ISSN 2229-5518

Rubber Processing is detrimental to environment: A case study

Dibyendu Das[1], Ankuran Saha[2], Homagni Bhattacharjee[3]
[1, 3] GA (P&T) Department, Government of Tripura, India.
[2] Mechanical Engineering Department, NIT AGARTALA, India.

Abstract— Natural Rubber is an abundantly available in India. In fact, India is the fifth largest producer of natural rubber in the world [Source: ANRPC, 2015]. NR is obtained in the form of latex, which is collected from the hevea brasiliensis tree. Natural rubber is used in many manufacturing industries for the production of rubber products after chemical treatment, which is generally known as rubber processing. In the present study, we have made an investigation of the operation of rubber processing to identify whether rubber processing yields any kind of by product or waste which is detrimental to the environment. So, in this connection, the whole operation of rubber processing including the waste disposal system is meticulously studied and subsequently the waste water sample from the discharge point is collected and analyzed to meet the stated objective.

Index Terms—environmental impact, natural rubber, rubber processing, water pollution.

1 Introduction

Rubber industry is a very important one, feeding many other industries with its outputs. A few of the beneficiary industries to name are the automobile, foot-ware and construction industries. These examples of dependent industries bring to fore the very important nature of the rubber industry. Rubber industry uses natural rubber as raw material, though in present days use of synthetic rubber also is in practice.

Natural rubber consists of polymers of the organic compound isoprene, with minor impurities of other organic compounds plus water. It is an indispensible biopolymer of high economic importance with very important properties such as high elasticity, resilience and efficient heat dispersion. Tropical monsoon climate favors the growth of natural rubber tree. Therefore, Southeast Asia region grow natural rubber tree in abundance. Malaysia is a leading producer of natural rubber. India stands fifth in terms of natural rubber production in the world as per the latest estimate [ANRPC, 2015]. Naturally, rubber based manufacturing industry has a deep root in India. The raw material used in rubber industry is generally known as latex, which is obtained from rubber tree i.e. Hevea brasiliensis, which is a white milky fluid.

Natural rubber combines high strength with outstanding resistance to fatigue. It has an excellent green strength and tack which means that it has the ability to stick to itself and to other materials which makes it easier to fabricate. It has moderate resistance to environmental damage by heat, light and ozone which are one of its drawbacks [Vijayaram T.R, 2009].

Natural Rubber is useful in many industries like garment, automotive, cement and other industries with processing. Fabrication of dry rubber from raw latex involves the following four processes i.e centrifugation (CENEX), which is primarily a step to processing of natural rubber latex into high quality latex concentrate of 60% dry rubber content and involves the separation of preserved field latex into two fractions, one containing the concentrated latex of more than 60% dry rubber and the other containing 4-6% dry rubber content. In the second step, compounding (mixing) is done, where, the process is usually performed in heavy internal mixers to accomplish two main functions: firstly, to soften the rubber, often known as mastication and, secondly, to admix the rubber with the compounding ingredients, which may include fillers, vulcanizing agents, protective agents and blends with other chemicals. After mixing, the compounded rubber becomes plastic and is now ready to be shaped. This is done in a variety of ways and is generally followed by vulcanization in which the rubber undergoes a chemical reaction at a high temperature, which transforms rubber from plastic state to a strong, highly elastic material.

1.1 Environmental concern of NR processing

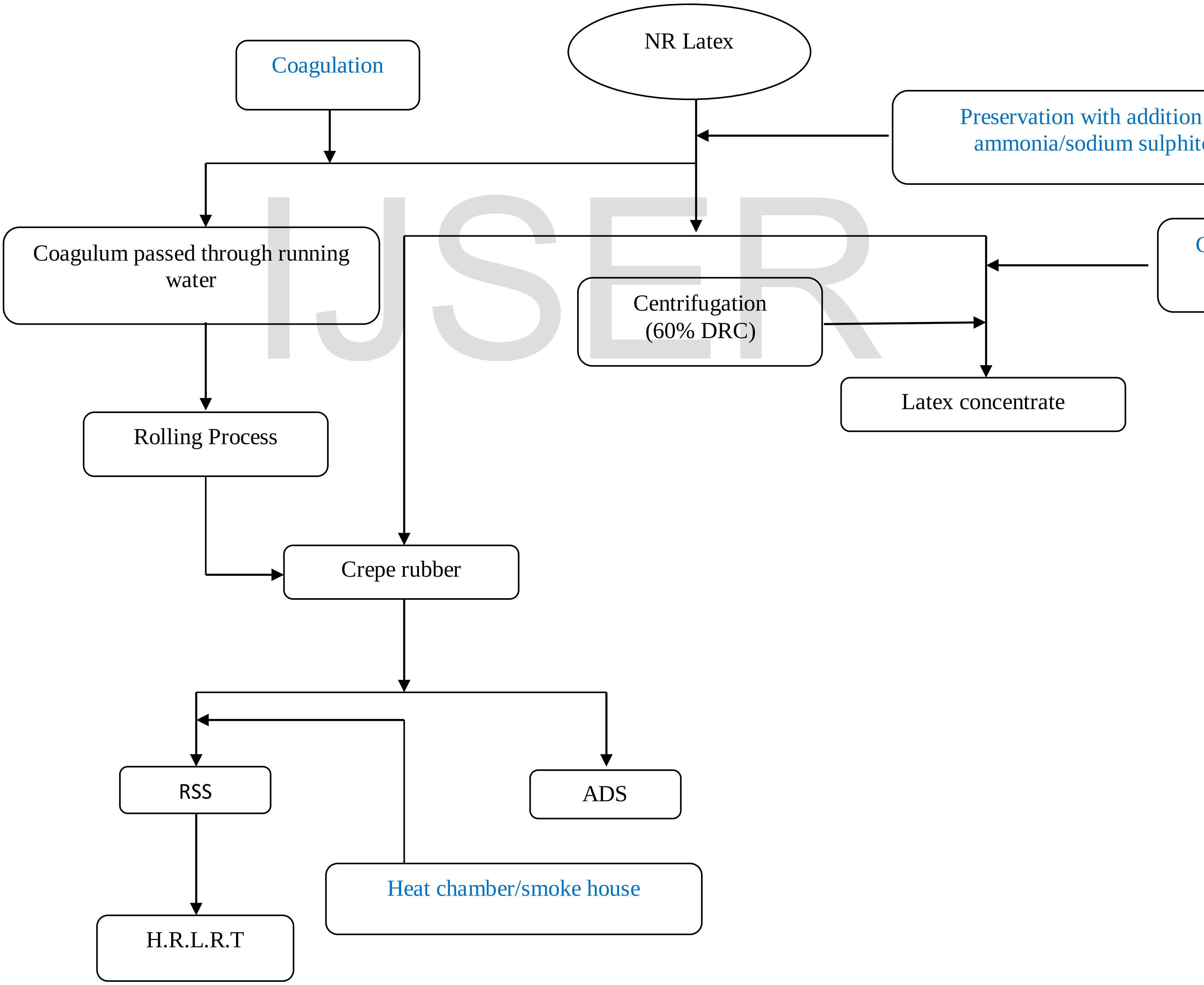
The environmental impact considered includes global warming, acidification, eutrophication, human toxicity, photochemical oxidation and the total environmental impact. Natural rubber processing sector consumes large volumes of water and chemicals as well as other utilities. It also releases large amount of wastes and effluents into the environment (H.P.Jai Shanker Pillai and K.Girish, 2014). Effluent derived from the rubber processing industry can cause serious environmental impact in the neighboring receptor water bodies because of the presence of toxic chemical residues (Smitha et al., 2012). If the wastewater is put straight into surface waters wells, streams, lakes or even the sea without any treatment, it will inevitably pollute that water (H.P.Jai Shanker Pillai and K.Girish, 2014).

2. RUBBER PROCESSING & ENVIRONMENTAL IMPACT

Chemically, latex consists of rubber, resins, proteins, ash, sugar, and water. The rubber content in the latex comes from the trees is approximately 30 to 40%. Latex, which is a kind of biotic liquids, deteriorates if it is not preserved by ammonia or sodium sulfite which is called anticoagulant. Anticoagulants prevent latex from pre-coagulation. The kind of anticoagulant used depends upon the production process. Sodium sulfite is preferred if crepe or sheet rubbers are to be made, but ammonia is more suitable for latex concentrate. Coagulation of latex can be done by either spontaneously or by acid treatment. In the total process of natural rubber processing both dry and wet processes are involved. Size reduction, digestion, washing and drying are unit operations involved in these processing activities. Washing consumes large amount of water, therefore, wastewater generated from processing operations mainly comes from this step.

2.1 PROCESSING OF RUBBER SHEET

Rubber sheet could be categorized as Air Dried Sheet (ADS) and Ribbed Smoked Sheet (RSS). The main difference of ADS and RSS is on the method used for drying the sheet, in which ADS exploits air, whereas RSS uses smoke provided in a smokehouse with the temperature up to 60°C. Rubber sheet processing is started from latex collection in the field. It is then diluted and screened before the addition of formic acid for coagulation process. The wet sheet is sheeted off to a thickness of about 3 mm and finally passes an embossed two roll mill. The sheets are dried whether by air or in a smokehouse. The specific smell of the smoked sheets is caused by the wood and other organic materials such as coconut shells used to produce the smoke. The sheets produced are finally classified and packaged. The following flowchart gives a detailed pictorial view of the Rubber processing operations:



ISSN 2229-5518

Fig.1: Flow chart of operation in NR processing

N.B: Blue colored steps contributes to the effluent discharge from the rubber processing as these involve the acidification process as well as the use of water that is discharged as waste water.

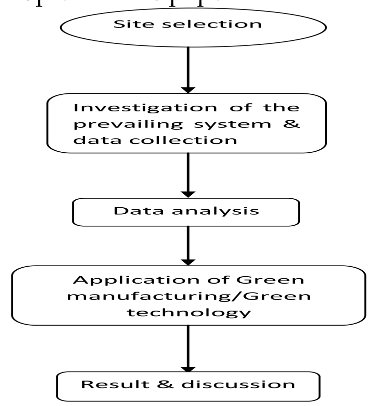
2.2 ENVIRONMENTAL IMPACT OF RUBBER PROCESSING

Rubber processing yields a serious problem for environment due to the release of highly polluted effluents. The effluents coming out from rubber processing is a serious concern because of the presence of high biological oxygen demand and ammonia. Without proper treatment, discharge of wastewater from rubber processing industry to the environment may cause serious and long lasting consequences. Wastewater collected from rubber processing industry was characterized for their pollution characteristics. Different effluents generated from rubber processing are coagulation serum, carbonaceous organic materials, nitrogen & sulphate compounds, sulphuric acid, hydrogen sulphide, ammonia and different amines etc.

Wastewater discharged from latex rubber processing usually contains high level of BOD, COD and SS. Compounds like coagulation serum are readily biodegradable and this will result in high oxygen consumption upon discharge of wastewater in surface water. Effluent from latex rubber processing industries is basically acidic in nature [Pandey *et. al.* (1990)]. Usage of different acids attribute to pH variation of different effluent. Due to the use of acid in latex coagulation, preservation and creaming process, the effluent discharged from rubber processing plant is acidic in nature. The effluent comprises mainly of carbonaceous organic materials, nitrogen and sulfate. The use of high concentrated ammonia in the latex concentrate effluent is another serious threat to the environment. From different survey, it is evident that most of the concentrated latex factories in India & South Eastern Asia Pacific region discharge wastewater that contains high level of nitrogen & ammonia to adjacent water bodies like pond, canal or river leading to water pollution problem. If high level of ammonia is discharged to water bodies, it could lead to death of some aquatic organisms living in the water. The effluent from rubber processing contains high level of sulfate which originates from sulfuric acid used in the coagulation of latex. The high level of sulfate in this process can cause problem in the biological anaerobic system as high level of H_2S produces noxious problem.

3. METHODOLOGY

The present paper is based on a case study carried out on a rubber processing plant to study the waste disposal system of a rubber processing plant. It is observed that rubber processing generates large amount of effluent and waste water, which is discharged directly into the nearby water body. The effluents discharge in the water body from rubber processing plant releases certain pollutants, which increases the concentration of BOD, COD, & SS. The objective behind the investigation is to study the generation of acidic effluent and waste water from rubber processing operation. The following flowchart gives a graphical representation of the methodology adopted in this paper.



4. SELECTION OF STUDY AREA

The study area is located at Bodhjung Nagar Industrial Growth centre which is about 20 km North West of Agartala. Agartala is the state capital of Tripura, which is a North Eastern state of India. Different small scale industries & manufacturing facilities are located here. Industries based on locally available raw materials like bamboo, rubber has processing & manufacturing units located in this site.

5. INVESTIGATION OF THE PREVAILING SYSTEM & DATA COLLECTION

The investigation of the prevailing system of natural rubber processing was carried out in Abhisar Buildwell Pvt. Ltd, a company engaged in business of processing raw rubber in Tripura, located in the study area (Bodhjung Nagar Industrial Estate). The established process in the plant is given as flow diagram below:

	Conductivity	TDS	pH	Hardness	Ca	Mg	Alkalinity	Nitrate	Chloride	Fe	Fluoride
Sample1	220	180	4.30	44.70	3.87	4.20	8.60	2.30	0.02	0.89	0.00
Sample2	218	175	4.21	44.89	3.67	4.1	8.42	2.23	0.02	0.85	0.00
Sample3	209	172	4.23	43.62	3.56	4.26	8.34	2.21	0.02	0.84	0.00
Sample4	205	160	4.25	42.60	3.47	4.0	8.23	2.29	0.02	0.82	0.001
Sample5	198	179	4.0	41.50	3.41	4.20	8.60	2.29	0.02	0.83	0.001

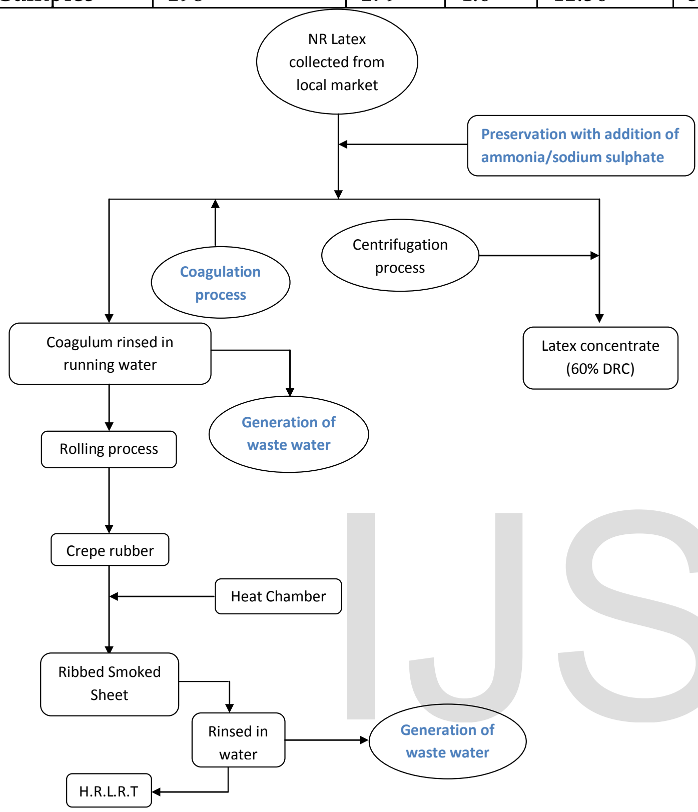


Fig.2: Flow diagram of NR processing at Abhisar Buildwell Pvt Ltd.

Fig.4: Waste water pond from where waste water sample was collected.

Parameters	Environmental Standard
Conductivity (S/m)	110.0-130.0
TDS (mg/l)	60.0-80.0
pH	6.0-7.0
Hardness (mg/l)	40.0-50.0
Calcium (mg/l)	8.0-12.0
Magnesium (mg/l)	5.0-6.0
Alkalinity (mg/l)	50.0-60.0
Nitrate (mg/l)	0.010-0.015
Chloride (mg/l)	0.6-0.8
Iron (mg/l)	0.35-0.45
Fluoride (mg/l)	0.001-0.003

Table 1: Standard water quality data as provided by TSPCB

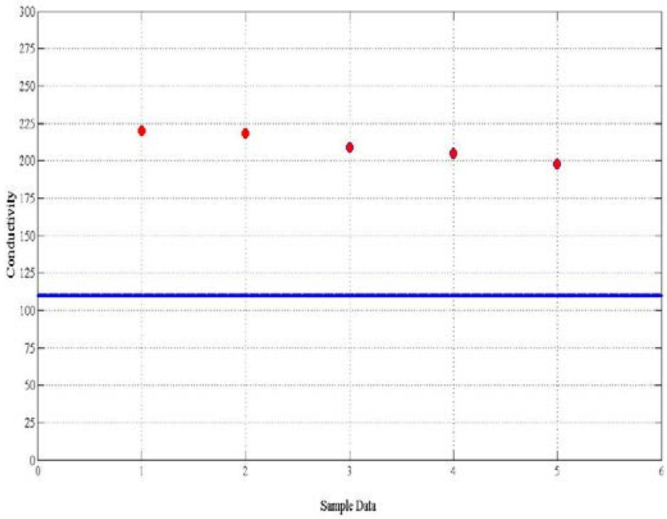
The samples collected from the water body where the waste water is being discharged are tested in School of Hydro informatics of NIT AGARTALA and the results are tabulated in the following table:

The analysis of waste water sample and the result thus obtained in terms of the above mentioned parameters like conductivity, TDS, pH etc. are drawn into a comparison with the acceptable standard, which are considered acceptable in reference to environmental standard.

ISSN 2229-5518

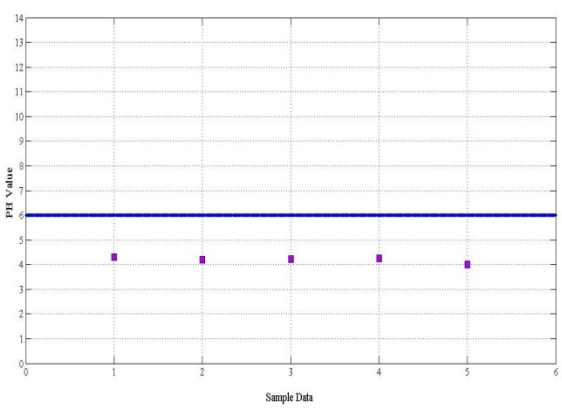
6. ANALYSIS

Conductivity for all the samples are graphically represented in the graph. From the graph, it is evident that conductivity of all the samples collected from waste water body remains to be higher than the normal range.



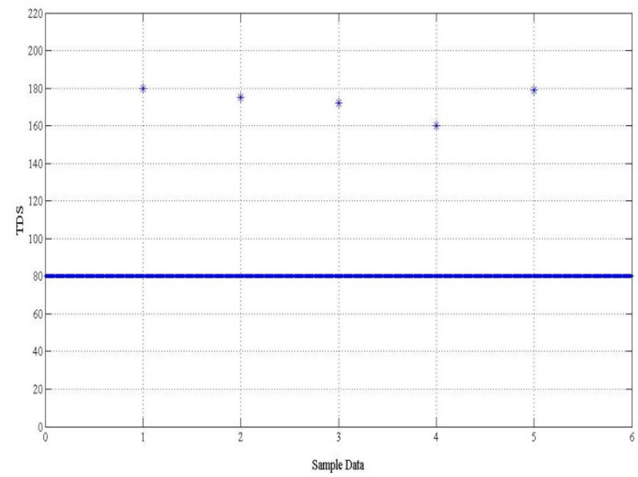
Next important parameter, in the analysis is TDS i.e. Total Dissolved Solid. As mentioned in the article, that waste water contains acidic and other chemical compound, therefore, TDS of the waste water is generally remains high in comparison to normal water or fresh water.

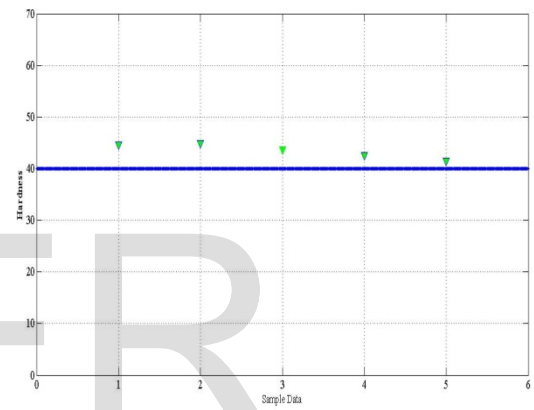
The most important parameter for determining pollution



characteristic of water is the pH value. Generally, pH value for normal water ranges between 6-7. Below this range signifies acidification of the water. From the above graph, it is evident that the pH value for all the samples remains low from standard range thus signifying the acidification of water.

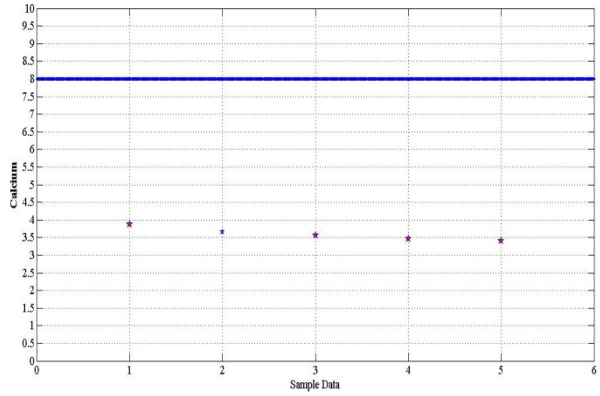
Next parameter we have considered in this case study, is hard ness. Increase in hardness signifies the level of basic compounds in water. Effluents discharged from plant increases the hardness of the water.



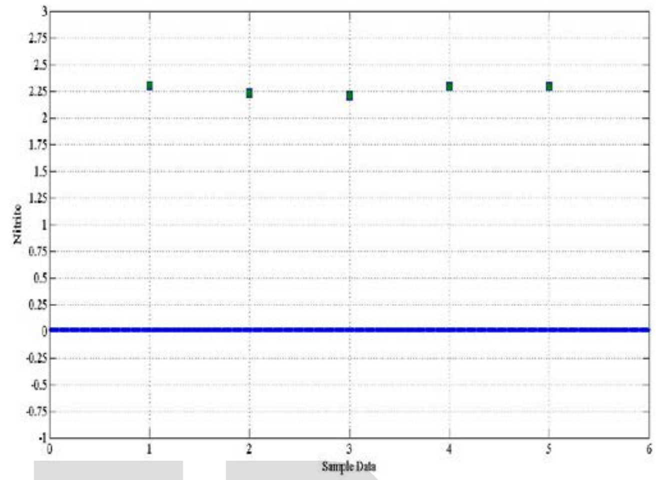


Levels of calcium, magnesium donot have very significant impact on pollution of water. However, deviation from normal range is an indication of pollution characteristic.

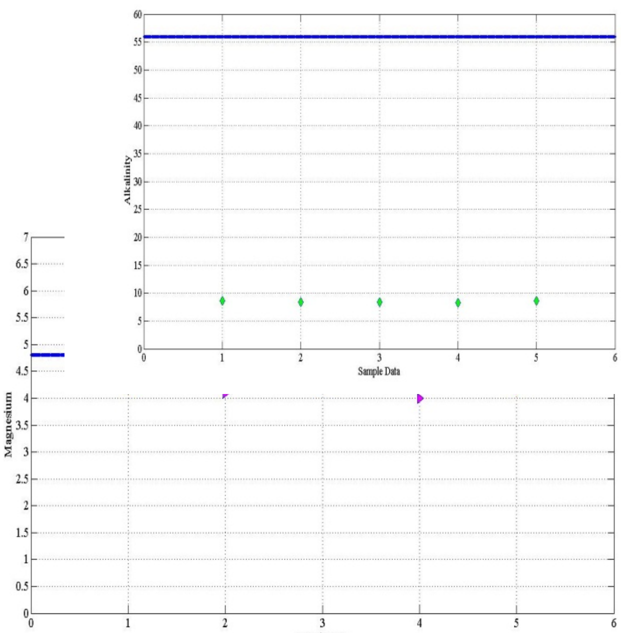
.



High level of nitrate compounds is an indication of acidic effluents present in waste water.



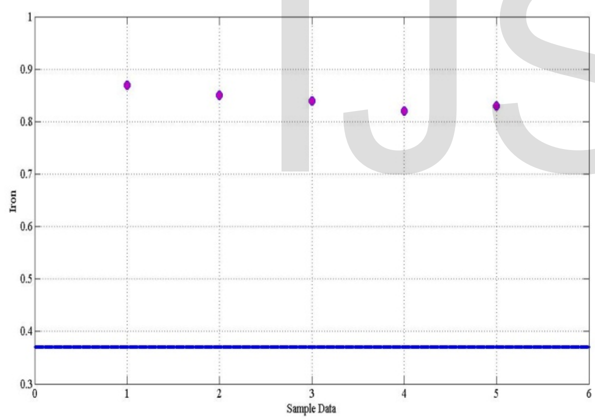
Alkalinity is also a very important parameter in the study of water pollution. From this analysis, it is found that, the level of alkali in waste water sample is very low, which signifies the acidification of the waste water. This is because of the use of certain types of acidic compounds in rubber processing.



Presence of high level of iron indicates a tendency of acidification of water, as the operation of rubber processing includes the use of acidic components.

DISCUSSION & CONCLUSION

The present is focussed on comparative analysis of water samples collected from waste disposal facility of rubber processing plant. The result of the investigation yields that some pollutant parameters present in the water in the vicinity of the plant are higher than the normal range. Therefore, a conclusion can be drawn in reference to the analysis of waste water sample collected from plant discharge point that rubber processing yields an adverse impact on the environment. However, the conclusion is only subjective to the result obtained. The analysis of air quality; soil degradation & time bound changes in the atmospheric condition like temperature, humidity, rainfall characteristics etc has not been carried out in the present case study. However, the result of the present case study indicates that processing of natural rubber is detrimental to environment.



ACKNOWLEDGMENT

We acknowledge our sincere thanks to TSPCB for guidance and help with resource as well as to NIT AGARTALA for providing the platform to conduct experiment for the present work. We are also thankful to Abhisar Buildwell Pvt. Ltd. for providing necessary information in this regard. Finally we pay our sincere thanks to Rubber Board, Government of India, Agartala Regional Office for providing us necessary information and guidelines for conducting the work.

NOMENCLATURE

NR Natural Rubber
ADS Air Dried Sheet
RSS Ribbed Smoked Sheet
BOD Biochemical oxygen demand (mg/l)
COD Chemical Oxygen Demand (mg/l)
TDS Total Dissolved Solid (mg/l)
CPCB Central Pollution Control Board
TSPCB Tripura State Pollution Control Board
SS Suspended Solid (mg/l)

REFERENCES

[1] Thoguluva Raghavan Vijayaram. A TECHNICAL REVIEW ON RUBBER. International Journal on Design and Manufacturing Technologies, Vol.3, No.1, January 2009.

[2] H.P.Jai Shanker Pillai and K.Girish, Rubber processing industry effluent treatment using a bacterial consortium. Int.J.Curr.Microbiol.App.Sci (2014) 3(10) 775-782.

[3] Smitha et al., Bioremediation of rubber processing industry effluent by Arthrobacter sp. International Journal of Research in Environmental Science and Technology, ISSN 2249–9695. 2012.

[4] The Environment (Protection) Rules, 1986, CPCB

[5] TSPCB Technical manual document, 2014.

[6]https://businessimpactenvironment.wordpress.com/2011/10/03/environmental-issues-caused-by-rubber-industry.

[7] Felix Osarumhense Aguele et al., A Study of Quality Improvement of Natural Rubber Products by Drying Methods. Journal of Materials Science and Chemical Engineering, 2015, 3, 7-12.

[8] Gideon Mensah, Analysis of Environmental Threats during Rubber Processing in Ghana, ARCADA, 2014.

[9] Official website of Rubber Board of India, www.rubberboard.org.in.

[10]Official website of Central Pollution Control Board, www. cpcb.nic.in.

- *Dibyendu Das is currently working in the capacity of Tripura Civil Service under Government of Tripura, Union of India. E-mail:dibyendu.tec@gmail.com*
- *Ankuran Saha, Assistant Professor, Mechanical Engineering Department, NIT AGARTALA. E-mail:* ankuran.saha@gmail.com
- *Homagni Bhattacharjee is currently working in the capacity of Tripura Civil Service under Government of Tripura, Union of India. E-mail:homagni87@gmail.com*