International Journal of Mechanical Engineering

Treatment of Pulp and Paper Mill Effluent using Novel Absorbent for Recycling

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Abstract **-** Wastewater and professional effluent treatment require associated with suspended shades for purification and possible re-usage. Regardless of the impact of the industry on the environment, the world of pulp and paper industry continues to broaden at alarming rates therefore more and more paper generators are booming upward in the recently industrialized countries. Treatability studies were performed to determine the feasibility of recycling where possible the effluents from the paper generator. The final results of lab scale investigation demonstrated that the chemical substance secondary treatment reduced turbidity (89%), Chemical substance Oxygen Demand (84%), total suspended shades (90%) and color (89%) at the mass loading of 3400 mg/L of magnesium sulfate (MgSO4), when primary-treated effluent was subsequently taken care of by the coagulation–flocculation process. The combo of primary moving and lime coagulation (optimum dosage of 1400 mg/L) come in a turbidity removal of 94%, a COD (Chemical Oxygen Demand) decrease of 86%, an overall total Hanging Solids (TSS) elimination of 93% and color removal of 91. 6% at an initial ph level of 11. Pollutant reductions at the rate of 99. 5%, 99. 1%, 99. 4% and 99. 5% were obtained for turbidity, COD, TSS and color, respectively, with the combo of the sedimentation, coagulation–flocculation process and turned on carbon adsorption conference the production process quality standards. The particular study revealed that a hybrid end-of-pipe physicochemical treatment was effective in decreasing the pollutant download of paper generators effluent and conference the discharging criteria.

Index Terms – effluent, quality standard, coagulation, effluents, flocculation.

INTRODUCTION

The particular pulp and document industry has already been facing stricter limitations on the discharges during the last few years and the same trend will continue in the future. Pulp and document mill is a major professional industry utilizing a large amount of vocabulary cellulogic materials and water during the manufacturing process and release chlorinated vocabulary sulphonic acids, chlorinated resin acids, chlorinated phenols and chlorinated hydrocarbon in the effluent. The highly toxic and recalcitrant compounds, dibenzo-p-dioxin and dibenzofuran are produced unintentionally in the effluent of pulp and paper generator. The untreated effluents from pulp and paper mills that are discharged into water bodies, problems the water quality. The undiluted effluents are toxic for aquatic organisms and exhibit a strong mutagenic effect. Inspite of the process investments in environment protection, the ancillary treatment of wastewater will become ever-more important in the future due to the large amounts of wastewater that are generated. The particular de-colorization of effluents, at least, should be performed. Typical biological treatment procedures have little if any effect on wastewater de-colorization. The particular brownish color is mainly due to lignin and the derivates which are difficult to weaken naturally. Biological treatment removes almost all of the wood extractives and the effluent is extremely diluted in the acquiring drinking water system. However, wooden extractives (e. gary the gadget guy. resin acids and sterols) can get transformed to other toxic compounds during biological treatment. Additionally, there is no guarantee that natural treatment will usually work properly and serious toxicity innovations may occasionally take place. However, the natural color removal process is particularly attractive since in addition to color and COD, it also reduces BOD and low molecular weight chloro-lignins. Intensive drinking water recirculation in pulp mills causes a build up of wood extractives in the water process, as well as other harmful materials such as non-process elements. Non-process elements, which are unintentional aspects of the pulping and whitening chemicals, your process as trace elements in wood and impurities in process chemicals and organic water.

Pre-treatment before biological wastewater treatment could have an optimistic impact on the performance of the natural process. Effluent removal is a major problem round the world. Growing combined with the populace growth, industries create environmental problems and health hazards for the population. The particular effluents are highly undesirable and dangerous to utilize. Wastewater consists of solid particles with a multitude of shapes, sizes, densities and composition. Particular properties of these particles affect their behavior in water phases and therefore the removal capabilities.

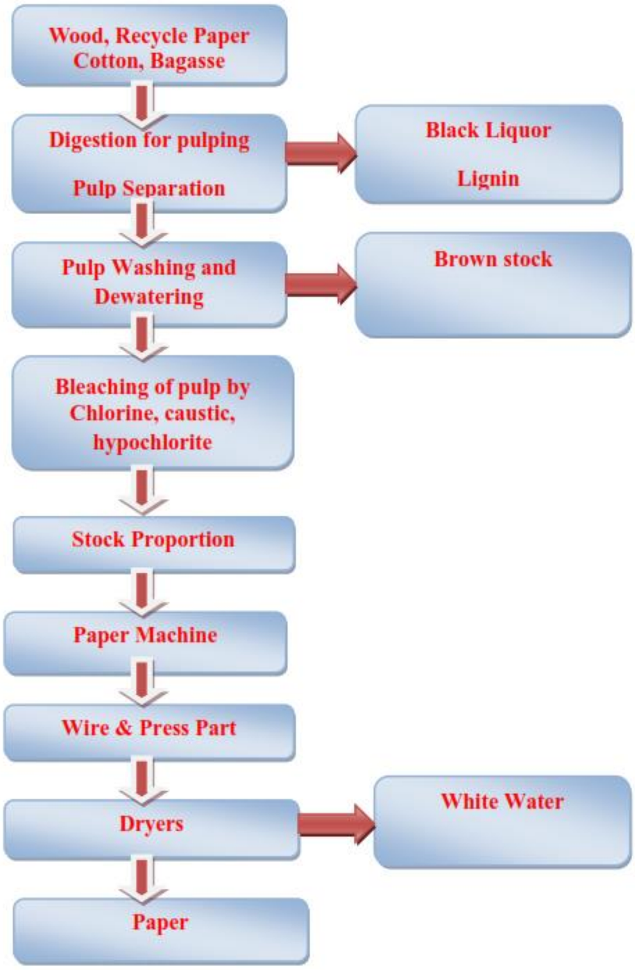

FIGURE 1

SIMPLIFIED SCHEME OF THE TEXTILE PROCESS

OBJECTIVE

In order to produce a system in which the outcomes of decomposition are easily gathered for proper removal

To remove or slow up the concentration of natural, inorganic compounds nutrition specially nitrogen and phosphorus.

To draw out pollutants, remove toxicants, neutralize coarse contaminants, kill pathogens so that quality of discharged water is improved to achieve the permissible degree of water to be discharged into water bodies

SCOPE

The particular treating wastewater following to removing hanging solids by organisms such as algae, fungi, or germs under aerobic or anaerobic conditions.

Natural methods have certain advantages such as treatment technology is traditional and well understood and improved efficiency in phrases of natural content removal.

Biological wastewater treatments, chemical treatments use chemical reactants necessary can help determine the total expense.

LITERATURE

Fleiter, T et.al, (2012) This particular pulp and document industry is an energy intensive production process because the energy cost was almost 13% of its total creation costs. The document industry consumed 6% and 5% of the global professional energy consumption in 2006 and 3 years ago, respectively. This industry utilizes a high quantity of fresh water (between 60 and 230 m3 for each ton of document production), resulting in the generation of huge amounts of wastewater. It does not take sixth most significant polluter (after essential oil, cement, leather, fabric and steel industries), discharging a variety of wastes to the environment. The high usage of fresh water and era of a huge amount of poisonous wastewater are the main environmental concerns related to the pulp and paper industry. Even with the most modern and ancient operational techniques, about 60 m3 of water is required to create a ton of paper, resulting in the generation 3 of at minimum 50 m of wastewater. The vast majority of Indian document and pulp generators discharge their effluents, containing bleach and black liquor, straight into the acquiring water bodies, and so cause serious environment concerns. PBMWW (Pulp and Board Generator Wastewater) contains high concentrations of recalcitrant dissolved organic and natural issue, and when marine systems are inundated it can generate high biochemical air demand.

Pokhrel, D et al. (2016) A lot of countries are dealing with severe water lack during summers, leading to reduced professional production dependent on water, specially the papermaking industry. Within recent years, drinking water recycling and recycle has gained energy in the Native indian industry for the similar reason and do with competitors against other users. Experiments are now being conducted to obtain techno-economically practical treatment options for the recycling and reuse of professional effluents. It is possible to gradual up the fresh water consumption for each ton of document produced. For example, a mill in Finland achieved upward to 75% decrease in freshwater intake by simply modifying feedstock, recycling white water from the paper machine and cooling water by adopting the latest techniques of screening process (the first part of wastewater treatment is to remove suspended solids, electronic. g., by using a club screen or membrane-based micro filtration), clarification and evaporation.

Schnell, A et al. (2019) The particular pulp and papers production generates a significantly large amount of pollutants recognized by this high concentration of hanging solids (SS), COD, toxicity and biochemical oxygen demand (BOD). The volume and pollution load of the created wastewater depends after different combinations of device processes involved in the production, kind of raw materials and chemicals taken, types of papers products and the amount of water recuperation. The pollutants released from the papers industry aquatic and land ecosystems. Several research studies documented toxic ejects on various fish varieties because of the exposure of pulp and paper business wastewater, including liver organ damage, mixed functionality oxygenase activity, physical changes, respiratory stress, toxicity and deadly elects on the fish exposed to this wastewater.

Thompson et al., (2017) There are numerous existing treatment procedures for pulp and paper commercial effluents, including aerobic, anaerobic, photo-catalysis, electrochemical, ozonation, coagulation–flocculation and adsorption treatment processes. The particular kind, amount and characteristics of wastewaters are essential to develop the best treatment technology. According to sedimentation is the predominant primary treatment to treat papers and pulp work wastewater in the Asia, and it contributed to more than 80% hanging solids removal on an average, but there was little BOD removal.

Bajpai et.al., (2011) Pulp and paper production process Cellulosic fibers obtained from grow materials, agricultural residues and recycled papers are traditionally utilized in the pulp and paper production process. The primary processes involved within the pulp plus paper manufacturing are usually: wood handling plus debarking, pulping plus paper manufacturing. Within this section; these types of primary processes are usually described.

Biermann et.al., (2014) Wooden handling and debarking Bark accounts with regard to 10-20% of the particular stem. The start barking contained in the particular feed source will be considered to turn out to be a contaminant within the paper plus pulp manufacturing procedure. The tolerance with regard to bark within the particular wood chips usually ranges between zero. 2-0. 5%. Subsequent the initial debarking stages, the wooden is cut in to smaller pieces known as chips, using mechanized chippers, and saved. Wood chips are usually then processed in to pulp.

Pokhrel & Viraraghavan et.al.,.(2004) Pulp manufacturing Most of the pollutants produced during the document manufacturing process take place within the first pulping stage. Within the paper industry, there are numerous ways of pulping, which directly have an effect on the characteristics of the wastewater being produced. Mechanical, chemical substance, chemo-mechanical (CMP), thermo-mechanical (TMP) or chemi-thermomechanical (CTMP) pulping are widely-used in the industry.

METHODOLOGY

The particular schematics of drinking water reuse treatment procedures. Pre-treatment and natural treatment techniques have been introduced in. Therefore, the treatment technology of reused water from pulp and paper wastewater was introduced in this study after treatment.

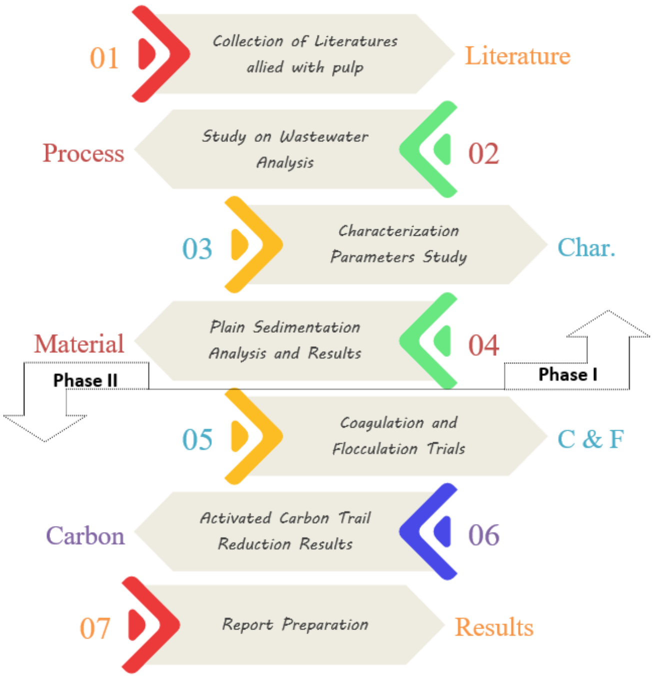

FIGURE 2

METHODOLOGY

MATERIAL TEST

The original characterization of the PBMWW was carried out by using various analytical procedures already described. The average parameters are given in Table 1, together with the Indian NEQS (National Environment Quality Standards) and NSDWQ (National Criteria for Drinking Drinking water Quality).

TABLE I

POLLUTANT CONTENTS OF INFLUENTS

Parameter	Unit	Raw Wastewater Value	NEQS	NSDWQ
pH	-	7.61	6.0-10	6.5-8.5
COD	mg/L	2820	150	-
BOD	mg/L	975	80	<4
Color	Units	6660	-	<15 Units
TS	mg/L	3494	-	-
Turbidity	NTU	645	-	<5
TSS	mg/L	784	150	-
TDS	mg/L	2710	<3500	<1000

The presence of significant turbidity in the PBMWW is evident, as seen by the increased TSS value. Because of the presence of lignin and its derivatives, the effluent has a dark brown colour. The collected wastewater has a biodegradability index (BOD/COD ratio) of 0.346, which is lower than the average value of 0.4. If the BOD to COD ratio is more than 0.4, wastewater is considered easily biodegradable. If the BOD/COD ratio is less than 0.4, biodegradation would be exceedingly sluggish, and biological treatment will be impossible. As a result of the presence of non-biodegradable substances like lignin, the effluent from this mill is not particularly biodegradable, posing a treatment problem.

Because of its higher molecular size, lignin and its derivatives decay exceedingly slowly in typical biological processes. To cleanse the wastewater of the Paper and Board Mill, a hybrid physico-chemical treatment method, simple settling followed by chemical coagulation and an activated carbon adsorption process, is employed in this research study.

TABLE 2

CHARACTERISTICS AFTER PRIMARY SEDIMENTATION

Parameter	Unit	Initial Characteristics	Characteristics after Sedimentation	% Reduction
pH	-	7.61	7.5	1.45
COD	mg/L	2820	2410	14.54
Conductivity	mhos/cm	1348	1170	13.20
Color	Units	6520	4995	23.39
TS	mg/L	3524	2945	16.43
Turbidity	NTU	645	455	29.46
TSS	mg/L	784	784	784
TDS	mg/L	2740	2395	12.59

Before this physico-chemical treatment method, plain sedimentation is utilised as a pre-treatment. The influence of sedimentation on wastewater properties is shown in Table 2. It claims that initial settling eliminates more than 29% of total suspended solids (TSS) and 13% of total dissolved solids (TDS). Table 2 further shows that after four hours of sedimentation, the feasible percentage reductions of COD, turbidity, and colour are 14.5 percent, 29.46 percent, and 23.4 percent, respectively.

RESULTS ANALYSIS

I. PRIMARY RESULTS

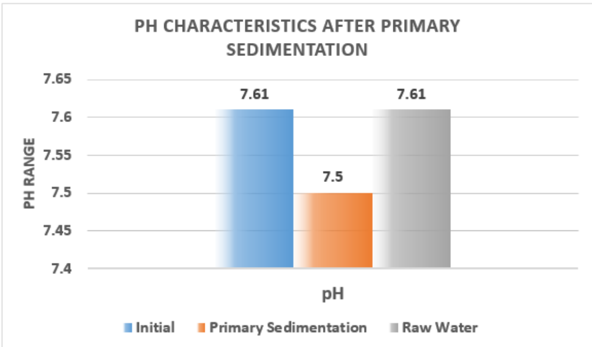

FIGURE 3

PH CHARACTERISTICS AFTER PRIMARY SEDIMENTATION

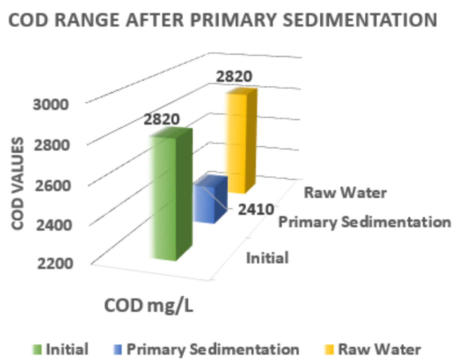

FIGURE 4

COD RANGE AFTER PRIMARY SEDIMENTATION

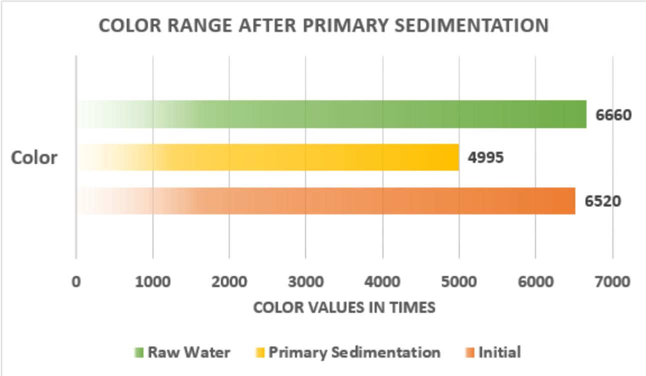

FIGURE 5

COLOR RANGE AFTER PRIMARY SEDIMENTATION

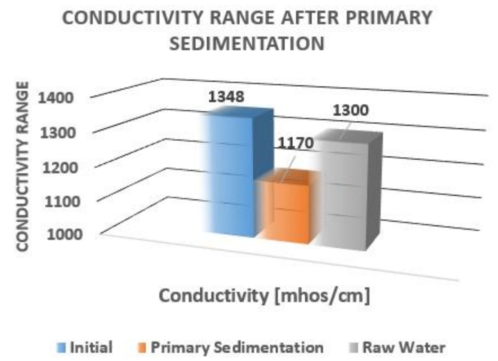

FIGURE 6

CONDUCTIVITY RANGE AFTER PRIMARY SEDIMENTATION

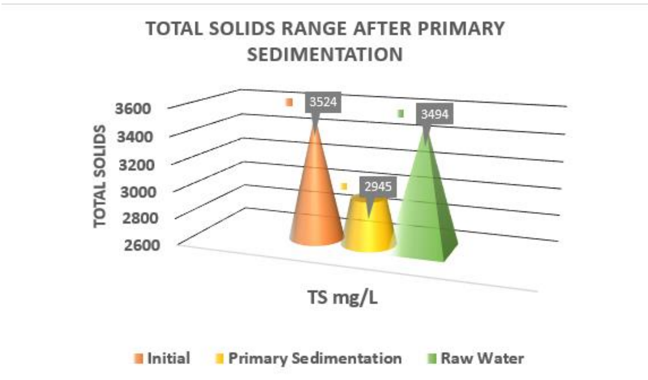

FIGURE 7

TOTAL SOLIDS RANGE AFTER PRIMARY SEDIMENTATION

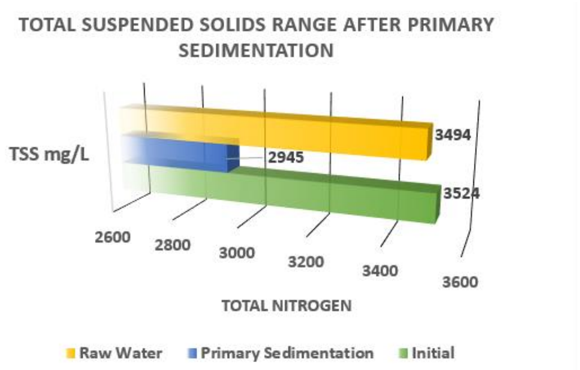

FIGURE 8

TOTAL SUSPENDED SOLIDS RANGE AFTER PRIMARY SEDIMENTATION

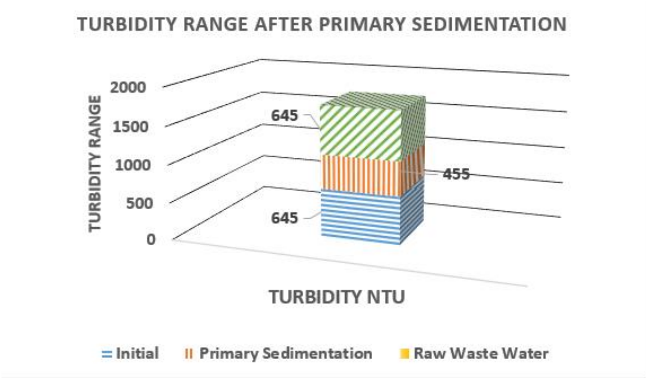

FIGURE 9

TURBIDITY RANGE AFTER PRIMARY SEDIMENTATION

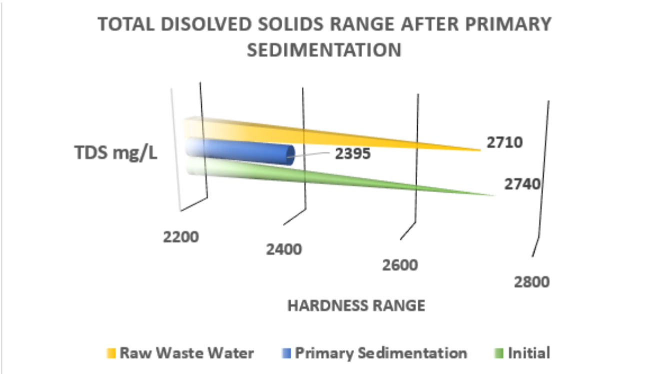

FIGURE 10

TOTAL DISSOLVED SOLIDS RANGE AFTER PRIMARY SEDIMENTATION

A larger dose of alum, lime, or MgSO4 did not result in a significant reduction in turbidity or COD. As a result of the jar test, it can be determined that alum is the best coagulant, with an optimal concentration of 1200 mg/L at pH 6.0. With the optimal dose of 1000 mg/L of alum at pH 6.0, turbidity was reduced by 99.8%, COD was reduced by 91 percent, and TSS was reduced by 99.7%. The results show that alum is more effective than MgSO4 and lime at removing pollutants from paper mill effluent. Figures 12 and 13 show that at an alum dose of 1200 mg/L, the greatest percentage turbidity reduction of 98 percent, COD of 93 percent, 98 percent for TSS, 82 percent for TDS, and 96 percent for colour happened.

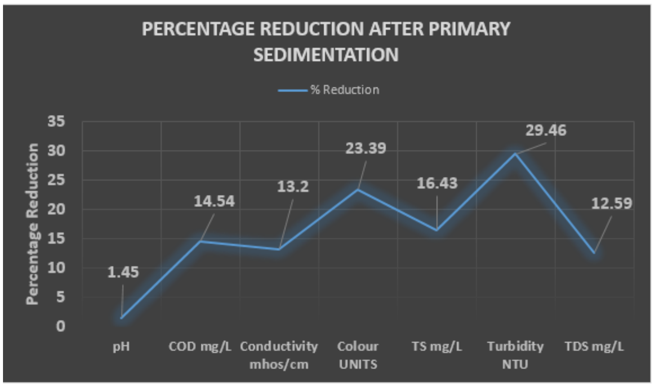

FIGURE 11

PERCENTAGE REDUCTION AFTER PRIMARY SEDIMENTATION

III. Treatment Removal Rate

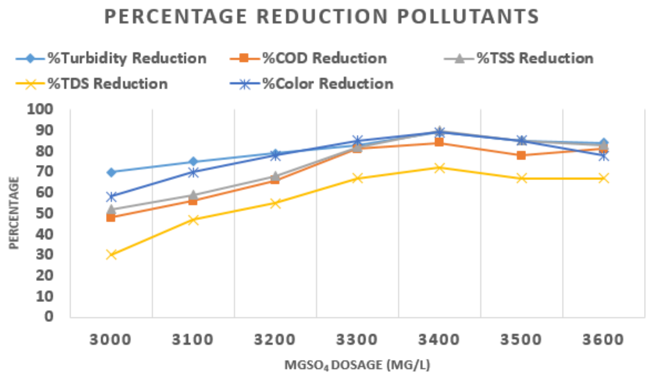

FIGURE 12

PERCENTAGE REDUCTION POLLUTANTS REDUCTION BY LIME MGSO4 DOSAGE

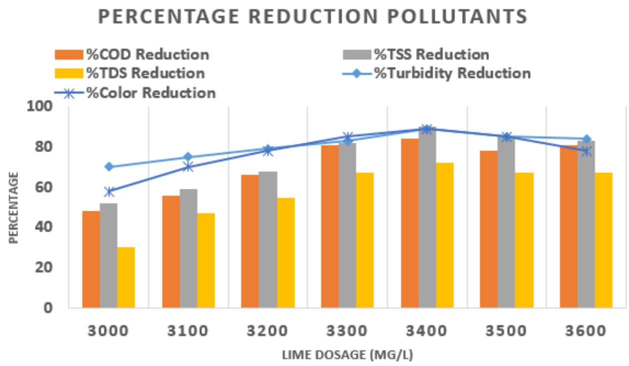

FIGURE 13

PERCENTAGE REDUCTION POLLUTANTS REDUCTION BY LIME DOSAGE

COD, TDS, TSS, and pH of municipal and industrial effluents in India shall be less than 150 mg/L, 3500 mg/L, 200 mg/L, and 6–9, respectively, according to the National Environmental Quality Standards. As a result, chemically enhanced treatment with the right dosages of alum is effective in satisfying TDS, TSS, and ph criteria in wastewater. However, to achieve mill water quality regulations, reusing this chemically treated water requires a tertiary treatment, such as activated carbon adsorption.

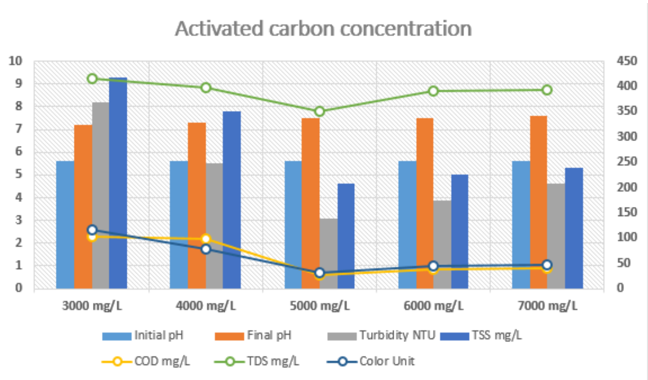

FIGURE 14

ACTIVATED CARBON CONCENTRATION

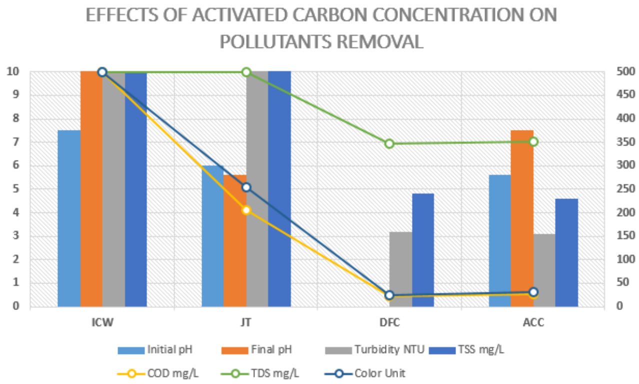

FIGURE 15

EFFECTS OF ACTIVATED CARBON

CONCLUSION

The goal of this project was to use physico-chemical treatment to recover a large volume of wastewater. The first treatment phase was a four-hour plain settling period. The plain settling was found to reduce the pollutant load for the secondary wastewater treatment facility. At a mass loading of 3400 mg/L of MgSO4, when four hours' primary effluent was further treated by the coagulation–flocculation process, significant reductions in turbidity (89 percent), COD (84 percent), TSS (90 percent), TDS (72 percent), and colour (89 percent) were obtained. The results showed that alum (at an optimal dosage of 1200 mg/L at pH 6.0) had a higher pollutant removal effectiveness than the other coagulants (MgSO4 and lime).

A combination of initial settling and coagulation–flocculation-aided clarifying (alum clarification) resulted in a decrease of ecological parameters (turbidity, COD, TSS, TDS, and colour) of more than 90%. After treatment with granular-activated carbon in the finishing stages, this decrease can be enhanced even more. Integrated physico-chemical treatments created the water, which then satisfied the quality criteria of the manufacturing process. As recovered water, the purified water might be recycled back into the manufacturing process. Under ideal conditions, chemical use and sludge formation were likewise at a minimum.

A hybrid end-of-pipe physicochemical treatment procedure is effective but costly, and it necessitates suitable treatment plant design based on the effluent's properties. Before executing the planned physicochemical treatment, the cost-benefit ratio of the various treatment options should be evaluated. Before this proposed treatment technique may be used, a pilot size research and more inquiry are necessary.

REFERENCES

[1] Fukuzumi T. [1980] Microbial decolourisation and defoaming of pulping waste liquors. In: Kirk TK, ChangHM, Higuchi T, editors. Lignin biodegradation: microbiology, chemistry and potential applications, Vol. 2. Boca Raton, FL, USA: CRC Press; 1980 p 161–171.

[2] Wittich RM, Wilkes H, Sinwell V,Franke W, Fortnagel P.[1992] Metabolism of dibenzo-p-dioxin by Sphingomonas sp.strain RW1 . Appl Environ Microbiol 58:1005–1010.

[3] Thakur IS. [1996] Use of monoclonal antibodies against dibenzo-p-dioxin degrading phingomonas sp. strain RW1. Lett Appl Microbiol 22:141–144.

[4] Nagarthnamma R, Bajpai P, Bajpai PK. [1999] Studies on decolourization, degradation and detoxification of chlorinated lignin compounds in kraft bleaching effluents by Ceriporiopsis subvermispora. Process Biochem 34: 939–948.

[5] Barton DA, Lee JW, Buckley DB, Jett SW. [1996] Bio treatment of kraft mill condensates for reuse. In: Proceedings of Tappi minimum effluent mills symposium, Atlanta, GA, USA. pp. 2702288.

[6] Ulmgren P. - Nord. Pulp Pap. Res. J. 12(1):32(1997) and Ulmgren, P., Radestrom, R. – TAPPI Minimum Effluent Mills Symposium, San Francisco, CA p. 51(1997)

[7] Kucerova.R. [2006] Application of Pseudomonas putida and Rhodococcus sp.by biodegradation of PAH(S), PCB(S) and NEL soil samples from the hazardous waste dump in pozdatky (Czech republic). Rud.-geol.-naft. Zb 1897:101.

[8] Thakur IS. [2004] Screening and identification of microbial strains for removal of colour and adsorbable organic halogens in pulp and paper mill effluent. Process Biochem 39:1693–1699.

[9] Park C, Lee M, Lee B, Kim S-W, Chase HA, Lee J, Kim S. [2007] Biodegradation and biosorption for decolourization of synthetic dyes by

Fulani tragic Biochem Eng J 36:59–65.

[10] Malaria P, Rather VS. [2007] Bioremediation of pulp and paper mill effluent by a novel fungal consortium isolated from polluted soil. Bores Techno 98:3647–3651.

[11] Ebeling G. [1931] Recent result of the chemical investigation of the effect of waste waters from cellulose plants on fish. Vom Wasser 5: 192– 200.

[12] B. Wills, Mineral Processing Technology, Pergamon, Oxford 1985.

[13] World Bank [1998] "Pollution prevention and Abatement: Pulp paper mills "Draft technical background Document. Environment Department, Washington. DC.1998.

[14] CPCB [2001] "Comprehensive industry document for large pulp and paper industry."COINDS/36/2000-2001, 2001.

[15] Cheremisinoff, N.P., Rosenfeld, P., & Rosenfeld, P.E. (2010). Handbook of pollution prevention and Cleaner production (1st ed.). Norwich, NY: Elsevier Inc.

[16] Ahmadi, S., Batchelor, B., Koseoglu, S.S. 1994. The diafiltration method for the study of the binding of macromolecules to heavy metals. Journal of Membrane Science. 89, 257-265.

[17] Ragunathan R, Swaminathan K. [2004] Biological treatment of pulp and paper industry effluent by Pleurotus spp. World J of Micro and Biotech 20:389–393.

[18] Bajpai P, Mehna A, Bajpai PK. [1993] Decolourization of kraft bleach plant effluent with the white rot fungus Teammates versicolor Process Biochem 28:377–384.

[19] Leuenberger C, Geger W, Coney R, Grayder JM, Molnar- Kubica E. [1985] Persistence chemicals in pulp mill effluent: occurrence and behaviour in an activated sludge treatment plant. Water Res 19:885–894.

[20] US EPA. [1995] EPA office of compliance sector notebook project: profile of pulp and paper industry, Washington, DC 20460. US EPA/310-R95-015;1995.

[21] Central Pollution Control Board (CPCB), [2000] Available from: http://www.cpcb.nic.in/standard39.htm; http://www.cpcb.nic.in/standard 53.htm (accesses 09.03.07).

[22] Kalyani KSP, Balasubramanian N, Srinivasakannan C. [2009] Decolourization and COD reduction of paper industrial effluent using electro coagulation. Chem. Eng J 151:97–104.

[23] Shaw LE, Lee D. [2009] Sonication of pulp and paper effluent, Ultrason Sonochem 16:312–324.

[24] Zhang Y, Ma C, Ye F, Kong Y, Li H. [2009] The treatment of wastewater of paper mill with integrated membrane process. Desalination 236:349–356.

[25] Kansal SK, Singh M, Sud D. [2008] Effluent quality at kraft /soda agro-based paper mills and its treatment using a heterogenous photo catalytic system. Desalination 228:183–190.