminary studies in the laboratory showed that *Chlorella* sp. can be grown in the rubber factory effluent[7]. It has also been noted that pollution load can be considerably reduced by culturing *Chlorella* sp. and by aeration.

Conclusion

The results of the present study clearly show that the effluent from various rubber processing factories are highly polluted and the pollution load is very high in the effluent from latex concentrate factories. In addition to the enhanced level of BOD and COD, this effluent contains a large amount of nitrogen

which is highly dangerous when it reaches the drinking water source. Considering all these evil effects as well as the restriction imposed by the Pollution Control Board, these effluents warrant proper treatment systems. Development of a simple, economic and effective method of treatment system coupled with additional return by way of fish culture, organic manure, single cell protein etc. will be much beneficial for the natural rubber processing industry.

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(unpublished data)