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TREATMENT AND DISPOSAL OF RUBBER EFFLUENTS

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The process of production of natural rubber in rubber trees is a non-polluting process, taking place within the plant. However, the natural rubber processing industry contributes to water pollution as a result of the disposal of effluents from crop processing factories of rubber plantations. Studies conducted by the different Rubber Research Institutes in the world have shown that the effluents from rubber processing factories are high pollutants. Therefore, it would seem to be a matter of utmost importance to find out the nature and extent of pollution problems arising out of the disposal of the effluents from natural rubber processing factories in India and to discuss ways and means of preventing the pollution hazards.

Pollution: Nature and extent

Latex is a weak lyophillic colloidal system of spherical or pear shaped rubber globules suspended in an aqueous serum. The rubber particle is surrounded by a protective layer of protein and phospholipids which imparts the colloidal nature to the latex. In addition to these rubber particles, the latex also contains a variety of non-rubber constituents-both organic and inorganic in nature. The general composition of latex is as follows:

Rubber	—30-40 %
Protein	—2-2. 5 %
Ash	—0.7-0.9%
Resin	—1.0-1.6 %
Sugar	—1.0-1.5 %
Water	— 55-60 %

The different kinds of crop harvested from a rubber estate are highly susceptible to bacterial action due to contamination on keeping. Therefore, it is essential to process them into forms that will help safe storage and marketing.

The four important methods of processing the crop from rubber plantations are Ribbed Smoked Sheets, Crepe Rubbers, Block Rubbers and Preserved Latex Concentrates. Out of the present annual production of 220,000 lakh M. Tons of natural rubber produced in India, nearly 10% is processed in the form of preserved latex concentrates, 70% processed in the form of ribbed smoke sheets, 16% processed in the form of crepe rubbers and the balance processed in the form of block rubber. The factories undertaking the processing are mostly located in Kerala and in the Kanyakumari District of Tamil Nadu.

During the processing of rubber adopting any of these methods, water is always required in varying quantities (about 20-30 litres/kg drc) for washing, cleaning, dilution etc. The field latex itself contains about 60% water. All these constitute to the final waste water i.e., effluent produced. The effluent thus consists of process water, un-coagulated latex and significant amount of non-rubbers which include proteins, sugars, lipids carotenoids and organic and inorganic salts which originate from the latex. These form excellent substrates for the proliferation of micro-organisms, generating high BOD and objectionable odour. Therefore, indiscriminate discharge of effluent to public waters is objectionable. All the rubber processing factories in the country are now legally bound to build up facilities to ensure that effluent let out to public water ways conform to the specifications prescribed by the respective Pollution Control Boards.

The specification parameters and their limits for the treated effluent for land application and discharge into water ways are as shown in Table-1.

Table-1

Specification parameters for effluents

Parameter	Inland surface water	Irrigation
Colour & Odour	Not objectionable	—
PH	6-8	6-8
COD	250 ppm	250 ppm
BOD	50 „	100 „
Dissolved solids	2100 „	2100 „
Suspendeed solids	100 „	200 „
Oil & Grease	10 „	200 „
Sulphides	2 „	10
Total Nitrogen	100 „	—
Dissolved phosphate	5 „	—

The average physical, chemical and bacteriological properties of typical effluent from different types of rubber processing factories are given in Table-2.

Table 2

Properties of effluents from rubber processing factories

Properties	Latex conce-ntrate	Sheet	Crumb	Crepe
PH	4.5	6.3	5.2	6.5
Total solids mg/1	6000	2500	1500	750
Suspended solids „	1500	500	600	400
COD „	6000	3000	2500	1000
BOD „	4000	2000	1500	750
Ammoniated N2 „	500	10	50	10
Total Nitrogen „	800	100	150	50

The acidic nature of the effluent is attributed to the use of formic, acetic, phosphoric or sulphuric acid in the process line. The high BOL and COD of the latex cocentrate and sheet factory effluent indicate that the total solids in the effluents are mainly of organic origin with high. oxygen demand for their oxidation. The high ammoniacal and total nitrogen of latex concentrate is due to the use of substantial quantity of ammonia in the preservation of latex. Ammonia is said to be toxic to fishes. It promotes algal bloom due to the conversion of ammonia into nitrates by aerobic bacteria. Hence in rubber effluent the two potential pollutants are organic carbon and ammoniacal nitrogen.

Present practice

At present there are over a lakh of sheet processing units consisting of about 100 large factories in the estate sector and the balance in small units of varying sizes. Besides these, there are about 30 latex concentrate and 14 block rubber factories and also 120 crepe mills in the major rubber growing tract in South India.

Out of these, proper treatment facilities are made only by the block rubber factories established under Kerala Agricultural Development Project, financed by the World Bank and a few other factories in the estate sector. Proper treatment and discharge of effluent from the other factories did not receive the attention it desired in the past. The general practice in most of these processing. factories is to discharge the effluent indiscriminately to the environment without treatment. Some of these factories provided rubber traps to detain rubber particles and one or two settling tanks before discharging the effluent to public water ways. Some factories discharge the effluent into their own estate where it is allowed to percolate in the soil or used for irrigation purposes.

Now there is a growing awareness on the need of treating the effluent as pollution has already become a social problem. The existing factories are now under statutory obligation to make arrangements for the treatment and discharge of effluent as per the specifications of the respective State Pollution Control Boards.

Effluent treatment methods

Since the rubber effluent contains mainly organic pollutants as indicated by high BOD, biological treatment methods are generally followed. At present two systems are widely followed in Malaysia, the major rubber producing country of the world. They are

1 Anaerobic-facultative ponding system and
2 Oxidation ditch system.

Among these systems, the first system involves an anerobic break down of the organic materials to a level acceptable for further breakdown aerobically. In the breakdown process the end products are methane and carbon dioxide. Since methane bacteria are slow growers, the gasification step is the rate determining stage of the anaerobtc process.

The anaerobic liquor containing part of the organic matter is further treated in facultative ponds which further converts the remaining organics into carbon dioxide, water etc. The aerobic breakdown in the facultative pond occurs in the top layer where oxygen required is available from the photosynthetic activity of the algae as well as by diffusion. However, in the bottom sediments anaerobic breakdown occurs.

The success of the anaerobic/facultative ponding system depends on the thriving population of methane forming bacteria in the anaerobic stage and the presence of balanced population of algae and facutative aerobes in the facultative ponds.

The second system-the oxidation ditch-is essentially an aerobic process. However, in contrast to the ponding system, direct control of bacterial solids retention time is possible in the ditch. This is achieved by manipulation of solids recycle. As a result a better performance is attainable.

The following factors are significant in achieving an efficient operation of the oxidation ditch: (1) environmental conditions in the ditch should be conducive to the survival and growth of the facultative aerobe, and (2) the organic loading should be maintained at a level not only to achieve maximum removal but also to produce subsidable sludge. This will ensure a clear final effluent and enable a better control of solids recycle.

The anaerobic-facultative ponding system

This system consists of rubber trap, compositing pond, anaerobic and facultative ponds. The main function of the rubber trap is to detain the rubber particles in the effluent. It also removes 60-70% of the total solids, thereby reducing its loading rate in the anaerobic pond. The rubber trap should have a holding capacity of atleast 12 hrs retention with proper baffles to induce continuous up and down flow pattern

The purpose of the compositing pond is to average out any fluctuations in PH, BOD loading, etc. The compositing pond is disigned to operate under anaerobic condition. The capacity of the pond should be around two days retention.

The operating depth of anaerobic pond is 1.8 to 3m or even more depending on the site condition. Usually its length is more than twice its width. The holding capacity of the pond depends upon the retention period required in order to avoid any overload to the facultative pond.

The operating depth of the facultative pond is not more than 1m and the length-width ratio is the same as that of anaerobic pond. The capacity of the pond depends upon the retention period required to reduce the BOD to the desired level.

The optimum retention period in the anaerobic pond depends on initial concentration of pollutants in the raw effluent.

The oxidation ditch system

This system consists of a rubber trap compositing pond, sludge mixing chamber, oxidation ditch, sedimentation tank, sand filter and sludge pond. The oxidation ditch is elliptical in shape and is fitted with an aerator which oxygenates and circulates the effluent. Sedimentation tank is usually cylindrical in shape with a conical bottom and with a capacity of about 3-4 hr retention. The treated effluent from the oxidation ditch overflows into the sedimentation tank where the sludge settles at the conical bottom. The required quantity of sludge is recycled with the raw effluent through the sludge mixing chamber. The excess sludge from the sedimentation tank is then pumped into the sludge pond where it gets dried up. The clarified supernatant effluent from the sedimentation tank is then allowed to be discharged through the sand filter.

Choice of the treatment system

The choice of the method of effluent treatment depends on the availability of land and the nature of the site and location. Where land is available at an acceptable distance from residential areas, the ponding system would be preferred in view of its lower initial and operating costs. The extensive land requirement and air pollution problems make ponding system unsuitable to urban areas. The preferred system in such cases is oxidation ditch method.

Out of the four methods of processing, it is seen that the effluent produced in latex concentration is the most polluting. If the effluent is kept in anaerobic condition, the foul smell produced due to the evolution of hydrogen sulphide is very high. This is because of the use of sulphuric acid in the coagulation of skim latex. On account of this it is, therefore, suggested that the oxidation ditch method is the more suitable for treating such effluent to prevent the foul smell as well as to bring down the pollution load to an acceptable level. The same method of treatment is preferred for sheet processing and PLC producing factories.

The pollution load in the effluent produced from scrap processing factories — i. e., from crumb rubber and crepe rubber factories, is comparatively very very low. For such factories, if sufficient land is available anaerobic/facultative ponding system can be followed quite satisfactorily. However, if there is limitation on availability of land, oxidation ditch method would satisfactorily treat the effluent to the required level. □

STATEWISE CONSUMPTION OF ALL KINDS OF RUBBER DURING 1987-'88

State/Union Territory	No. of Manufactures	Consumption (tonnes)			
		Natural	Synthetic	Reclaimed	Total
Maharashtra	524	33,781	14,631	6,393	54,805
West Bengal	460	37,618	9,107	5,828	52,553
Uttar Pradesh	419	38,200	9,605	4,689	52,494
Kerala	711	39,337	8.391	3,477	51,205
Punjab	452	34,336	2,562	10,366	47,264
Tamil Nadu	395	23,270	8.311	3,444	35,025
Haryana	222	20,196	6.419	1,470	28,085
Karnataka	199	12,252	5,046	2,130	19,428
Delhi	373	12,436	3,221	743	16,400
Rajastan	57	12,099	3,721	204	16,094
Andhra Pradesh	132	6,972	1,691	852	9,515
Goa & Daman	17	6,066	1,537	311	7,914
Gujarat	285	6,110	1,017	501	7,628
Madhya Pradesh	59	2,660	373	652	3,685
Others	88	2,147	708	80	2,935
TOTAL	4,393	287,480	76,410	41,140	405,030