CHARACTERISATION OF WATER TREATMENT SLUDGE AND ITS REUSE AS COAGULANT IN WASTE WATER

A

PROJECT REPORT

Submitted in partial fulfillment for the requirement of the degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

of

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Mr. Anirban Dhulia(Assistant Professor)

by

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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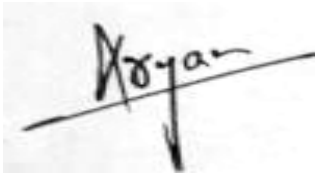
HIMACHAL PRADESH, INDIA

MAY - 2020

STUDENT'S DECLARATION

I hereby declare that the work presented in the project report entitled **"Characterization of Water Treatment Sludge and Its Reuse as Coagulant in waste water"** submitted for partial fulfillment of requirements for the Degree of bachelor of Technology in Civil Engineering at **Jaypee University Of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. Niraj Singh Parihar and Mr. Anirban Dhulia.** This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Harshit Bansal (161602)



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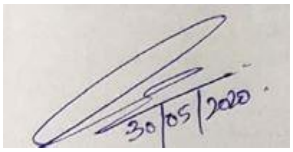
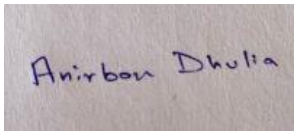
CERTIFICATE

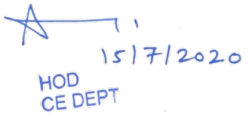
This is to certify that the work which is being presented in the project report titled **"Characterization of Water Treatment Sludge and its reuse as Coagulant in Wastewater"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology**, Waknaghat is an authentic record of work carried out by **Harshit Bansal (161602)** during a period from August,2019 to May, 2020 under the supervision of **Mr. Niraj Singh Parihar** And **Mr. Anirban Dhulia** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: May, 2020







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ABSTRACT

Coagulation-flocculation process brings about the age of enormous volume of waste or buildup, known as water treatment sludge (WTS), in the purging of surface water for consumable supplies. Feasible administration of the unavoidable waste requires cautious consideration from the plant administrators and slop directors. In this investigation, WTS delivered with the ideal alum portion of 30 ml/L at the lab scale has been treated with sulphuric corrosive to deliver an item known as Sludge reagent Product (SRP). The presentation of SRP is assessed for its effectiveness in expelling the colloidal suspensions from the PST gushing of JUIT's WTP over wide pH scope of 2 to13. 1% slime fermented with sulphuric corrosive of typicality 2.5 at the pace of 0.05 ml/ml ooze has been seen as the ideal condition for getting ready SRP from WTS. The rate turbidity evacuation is more noteworthy at higher pH worth and increments with expanding the measurement of SRP. The ideal SRP measurements of 8 ml/L in the pH scope of 6 to 8 performed well in evacuating the colloidal suspension and different contaminations from the PST gushing from JUIT's STP. The nature of treated water fulfilled the endorsed guidelines for the greater part of the quality parameters. Along these lines, SRP can possibly substitute the customary coagulants somewhat or totally in the water treatment process, contingent upon the quality required at the clients end.

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LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids
TDS	Total Dissolved Solids
pH	Power of Hydrogen
TS	Total Solids
DO	Dissolved Oxygen
mg	Mili Gram
mL	Mili Litre
WTS	Water treatment Sludge
STP	Sewage Treatment Plant
SRP	Sludge Reagent Product
PST	Primary Sedimentation Tank
JUIT	Jaypee University of Information Technology

CHAPTER 1

INTRODUCTION

1.1 General Introduction

In the current occasions, the shortage of safe consumable water is a notable issue. To adapt to this, it is critical to shield our regular water bodies and sources. For this it turns out to be essential to watch out for different components answerable for this like populace blast, increasingly more development of individuals to urban communities, the decrease in backwoods spread and changing climate designs comprehensive of a worldwide temperature alteration. Because of increment in water tainting, the living animals inside the water bodies additionally face different issues like diminishing in oxygen level. Thus there is a need to raise such advancements that demonstrate effective in the decrease of such defilements from wastewater while guaranteeing natural wellbeing too.

Earth is a live planet as a result of barely any uncommon fixings out of which water embrace an incredible employment. It is concentrated as the most expressive and fundamental resource for the natural hover like for human progress. Not at all like authorities that are in tally of the biosphere on circle are Air, Fire, land and Sky. Everything about administrators are fastened in themselves to an immeasurably progressively opportune degree and each irregularity in one of them influences others too. Close by the headway of our human progress, water has begun being debased and its quality began corrupting due to numerous reasons like industrialization, neighborhood wastes, spill capable from urban territories, urban and common refuse. By the start and up degree of human culture, it has ceaselessly been seen that the sea shore front regions like as the conduit banks have been the significantly kept an eye on plots as a result of the availability of sufficient water resources for the mount of step by step life close by developing and some other climatic focal points.

Arrangement of safe drinking water and the viable evacuation of substantial waste are imperative for human wellbeing and prosperity. The United Countries Covenant on Economic, Cultural also, Social Rights, marked by more than 140 nations, presently incorporates an exceptional reference (General Remark 11, November 2002), which pronounces that 'Water is a constrained regular asset and an open decent crucial to life and wellbeing. The human option to water is crucial for having a solid existence in human pride. It is an essential to the acknowledgment of other human rights.

About 3.4 million individuals kick the bucket every year from sicknesses related with debased water supplies and insufficient waste removal. The ailments related with water pollution are jungle fever, cholera, looseness of the bowels, hepatitis A and schistosomiasis. Absence of safe drinking water is the main consideration basic the passings of over 1.5 million babies and kids from the runs each year. While sullied water is a significant reason for irresistible sickness, it additionally affects wellbeing through the spread of natural and inorganic synthetic concoctions that are unsafe to wellbeing. These incorporate chlorinated solvents (which cause malignant growth), trihalomethanes (which cause liver and kidney harm), substantial metals, for example, lead (which causes nerve and cerebrum harm, and birth absconds), and polychlorinated biphenyls (PCBs) (which cause liver harm, and may likewise cause disease). Given the danger of irresistible sickness and synthetic toxic substances from sullied water, clearly access to safe drinking water is a major prerequisite for human presence. Be that as it may, the accessibility of water additionally has more extensive ramifications through its commitment to different parts of human life. Need of availability of clean water associates emphatically with neediness.

1.2 Need of Study

The ordinary water treatment stream diagram includes the procedure of coagulation, flocculation, sedimentation, filtration and sterilization in an arrangement to treat the surface water for drinking reason. Coagulation is a basic segment of the treatment conspire and principally planned for destabilizing the colloidal particles, causing turbidity in the crude water. Coagulation procedure could be considered as one of the most average physiochemical forms utilized in water medicines because of its simple activity, moderately straightforward plan and low vitality utilization. The destabilized colloidal particles are agglomerated into bigger totals which get settled productively in the sedimentation procedure or further expelled in the ensuing filtration process.

Aluminum salts or Iron salts are ordinarily utilized as coagulants . Aluminum sulfate or alum is that the most by and large utilized coagulant inside the world for refreshment treatment. Alum hydrolyses in water to make aluminum hydroxide , and in this manner the colloidal and suspended debasements present inside the water are evacuated by charge balance, clear floc-component and adsorption onto hydroxide encourages. Truth be told, the coagulation procedure prompts the get together of voluminous slime alluded to as water treatment sludge (WTS) or water treatment remaining (WTR) that presents trouble in taking care of and removal to natural specialists. For the most part , slime from water treatment plants are dumped legitimately into close by hydric bodies. Notwithstanding, it is anything but a right arrangement since it might brings about unfortunate development of mud stores and tainting of the getting water bodies on account of the compound items used in the treatment. Different options for slop removal, as of now rehearsed inside the world are cremation, land application and landfilling considering these muck as non-poisonous.

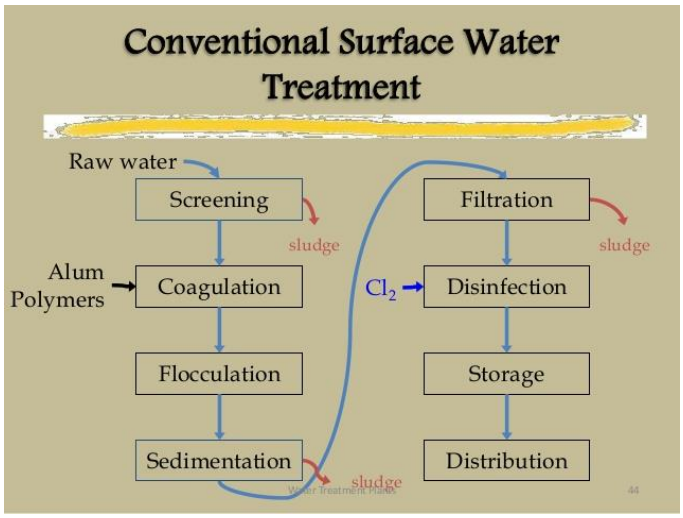

Figure 1:Conventional Surface Water Treatment Diagram

In India and heaps of creating nations these Water treatment muck released legitimately into downstream side of the waterway or arranged into close by stream which at last meet the downstream stream. Such practice antagonistically influences the water quality and sea-going life. In any case, with the conviction of unfavorable ecological effects and open mindfulness, all things considered, severe guidelines would be actualized soon.

Inside the current examination, an exceptional methodology of WTS use has been researched. The muck created from common turbid water through the technique for coagulation/flocculation by alum, has been synthetically treated with corrosive to cause an item alluded to as sludge reagent product (SRP). The delivered SRP is legitimately utilized as a coagulant and along these lines the exhibition of SRP as a coagulant for the expulsion of colloidal suspensions from the waste water from JUIT's PST is assessed under factor conditions. the most target of the examination is to flexibly muck from the coagulation/flocculation of the water source in Domehar locale of area Solan in Himachal Pradesh by utilizing ideal portion of traditional coagulant, describe the slime at that point get ready SRP from the delivered ooze. At that point, the SRP is utilized as a coagulant and its productivity inside the evacuation of suspended colloids at variable pH has been assessed.

Figure 2: JUIT's Sewage Treatment Plant

1.3 Description of Study Area

Solan is a locale of Himachal Pradesh. Solan showed up on first September, 1972. It positions ninth with the region of the state with a district of 1936 sq. km. (3.48% of full scale state an area). It is known as the advanced and business territory of Himachal Pradesh. It has pulled in significant present day financing with Baddi, Barotiwala, Nalagarh being home to most of the endeavors. Domehar is a town panchayat situated at the scope 31.0231588 and longitude 77.0585151 . Shimla is the state capital for Domehar town. It is situated around 30.0 kilometer away from Domehar. The other closest state capital from Domehar is Chandigarh and its separation is 101.0 KM. By and large, Domehar has a cool atmosphere. Lying in the Solan - Shimla fragment of N.H.- 22 it has a moderate arrangement of conditions; i.e., neither so cold as Shimla, nor excessively hot as Kalka as the temperature barely transcends 32 °C (90 °F). Temperatures regularly extend from −4 °C (25 °F) to 32 °C (90 °F) through the span of a year.

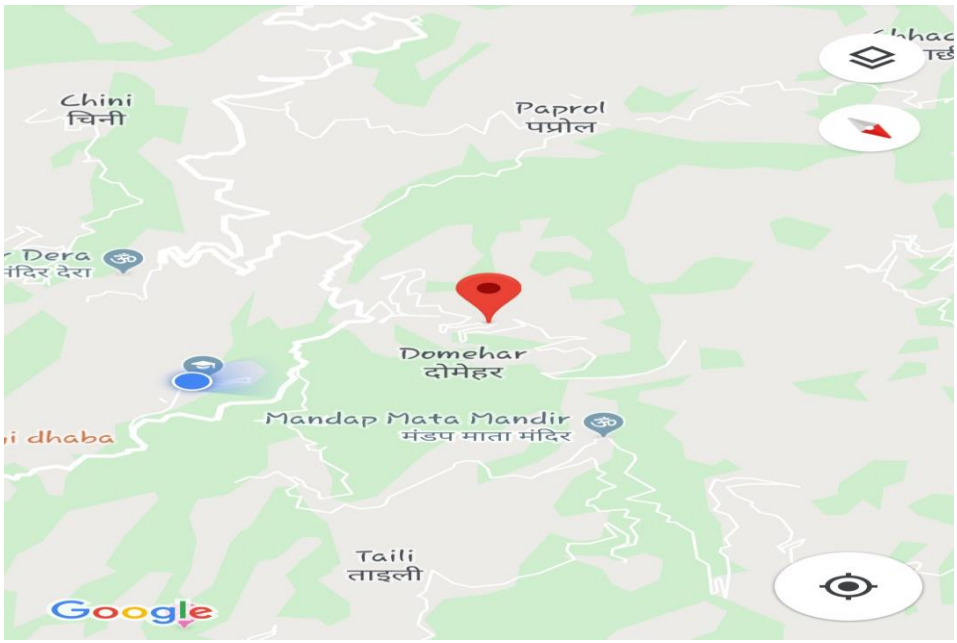

Figure 3: Map of Area of Study(DOMEHAR)

Figure 4: Raw Water Source (DOMEHAR)

CHAPTER 2

LITERATURE REVIEW

2.1 General

This assessment have concentrated on valuable reuses of WTS for practical and prudent slop the executives and being developed of ooze taking care of and removal. Impact of muck on the crude water and waste water as coagulants has been principally engaged. Along these lines, a few examinations have been led for adjusting and discovering the utilization of produced slime and its sheltered removal alternatives.

2.2 Literature Review

- **King et al. (1975) [1]** found that aluminum recovery from the alum sludge could be achieved at lower pH ranging between 1 and 3 and pH value of 2.5 accounted for maximum recovery. It also indicates that the efficiency of sludge in coagulating suspended solids is not materially reduced from that of fresh coagulant.

- **Menkiti et al. (2001) [2]** investigate coag-flocculation (using TFC) of PW and characterization of the post treatment settled sludge (PTSS). Effects of dosage, pH and settling time on treatment efficiency were evaluated. TFC and PTSS were subjected to Fourier transform infrared (FTIR), X-ray diffraction (XRD), Thermogravimetric/Differential scanning calorimetric and Scanning electron microscopic (SEM)/Elemental analyses. Optimal treatment efficiency of 91.5% was obtained at 1 g/L and pH 2. It could be concluded that TFC was thermally stable and has potential for application as an effective bio-coagulant.

- **Gao et al. (2002) [3]** delivered Aluminum-silicate substance compound composite (PASiC), a pristine very inorganic specialist by 2 methodologies: (1) hydroxylation of the blend of AlCl3 and ongoing polysilicate (PASiCc); (2) hydroxylated polyaluminum-chloride (PAC) joined with late polysilicate (PASiCm). The PASiC item had the ensuing properties: Al2O3 content=6.40–7.30%, SiO2 content=0.40–0.82%, Al/Si ratios=10–20, basicity (OH/Al molar greatness connection, meant B)=1.2–2.0. The regular activity conduct of PASiC and board of trustees underneath conditions run of the mill for common activity and action in water treatment were examined by learning the speed of floccule size turn of events, the changeability of spilling ebb and flow value, the intensity of dimness evacuation and furthermore the aftereffect of hydrogen particle focus on the dinkiness expulsion power, and furthermore the dependability of PASiC. The outcomes expand during this investigation counsel that, contrasted and advisory group, PASiC may upgrade

conglomerating strength and gives higher coagulating impacts, anyway debilitate charge adequacy in method|natural action|action|activity} process or become temperamental once save for broadened time, especially at higher B cost and lower Al/Si greatness connection. The Al/Si extent connection mustn't be excessively low or the B cost mustn't be excessively high, in any case, the PASiC item will in general become shady or part gelatinlike, which can make them misfortune some characteristic activity strength.

- **Guan et al. (2005) [4]** endeavored to check the practicability of reusing water treatment works slop ("alum slime") to upgrade particulate waste item expulsion from biodegradable contamination. the most issues focused upon were: (1) the adequate portion of the alum muck, (2) the worthy in activity conditions, and (3) the potential instruments for improving by including alum slime. Genuine alum ooze and biodegradable contamination were applied to a progression of container tests led underneath various conditions. it's been discovered that each the SS and COD evacuation efficiencies might be improved by the expansion of the alum muck, that was basically credited to the expulsion of nearly fine particles with a size of 48–200 millimeter. the satisfactory portion of the alum slime was unflinching to be 18–20 mg of Al/L. Speeding up or lessening the stuff size of the alum ooze expanded the SS and COD evacuation and furthermore the spread alum muck may remove particulate contaminants with littler size than the crude biodegradable contamination. it had been hypothesized that the range characteristic procedure as well as the physical sorption may assume key jobs inside the improving of particulate waste item expulsion from biodegradable contamination.

- **Monteiro et al. (2008) [5]** at first submitted ooze to portrayal tests to work out its molecule size circulation, substance creation, mineralogical organization, warm conduct and morphological viewpoints. Blends were prepared with measures of zero, 3, five and ten high rise of muck joined into the clayey body. Rectangular examples were gotten by twenty MPa pressure forming thus excused at 700, 900 and 1100 °C during a lab chamber. Clay properties related with the larger part thickness, direct shrinkage, water retention and flexural crack quality were resolved. The outcomes demonstrated that the joining of the slop increment the water ingestion and cut back the mechanical quality of the clayey excused earthenware. this can be a result of the progressions caused inside the consistence by the relatively raised weight reduction all through the terminating stage.

- **Jangkorn et al. (2011) [6]** assessed the attainability of reusing the aluminum sulfate (alum) slop as a coagulator or as a characteristic procedure help so the ongoing alum portion are frequently diminished or the expulsion diminished are regularly expanded. The trials were directed in an exceedingly container test hardware mimicking the coagulation-flocculation technique for correspondent expulsions of natural issues, anionic surfactants,

suspended solids, and turbidity. At the ideal introductory hydrogen particle focus worth of ten and consequently the ongoing alum grouping of 400 mg/L, the entire suspended solids (TSS), complete synthetic component request (TCOD), absolute anionic surfactants, and cloudiness evacuation efficiencies were seventy one.5%, 76.4%, 95.4%, and 98.2%, severally. The expansion of alum ooze as a coagulator alone with none ongoing alum expansion may significantly remove the dimness, TCOD, and anionic surfactants. The poisonous stun was left inside the supernatants once the subsidence sum, anyway would a short time later be expelled by including the ongoing alum. The TSS, TCOD, and cloudiness evacuation efficiencies were also expanded once each the alum ooze and in this way the ongoing alum were utilized. The TCOD expulsion diminished over eightieth has been practiced, that has ne'er fulfilled by exploitation the ongoing alum alone. it's over that the alum muck may be reused for the treatment of business squander matter created by the purchaser item exchange.

- **Caniani et al. (2013) [7]** presented a convention of investigations equipped for assessing substance qualities of drink slime from surface water treatment plants. Consequently prepared to evaluate their achievable supportive use for geo-natural applications, similar to the improvement of hindrance layers for swamp and for the development of "bio-soils", when blended in with the steady natural division of city strong waste. This paper reports the aftereffects of an investigation pointed toward assessing the norm and natural parts of reproduced soils ("bio-soil"), that zone unit used in bounteous bigger amounts than the {standard|the same old} standard, for "enormous" applications in ecological activities like a definitive cowl of landfills. The granulometric, concoction and physical examination of the ooze and furthermore the filter investigate the steady natural portion indicated the nature of the anticipated materials for reuse.The examination built up that the reuse of drink ooze for the advancement of obstruction layers and furthermore the arrangement of "bio-soils" diminishes the utilization of normal materials, the interest for swamp volumes, and offers different mechanical advantages.

- **Tyagi et al. (2013) [8]** saw the utilization of waste sludge as a renewable resource for energy recovery is the appropriate solution of how to manage the continuously increasing waste sludge generation effectively in order to meet stringent environmental quality standards, and at the same time, how to sustain the supply of reliable and affordable energy for our future generations and ourselves. The valuable characteristics of sludge, including high energy and nutrient content, with the stringent criteria of sludge disposal, driving the environmental engineers and scientist to change their standpoint to considering sludge as a viable resource of energy instead of a waste. It may be an important move towards the development of a sustainable energy solution to fulfill present and future energy requirements and thus reduce the dependency on non-renewable resource. Thus, this review discussed about the type of resources that can be recovered from waste sludge and, conventional and emerging methods used to convert the sludge

into valuable resources. Moreover, the major factors involved in the process, stage of application, advantages and possible drawbacks of the methods are also discussed.

- **Bonfiglioli et al. (2014) [9]** presented an overview on sewage sludge characteristics and recovery routes. Starting from an analysis of typical sewage sludge characteristics as found in literature, the most promising disposal options are presented. A focus on incinerated sewage sludge ash (ISSA) follows. Most of the authors agree on considering pyrolysis and gasification as the most viable treatments for sludge in the near future. For this reason, the last two chapters offer a brief description of these two processes and their products.

- **Ahmad et al. (2016) [10]** investigated the sludge produced a WTP at Ghaziabad, India for physical and chemical characteristics. It consist of about 60% fine sand in grain size range 150-75µ. Silica, alumina, ferric oxide and lime constitute the major percentage of chemical components present in the sludge. Some heavy metals were also found in the sludge. Discharging WTS into river, streams, ponds, lakes, drains etc. or landfilling the dewatered WTS is not environment friendly disposal option. Based on the characteristics, sustainable and profitable disposal through recycling and reuse have been reviewed. Utilization of WTS in brick making, in ceramics making, in the manufacture of cement and cementitious materials and as a substitute to building materials have been provided as safe disposal route. Reuse in wastewater treatment, in removal of heavy metals from aqueous solutions and in nutrient reduction from laden soils and runoffs are also some of the possible alternatives. It is required to explore suitable option for developing sustainable sludge management strategies under stringent environmental norms.

- **María et al. (2020) [11]** studied about a portion of the microorganisms present in urban wastewater, which incorporate intestinal protozoa and nematodes, can be pathogenic. Their (oo)cyst and egg transmissible stages are impervious to ecological burdens and disinfectants and they are in this way hard to evacuate. In this manner, they can establish a wellbeing hazard if water or slop acquired in the filtration of wastewater is reused for rural purposes. In this unique circumstance, the nearness of intestinal protozoa and nematodes were concentrated in influents, effluents and slop from five wastewater treatment plants (WWTPs) in the north of Spain by optical microscopy and PCR strategies. The expulsion proficiency of various wastewater medicines was likewise looked at. In fact, this is the primary report of Entamoeba histolytica and Entamoeba moshkovskii in Spanish WWTPs. The water medications considered demonstrated diverse expulsion efficiencies for every specie of intestinal protozoa, with the circulated air through tidal ponds giving the best outcomes. (Oo)cysts were likewise identified in ooze significantly after oxygen consuming absorption and drying out. To maintain a

strategic distance from dangers, (oo)cyst suitability ought to be investigated at whatever point the slop is to be utilized as a manure. This examination fortifies the need of building up lawful cutoff points on the nearness of protozoa in WWTP effluents and slimes, particularly if reuse is arranged. Further examinations are essential for a superior comprehension of the nearness and conduct of intestinal parasites.

- **Luis et al. (2020) [12]** has shown the use of Water Treatment Sludge (WTS), the primary waste produced by water potabilization exercises, for the advancement of a Supplementary Cementitious Material (SCM). The waste has been handled by calcining at a temperature scope of 600 °C–800 °C for 60 minutes. Concoction, mineralogical, physical, and morphological portrayal has been performed to distinguish the potential pozzolanic movement of the calcined WTS and approve the application as SCM. Compressive quality tests have been acted in concrete mortars with 14%, 35%, and half substitution of Portland concrete by WTS. The WTS is a non-perilous and non-inactive waste, made out of SiO2, Al2O3, Fe2O3 and contains basically quartz and kaolinite. Results affirmed the change of kaolinite into receptive shapeless stage by calcining. WTS calcined at 600 °C demonstrates extraordinary potential to the creation of SCM, affirmed by the compound and physical examination and the proof of pozzolanic movement. The mechanical properties of mortars created with 14% and 35% WTS calcined at 600 °C proposes a promising application in the creation of mixed and pozzolanic Portland concrete.

- **Norah et al. (2020) [13]** has shown Aluminum sulfate is the commonest and most broadly utilized coagulant for water treatment around the world. Aluminum is a notable adsorbent for phosphorous (P), a supplement exceptionally connected with eutrophication in most water bodies. In this way, this paper gives an audit on P adsorption from fluid media utilizing alum slime squander material created by water treatment plants that utilization aluminum sulfate as sole coagulant. A meta-examination of information on attributes of different alum slimes was finished. The obstacle components and adsorption limits, under changing working conditions are introduced, including future bearing. It is apparent from writing review that there is the developing movement from reuse and reusing of crude alum ooze towards union of significant worth included alum muck based adsorbents. Conceivable outcomes to improve adequacy as both channel media and adsorbent and yet diminishing metal draining are featured. Worth included items may likewise offer an additional preferred position of going about as wellspring of phosphorous for conceivable reuse in horticultural soils.

- **S. Gupta et al. [14]** In this report the waste material was accumulate with Indian typical for water framework (IS 11624: 1986) that reveals that the estimations of, cyanide, complete suspended solids(TDS), oil and oil outperform the given Indian ordinary characteristics. There aren't any ebb and flow measures for water framework water for the

larger part of the considerable metals. all things being equal, significant metal centers that square measure particularly remarkable square proportion of genuine concern as they will bio assemble through the common technique forever. The plant open N, phosphate, and metallic component substance of the wastewater-immersed soil square measure piles of underneath the administration soil. The lesser metallic component and N content in squander material immersed soil likely could be to boot inferable from solid profluent water framework that diminishes the customary microbic activity inside the earth, occurring in extra moderate appearance of plant open enhancements into the soil.

- **R Reza et al. [15]** The extent of pH in summer was fairly acidic to solvent though in summer extent of pH was all through the winter.The high pH of the stream water would be the game plan inside the utilization of overpowering metal harmfulness. everything considered the looking at regions there was alluring amount of deteriorated particles on the whole the models assembled, on the grounds that the occurrence of TDS. TDS center apparently was higher inside the stream water near the precarious edge of the midway segment of the geological territory that was inside the extent of 160-295 mg/land 159-343 mg/l in winter and summer seasons on an individual premise attributable to entirely unexpected next to no and huge degree adventures aggregated in these areas.

- **Gorde S.P. et al. [16]** Water is that the most significant in surrounding the land and dealing with the environment. it's a hero among the principal tremendous increase that basically influence life. the idea of water is unremarkably depicted by its physical, substance and normal attributes. Smart production and unusual use of manufactured humus and pesticides in horticulture as perpetrating liberal and balanced spoiling in land and water skilful condition agitative enervating of water quality and usage of sea science. Due of use of unclean water, human encounters water bred contaminations. it's along these lines critical to inspect the water quality at ordinary time frame time. Parameters that might be tried to join temperature, pH , Turbidity , Saltiness, Nitrates and phosphates. Partner in Nursing assessment of the maritime full scale gutless animals will in like way offer indication of water quality.

- **Bittner et al [17]** carried the study on the traits of consumable water. Various samples were occupied from different sources like stream, well and plants that treat water, all of which showed faulty results and contamination in water. Hence it was concluded that almost all of the potable and consummable water supplies are microbiologically defected**.**

- **Kittae Baek et al [18]** adsorbent of globule kind to dispose of arsenic (As) was created by oxidization of nuclear number 11 alginate and polyvinyl liquor containing a powder

sort of alum ooze. The substance that is adsorbs was assessed as far as surface digestion elements,limits in group tests and by a section study. The oxidization plan made harsh surface and swelled the surface zone of dab a hundred times, that expanded the surface osmosis elements of As onto the calcined adsorbent 3–21 times than uncalcined dab. Be that as it may, the surface osmosis ability diminished marginally contrasted with the uncalcined substance that adsorbs. The section study indicated comparable surface osmosis capacity with business adsorbent and powder type of alum slop considering the quality cost of As for drinkable. The oxidization strategy expanded the adsorption elements of the adsorbent for As expulsion, one among significant hindrance of dab kind adsorbent contrasted with powder kind, that may decrease the bed amount of the reactor.

- **Aggarwal Madhu et al [19]** measured aluminum salts square measure wide explored for the normal {process|natural action|action|activity} process for evacuation of halide, anyway the remaining Al over as far as possible is that the principle worry that is chiefly because of the arrangement of material that can get dissolved and blend Al-F buildings of metal and halide. Thus, it's important to explore the character and instrument of development of blend, broke up and hastened Al-F edifices and elective Al related species, that administer the convergence of leftover Al inside the defluoridated water. inside the blessing study, tests were performed to discover the advanced portion of metal sulfate (alum) and polyaluminium (PACl) for expulsion of halide from consumable. Remaining halide, sloppiness and TDS were seen as one.3 ppm, seven NTU and 280 ppm severally, for alum and zero.48 ppm, four NTU and 200 ppm severally for PACl for introductory halide centralization of 4 ppm. Remaining Al was seen as higher than as far as possible (0.2 ppm), anyway it had been less for PACl as looked at to alum, be that as it may, when the following microfiltration, remaining Al was zero.268 and 0.13 for alum and PACl severally that nearly met as far as possible. Portrayal of the treated water previously and once filtration by abuse microfiltration film was done through electrospray ionization spectroscopic investigation (ESI-MS) to spot the blend, broke down Al-F species. metal species inside the sort AlF5 2−,AlF2 +, AlF4 −, Al2(OH)2 2+, Al(OH)2 +, Al (OH)2F2−, AlOHF+ and so on as Al-F were recognised. From the ESI-MS results, it had been resolved that exclusively various Al-F edifices with lesser fixations were formed just if there should be an occurrence of PACl, that affirmed the established truth that PACl worked higher for the halide evacuation with low remaining Al. The dying down of the Al-F buildings for PACl was higher than alum because of the qualification in characteristic procedure system connecting just if there should arise an occurrence of PACl and clear normal procedure for alum. X-Ray Diffractory, Scanning Electron Microscope and Fourier Transformation and Iinfrared investigation of alum and PACl slop was done to recognize the encouraged species.

- **D. H. Bache et al [20]** contemplated the ideal inconclusive amount of a substance that isn't ionic synthetic compound all through the securing of partner degree alum overflow emerging from the treatment of a shaded, upland water. Dewaterability was examined through Capillary Suction Time (CST) and Specific Resistance to Filtration (SRF) tests, next to body estimations on the fluid area of slime. The ideal measurement identified with common time and SRF was one.5 kg/T while for the instance of body conduct it had been a two part harmony of.0 kg/T. From concoction compound surface absorption concentrates on the seepage, it had been demonstrated that the ideal dosages identified with the body estimations were joined to a portion at that the surface osmosis capacity arrived at an immersion cost (1.8 kg/T). The SRF and common time optima were discovered like a condition of 70–85% of the immersion inclusion. Equal surface digestion tests on alum slime and unadulterated accelerate demonstrated that concoction compound surface absorption on the encourage was the top determinant of the surface osmosis attributes of the seepage and asked that the ideal portion was joined to the mass of hasten blessing inside the seepage.

- **K. K. Manoj et al [21]** has analyzed issues with troubles to availability of superfluous water for moving towards reasonable flip of occasions. The examination attempted adequacy of regular coagulants in body process harms from surface water. Utilization of trademark coagulants go with a deterrent of limited time length of convenience that inferable from started skint up common carbon attributable to higher centralizations of the coagulants utilized. From now on, inside the present assessment lower mixtures of the trademark coagulants were attempted. Further, the efficiency of those coagulators is differentiated and typical coagulant alum. The capability of coagulants on a shallow level water was prevalent in turbidness clearing with seventy eight.72% by alum; sixty nine.15% by starch at pH seven with coagulator parcel zero.1 g/L and zero.3 g/L separately and sixty seven.73% by polysaccharide at pH six with coagulator partition zero.3 g/L. Fourier Transform and infrared examination of the coagulants showed amines, hydroxyl, and carboxyl accommodating social occasions asserting the concoction compound molding capacity of the coagulants. Scanning Electron Microscope photographs of the coagulants once treatment showed vivacious check of collaborations among coagulants and suspended solids acknowledged from the progressions inside the surface morphology. From the results it okay is additionally plausible that the trademark coagulants attempted square measure promising responses for challenges of water quality.

- **Eko Siswoyo et al [22]** evaluated the fluid level nuclear number 48 surface osmosis skirt of breakdown of a skimming adsorbent got from a consummable water treatment overflow. unlimited sludge, component destructive changed grime powder, and granular embodied slops were reviewed. Parameters, for instance, adsorbent fixation, contact time, hydrogen particle convergence of the game-plan, and in this way the essential

centralization of nuclear number 48 particles were examined exploitation pack normal procedure tests. Scanning Electron Microscope, Fourier Transform infrared, and rudimentary appraisal methods were used for the portrayal of the adsorbent. The physicist model was acclimated select the surface digestion farthest reaches of the entirety of the four adsorbents. the least difficult nuclear number 48 burden stretched out from twenty five mg/g for the unlimited ooze to forty.3 mg/g for the component hurtful changed material. The alginate gel-exemplified slop adsorbate thirty mg/g, genuinely more than that of the unpleasant sludge. The granular sensibly the exemplified material made it less muddled to dispose of the adsorbent from the watery stage once the surface absorption system. The divulgences of this appraisal have essential ramifications for the flight of fluid stage nuclear number 48 exploitation flood principally based, irrelevant perspiration adsorbents.

- **Shanshan Hu et al [23]** analysed the blend of 2 plant species (Phragmites australis and variety Typha angustifolia) and night crawler (Eisenia foetida) densities of two.7, 5.4, 8.1, 10.8, 13.5 and 16.2 kg/m3 in six STWs were investigated to pass judgment on their implications for withered water characteristics. In the mean time, impeding portrayal of the six STWs was assessed. The outcomes have shown that filtration rates inside the 3 worm STWs were 0–0.4 cm/s over those inside the STWs while not night crawler augmentation. P. australis and T. angustifolia effectsly impacted substance gas request (COD), all out component (TN), all out phosphorus (TP) and ammonium particle (NH4+) flight, with expulsion efficiencies wherever eightieth. In like manner, NH4+ evacuation ability was basically remarkable between P. australis and T. angustifolia; the upper NH4+ discharge efficiencies of eighty nine.5–90.4% were settled inside the 2 P. australis STWs. In the interim, real affiliation appraisal and head section assessment demonstrated that the blend of plants and worms was significant for depleted water treatment inside the STWs. Additionally, the correct depleted water treatment was settled inside the P. australis STWs with a worm thickness of ten.8 kg/m3, with the mass evacuation efficiencies for COD, NH4+, Tennessee and TP being ninety nine.1%, 93.1%, 91.5% and 91.0%, independently. Along these lines, it'll for the most part be mulled over that P. australis and night crawler expansion improved depleted water qualities and alleviated debilitating inside the STWs.

- **Shimaa A.Shahin et al [24]** inspected the absorption of copper particles (Cu2+) onto calcined overflow was investigated underneath totally extraordinary operational conditions (with dynamic temperature, Cu2+ starting center, pH, and filth portion). The prepared slime material was depict with transmission microscopy (TEM), X-bar optical wonder (XRD), dynamic light-weight dispersing (DLS), and Brunauer-Emmett-Teller (BET) surface zone. The activity furthest reaches of sludge was legitimately comparative with the basic Cu2+ center and oppositely like the slop portion. the ideal operational pH and game plan temperature were vi.6 and 80°C, on an individual premise. The wildcat

results followed an Irving Langmuir isogram and pseudo-first-demand sorption vitality. physical science parameters, for example, accomplishment essentialness, alteration in free imperativeness, enthalpy, and entropy were resolved. physical science examinations demonstrated that the characteristic {process|natural action|action|activity} of copper particles onto the calcined overflow was driven by a physical sorption process. The prepared ooze was incontestible to be an unfathomable sorbent material for the removal of Cu2+ from a watery course of action underneath perfect conditions.

2.3 Summary of literature review

- Sludge produced is a complex heterogeneous mixture of organic materials, inorganic material and moisture.
- Sludge reuse can vary largely depending upon its chemical properties.
- Sludge reuse varies from brick making, ceramic making,coagulating-aid etc.
- Using sludge as coagulant is quite cost effective in case of water treatment plants.
- It also reduces the challenges faced by environment and sustainably helps in reducing sludge quantities.

2.4 Objectives

- To determine the physical and chemical properties of the raw water obtained from the water source in Domehar region of district Solan in Himachal Pradesh.
- To determine the optimum coagulant dosage of alum for coagulation and flocculation process to be carried out in raw water.
- To form the sludge from the raw water using optimum coagulant dosage of alum.
- To determine the characteristics of the sludge produced.
- To form the SRP from sludge at various pH levels and its reuse as coagulant in PST effluent from JUIT's sewage treatment plant.
- To determine the physical and chemical properties of treated waste water and match them with required standards.

In order to achieve the above objectives, tests such as pH, Total Hardness, Electrical Conductivity, Turbidity, Chloride Content, Alkalinity, Acidity, TSS, TS, TDS, BOD and COD has been carried on raw water and waste water samples. Firstly, tests on raw water has been carried out succeeding by tests on waste water after its sedimentation for 8 hours. Later on sludge generated from raw water is used as coagulant at varying pH levels and results are recorded and matched with prescribed Indian standards.

CHAPTER 3

MATERIALS AND METHODS

3.1 Traits of water samples

15 liters of crude water test has been acquired from the water source located at domehar. These examples are composited and safeguarded in Poly Vinyl Chloride compartments that are non adsorbing in its nature. At that point, the composited crude water tests have been done for physical, compound and organic water featuring parameters according to system clarified in standardised procedure for examining the Water and Wastewater (APHA, 1998).

3.2 Finding out the optimum dose of coagulant

The alum chemical reagent of ten thousand mg/L (1 metric capacity unit of alum chemical agent is like ten mg alum) has been ready. Thereafter, this alum chemical agent is employed as a coagulator for the removal of mixture suspensions from the collected water sample in batch operations. the traditional jar test equipment has been used for acquirement of optimum coagulator dosage. The alum chemical agent dosage starting from zero.5ml/L to four ml/L with a go ahead of zero.5 ml/L are additional. A flash/rapid mix for two minutes at a speed of a hundred revolutions and a slow mix for twenty minutes at a speed of thirty five revolutions is disbursed. Thereafter, jars are unbroken and not moved for twenty minutes for the relieving of the flocs. The supernatant from every jar has been obtained and analysed for cloudiness through Nephelo-turbidity meter.

3.3 Sludge Delineation

The jar having optimum coagulant dose and the sludge produced by it has been separated by using separatory funnels. Then, the ooze acquired is studied and experimented for its physical and chemical properties. pH and solid portion of the sludge are obtained according to Standard Methods for Examination Water and Wastewater (APHA, 1998).

3.4 Sampling of waste water and its quality determination

Influent of JUIT's SWTP is gathered and it is screened or separated utilizing cotton material. From there on it is left for sedimentation process in a shut tank at the research center for 8 hours at JUIT. After the settling of solids emanating of sedimentation tank has been checked for its quality parameters and it is utilized for coagulation process utilizing alum ooze.

3.5 Making SRP from Sludge

The ooze acquired is reacted with with different normality of H_2SO_4 (0.5 N, 1.0 N, 1.5 N, 2.0 N, 2.5 N and 3.0 N) starting from 0.02 ml/ml to 0.12 ml/ml of sludge with gradual increment of 0.02 ml/ml for acidification of ooze. The ideal normality and dose of H_2SO_4 obtained during this

procedure is hand-picked for making ready SRP from the sludge. The acceptable sludge amount for the making of SRP has been found out by experimentation by variable the concentrations of sludge ranging from 0.5% to 3.5%. The sludge amount and normality of acid that gave most muddiness removal is chosen to supply SRP and so it's used as a coagulator for the treatment of PST effluent from JUIT’s SWTP throughout this study.

3.6 Performance Evaluation

The exhibition of SRP made at the center has been assessed for its power in expelling colloidal arrangement from common time gushing of JUIT's SWTP . The expulsion power has been found out over a huge change of hydrogen particle fixation from a couple of to thirteen. Container tests are performed to reproduce a standard coagulation and flocculation technique. Six containers containing a thousand cubic centimeter water test are put in an ordinary container investigate gear and hydrogen particle convergence of the water tests square measure somewhere around misuse H_2SO_4 or gathered by abuse NaOH for accomplishing the necessary hydrogen particle focus level. Once including the SRP portion, a blaze commixture of two min is given to understand the flocculation technique followed by moderate commixture for thirty min to coagulate the colloidal arrangement all through activity process. From that point, containers are solid stop for twenty min to loosen up the flocs thus supernatants square measure taken for determinative the sloppiness expulsion. The group tests are designated for each hydrogen particle fixation condition at various portion of SRP. The ideal portion of SRP and furthermore the ideal alum portion found inside the blessing study are applied independently to treat the gathered waste water and furthermore the aftereffects of fluctuated water trait parameters are looked at.

CHAPTER 4

TESTING METHODOLOGY

4.1 Testing Parameters

4.2.1 pH Determination Methods

pH is essentially a degree of the ruinous tendency or basicity of a watery strategy. game plans acquiring pH less proportionate to 7. Fundamental pH optimum attributes are found by utilizing a concentrated cell with transference, basically by surveying the potential intricacy between a standard anode, for example, the silver chloride positive electrode and hydrogen negative electrode. Acquiring of pH for fluid blueprints ought to be possible with a pH meter or a glass cathode. We can likewise discover the acquirement of pH by utilizing pointers. pH estimations have essential significance in the field of science, natural science, science, sedate, oceanography, food science, developing, food ,typical organizing, blend building, water treatment and water purifying and different applications.

Mathematically, it will when all is said in done be said that pH is the negative log of the activity of the hydrogen atom.

Procedure:

• First flush the test with twofold water(without ion) before utilizing it.

• Obtain the example of water in a holder.

• Meter has been set to the same the example temperature.

• The test has been into the model .Wait for the meter to come to adjust.

• Read the pH estimation of the example.

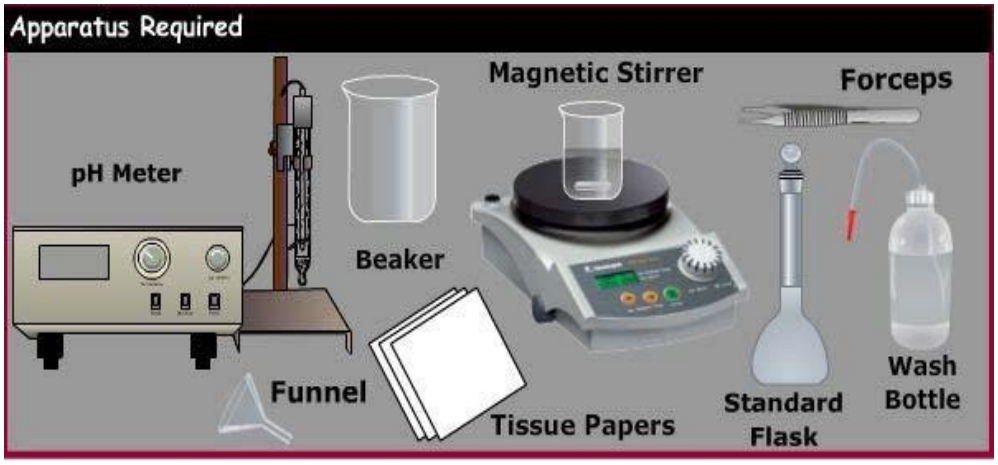

Figure 5:pH meter and required instruments.

4.2.2 Analysis method for Alkalinity

Alkalinity is a proportion of the buffering volume of water to neutralize strong corrosive. This limit is ascribed to stations that are available in characteristic waters including OH^-, HCO_3^-, and CO_3^{2-}. Greater alkalinity in your water test implies all the more buffering limit of your water test. It is significant for amphibian lifecycle as it makes preparations for fast pH changes. Living animals of oceanic life, work ideal in a pH scope of 6.0 to 9.0

Reagents:

• Purified water

• Standard 0.02N H_2SO_4

• Phenolphthalein marker

• Methyl orange marker

Technique:-

• Take 50 mL water test, by then incorporate 3 drops of phenolphthalein marker, 50ml model is titrated with 0.02N sulphuric scid and check phenolphthalein alkalinity.

• It will modify shading from pink to lackluster, note the adjustment in volume of sulphuric corrosive .

• If the example doesn't change shading there is presence of minerals in the given example.

• Then include 2-3 drops of methyl orange marker arrangement.

• Titrate the model with sulphuric corrosive till it turns the answer for block red.

• Note the volume of corrosive utilized for the titration.

Total Alkalinity Formulae=[Amount of H_2SO_4 utilized (ml)×Normality of H_2SO_4×100 × 50]/(test volume [ml])

4.2.3 Analysis strategy for Turbidity

Turbidity is characterized as the darkness of a fluid which is brought about by very lage number of individual particles. These particles are not obvious to unaided eye. These particles might be of numerous sizes. It can likewise be characterized as how much the water loses its straightforwardness. There are mamy factors that cause turbidity like water discharge,sediments from disintegration and so on. Unit for estimation of Turbidity is called as the Nephelometric Turbidity Unit(NTU).

Methodology:

• Take a little measuring utensil.

• The measuring utensil is fittingly washed and full with decontaminated water.

• Place the arrangement measuring utensil inside the turbidity meter and afterward it is adjusted to 100NTU.

• Distilled water is then traded in container to convey further examination.

• The screen shows the estimation of turbidity and it is brought down.

Turbidity meter: We utilized this kind of meter for exact readings and it is particularly exceptionally helpful for deciding low turbidity's (under 5 NTU).

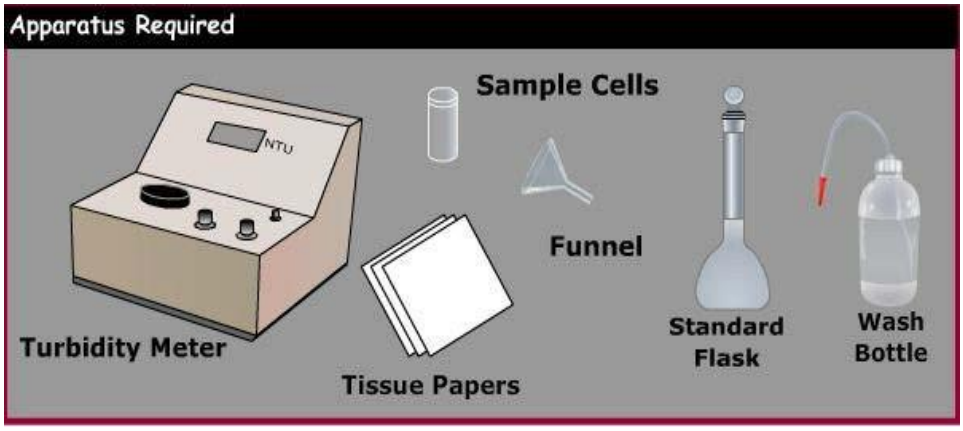

Figure 6:Turbidity meter and its required instruments.

4.2.4 Analysis technique for biochemical oxygen demand(B.O.D.):

It is the aggregate sum of broke up oxygen that is required by high-impact organic creatures for separating natural material.It gives estimation of level of proportion of oxygen compulsory for finishing characteristic breaking down of undesirable and common issue present in the water subsequently diminishing the carbonaceous substances from water. Body is evaluated using the Oxytop assessing gadget. The oxytop assessing system relies upon weight estimation which observes the weight by perizoresistive electric sensors.Take note of the features, for example, modified temperature area, data logging and evaluating range regard.

Technique: -

• Rinse the BOD bottles appropriately.

• The oxygen immersion is then accurately estimated by DO meter.

• Then put the attractive mixing pole in the jug.

• Then,on the highest point of the jug oxytop is in a bad way legitimately.

• Then bottles are kept at 200℃ for 5 days.

• The DO meter naturally quantifies the oxygen consumption during brooding period.

• The recorded worth is noted as BOD5 esteem.

4.2.5 Assessment Procedure for Chemical Oxygen Demand(COD):

Compound oxygen request is an appraisal of the oxygen which is expected to oxidize dissolvable and particulate natural issue present in water. It is an important water quality parameter in light of the fact that, like BOD, gives a gauge to review the unsafe impacts that released wastewater would have been on the conceding condition. COD having higher measurements mean a more record on the proportion of oxidizable normal material which would diminishes the broke up oxygen(DO) levels in the water.

Reagents:

• 0.25N standard potassium dichromate

• Sulphuric corrosive with reagent(conc. H_2SO_4 +Ag_2SO_4)

• Standard ferrous ammonium sulfate 0.1N

• Ferroin pointer

• Mercuric sulfate

Strategy:

• Take 2.5ml water test and refined water in two cylinders.

• Add 1.5ml of potassium dichromate to both the cylinders.

• Add 3.5ml of sulphuric corrosive reagent to the two cylinders.

• Keep tubes in COD digestor at 1500 C for 2 hours.

• After cooling to room temperature include 2 drops of ferroin pointer and titrate it against ammonium sulfate until shading changes to ruddy earthy colored.

Formulae:

Amount of Fe $(NH_4)_2(SO_4)$ included for refined water = A ml

Amount of Fe $(NH_4)_2(SO_4)$ included for the example = B ml

COD = [(A-B) × Normality of Fe $(NH_4)_2(SO_4)$ × 8 × 1000] ÷ amount of sample(ml)

4.2.6 Method of Analysis Chloride Content:

These are regularly present in entire water tests and practical total of chlorides are not hurtful in any case but rather they cause a danger if the purpose of control beats 250mg/ltr. The standard of chloride exposure wears out the going with structures :

This technique utilizes Silver Nitrate ($AgNO_3$) considering the way that silver particles join with chloride molecule to make a white rush of Silver Chloride (AgCl). Potassium chromate pointer direct its end point. Chromate particles join with silver particles to shape a tanned dull concealed rush of silver chromate. This gives the affirmation that the total of what chloride has been rushed. Chloride in water might be basically stretched out by activity process in which chlorine or chloride is utilized. Chlorides become basic forever when they join with metal, for example, sodium. A little measure of chlorides is likewise significant for cell working in plants and creatures.

System:

• 50 ml test ought to be pipette out in two porcelain dishes. Include 1 ml of potassium chromate pointer ought to in the example.

• Stir the example in the wake of including standard silver nitrate arrangement was included until a constant rosy shading appears.

• The amount of AgNO3 utilized in titration was famous and from this the chloride content is assessed.

Formulae utilized:-

[Volume of titrant used×Normality of silver nitrate × 35.45 × 1000]÷ Volume of test (ml)

4.2.7 Analysis strategy for Total Dissolved solids (TDS):

It is the finished of all the bust down characteristic and inorganic substances that square measure available in an extremely liquid in changed structures like ionized , suspended or sub-nuclear is named Total Dissolved Solids (TDS). The solids must be constrained to be sufficiently immaterial to suffer filtration through a channel that has 2 micrometer (clear size or humbler) pores. The Study of nature of water quality for conduits, offer and lakes is that the most enormous use of TDS. Calcium, phosphates, nitrates, sodium, potassium, sulfates and chloride contain not a few of the fundamental blend constituents. Pesticides climbing out of surface flood square measure sensibly unprecedented and dangerous things of TDS. bound routinely happening full scale segregated solids climb out of the anguish and debilitating of rocks and soils. Centralization of get a separation ionized solids inside the water is doubtlessly known with the electrical physical marvel of water. Particles inside the detached solids in water assemble the skirt of breakdown with respect to that water to modify electrical stream, that is overviewed by a TDS meter or antiquated physical wonder meter . H2O has high TDS levels, which can be the purpose for sludge improvement in channels, pipes, and valves, diminishing execution and adding to the cost of structure fixes. In aquariums, spas, pools, and switch osmosis water treatment structures, we can see these effects . Complete detached solids square measure attempted each as of now so in these applications, and filtration layers square measure to boot checked essentially to disappoint negative effects. TDS is normally checked to make a water quality condition that is effectual everlastingly structure ability by goals of agribusiness and cultivation.

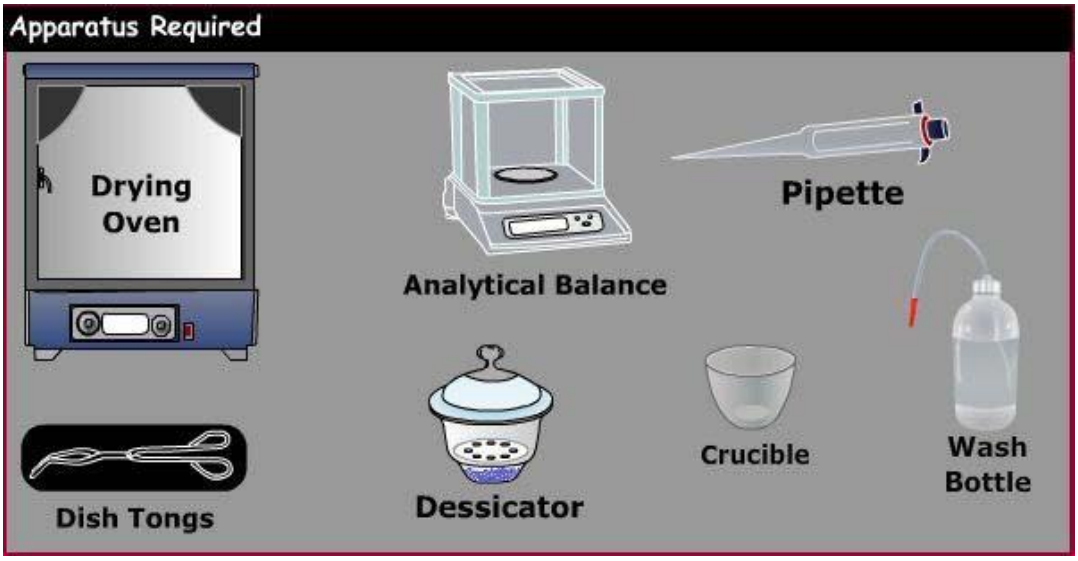

Figure 7: Instruments required for TDS

4.2.8 Analysis strategy for conductivity:-

Conductivity is defined as the capacity of water to allow the progression of electrical flow. It is noticeably identified with the centralization of atoms in water. Conductive particles originates

from inorganic materials like chlorides, sulfides and disintegrated salts. Furthermore, the aggravates that are broken down into particles are called as electrolytes. More the quantity of particles are available the more will be conductivity. Conductivity is also recommended as express conductance. Conductivity is estimated in Siemens per meter (S/m).

In different mechanical and organic applications, conductivity estimations are utilized as a proficient, trustworthy and expedient methodology for getting the degree of the ionic substance in a report.

We performed this experiment by Conductivity meter.

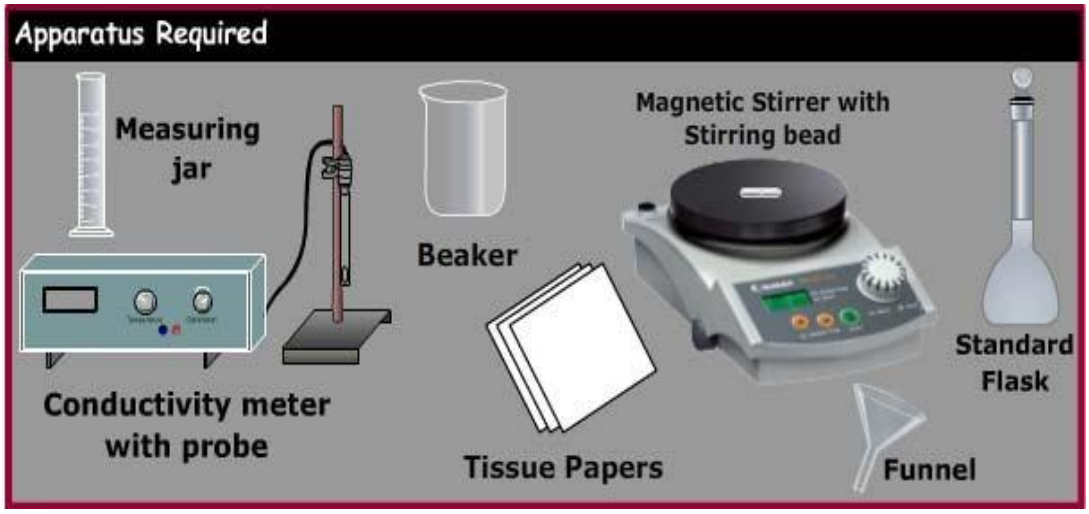

Figure 8: Conductivity meter and other required instruments

4.2.9 Analysis strategy for hardness:

Water hardness exhibits the live of full scale metal and Ca salts that zone unit hosed in water. The particles required with water hardness, for example Ca2+(aq) and Mg2+(aq), might be constrained by volumetric investigation with a chelating director, gas diaminetetra acidic harming (EDTA), for the chief half as disodium salt. typically Erichrome Black T is utilized as marker for volumetric examination. At pH 10, Ca2+(aq) particles firsts structures with the marker as Caln+(aq) that pig red. since the a great deal of grounded substance EDTA is tangled, the Caln+(aq) confused is displaced by the CaY2-aq) muddled that is blue. the top explanation behind volumetric examination is showed up by a pointy hiding adjustment from wine red to blue. volumetric examination misuse Erichrome Black T pointer picks unbeatable hardness in sight of Ca2+(aq) and Mg2+(aq) particles. Hardness considering Ca2+ (aq) particles comprises by Associate in Nursing substitute volumetric investigation at the following pH, by just as NaOH account stimulate Mg(OH)2, Carbonate hardness is recognized by the intensity auriferous particles essentially of Ca2+ and Mg2+ though chlorides, sulfates and nitrates cause uncarbonated hardness.

Method:

- Take out 50 ml sample of water into the burette with the help of pipette.
- For neutralising the power of Hydrogen of the sample , 1ml buffer solution has to be adulterated.
- Now, 2-3 drops of Erichrome Black T indicator is added.
- Then it has to be titrated with the 0.01M EDTA till the colour of solution turns from wine red to blue.
- Repeat the process of titration for coinsiding observation.

4.2.10 Determination of optimum coagulant dosage: Jar Test

The jar test is a typical research center strategy used to decide the ideal working conditions for water or wastewater treatment. This strategy permits changes in pH, varieties in coagulant or polymer portion, substituting blending velocities, or testing of various coagulant or polymer types, from a more minor perspective so as to anticipate the working of an enormous scope treatment activity. A container test recreates the coagulation and flocculation forms that energize the expulsion of suspended colloids and natural issue which can prompt turbidity, scent and taste issues. The container testing contraption contains six oars which mix the substance of six 1 liter compartments. One compartment goes about as a control while the working conditions can be shifted among the staying five holders. A rpm gage at the top-focal point of the gadget takes into consideration the uniform control of the blending speed in the entirety of the holders.

Method:

• Fill the container testing mechanical assembly holders with test water. One holder will be utilized as a control while the other 5 compartments can be balanced relying upon what conditions are being tried. For instance, the pH of the containers can be balanced or varieties of coagulant measurements can be added to decide ideal working conditions.

• Add the coagulant to every compartment and mix at around 100 rpm for 1 moment. The quick blend stage assists with scattering the coagulant all through every holder. Coagulants are compound augmentations, for example, metallic salts, which help cause littler totals to shape bigger particles.

• Reduce the mixing velocity to 25 to 35 rpm and keep blending for 15 to 20 minutes. This more slow blending speed advances floc arrangement by upgrading molecule impacts which lead to bigger flocs. These velocities are sufficiently moderate to forestall sheering of the floc because of disturbance brought about by blending to quick.

• Turn off the blenders and permit the compartments to make due with 30 to 45 minutes. At that point measure the last turbidity in every holder. The last turbidity can be assessed generally by sight or all the more precisely utilizing a Nephelometer.

Figure 9:Jar Test Apparatus for Optimum Coagulant Dosage

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Test performed on Raw Water

5.1.1 pH level

The pH strip resulted in a light green colour which implies that pH is between 6.5-8.

On checking pH through pH meter it was obtained as **7.2** which shows neutral behavior of raw water that is neither acidic nor basic.

5.1.2 Alkalinity content

The phenolphthalein alkalinity due to OH^- ions was not found as there was no change in colour which indicates **P=0**.The total alkalinity due to carbonate and bicarbonate ions in the presence of methyl orange as an indicator was found to be **T=77.2 mg/L.**

5.1.3 Turbidity levels

Turbidity was found using nephelometric turbidity meter along with the temperature of water sample. For three different turbidity measurements the mean measurement was found out to be **85.66 NTU**. The main reason of turbidity in raw water was the presence of suspended solids.

5.1.4 Chloride content

Chloride content was found using three samples of raw water and one for distilled water or blank as we say it. Mean volume of $AgNO_3$ used for sample was found out to be 1.46 mL and that for distilled water or blank sample was **0.6 mL**. Chloride content calculated was **17.18 mg/L**.

5.1.5 Hardness level

Hardness level was taken for three samples. The mean volume of EDTA used was **4.73 mL** which provided us with total hardness on scale of $CaCO_3$ as **94.6mg/L**.

5.1.6 Acidity content

The mineral acidity or the methyl orange acidity was not present as their was no change of colour observed on adding up of indicator. The total acidity or the acidity due to CO_2 or what we call as phenolphthalein acidity was found out to be **25 mg/L**.

5.1.7 Total solids, Total dissolved solids and Total suspended solids levels

TS found out to be **1093 mg/L.**

TSS found out to be **841 mg/L.**

TDS were calculated as **251 m/L.**

5.1.8 Optimum coagulant(alum) dosage

The jar test was carried out for 1% alum content at different dosages. The optimum coagulant dosage for the raw water was found out to be **30 mg/L** at a turbidity of **2 NTU.**

5.2 Tests performed on PST effluent

5.2.1 Turbidity level

The turbidity for waste water sample was found out to be **58 NTU**. It was mainly due to presence of dissolved solids in it.

5.2.2 Electrical Conductivity

The electrical conductivity at temperature of **293 kelvin** was found out to be **0.620 mMhos/cm**.

5.2.3 Chloride content

The chloride content was calculated for three samples and mean value for the volume of $AgNO_3$ used was **4.33 mL** and that for blank was **0.6 mL** . thus calculated value of chloride content was **75.91 mg/L**.

5.2.4 Alkalinity content

The phenolphthalein alkalinity that is due to OH^- ion was absent **(P=0)** as there was no change in colour on adding up of indicator. The total alkalinity due to bicarbonates was found out to be **T=246.6 mg/L**.

5.2.5 Acidity Content

The mineral acidity or the methyl orange acidity was absent as there was no change in colour on adding up of indicator. The total acidity or phenolphthalein acidity or the acidity due to CO_2 was found out to be **134 mg/L**.

5.2.6 Total solids ,Total dissolved solids, Total Suspended solids

Total solids in the PST effluent were found out to be **431 mg/L**.

5.2.7 pH level

pH of the waste water was found out to be **6.85.**

5.3 Depiction of sludge

The physical and chemical attributes of the created slime have been provided in table 1. The pH estimated was 6.8 like that of crude water tests and it contains around 9.62% of aluminum and 7.48% of iron in the dry mass. The iron substance of the Water Treatment Sludge would likewise add to the coagulation procedure.

Table 1: Physiochemical Characterisation of WTS produced.

Parameter	**Values**	**Unit**
pH	6.8	
Solid Content	4.2	(in percent)
Sodium	0.99	(percent sludge)
Potassium	2.89	(percent dry sludge)
Magnesium	1.45	(percent dry sludge)
Calcium	2.33	(percent dry sludge)
Iron	7.48	(percent dry sludge)
Aluminium	9.62	(percent dry sludge)
Silica	25.32	(percent dry sludge)
Oxygen	49.55	(percent dry sludge)

5.4 Making of Sludge Reagent Product

Fig. 11 exhibits the turbidity expulsion (%) for variable measurement of Sludge Reagent Product fermented with various ordinariness of H_2SO_4. The patterns of bends exhibit that, as the coagulant portion expands, the turbidity evacuation likewise increments up somewhat and afterward diminishes. It tends to be seen that the greatest turbidity expulsion (86%) happened at 8 ml/L portion of Sludge Reagent Product fermented with 2.5 Normal H_2SO_4. It tends to be additionally seen from Fig. 12, indicating the turbidity evacuation (%) for variable measurement of Sludge Reagent Product fermented with various paces of 2.5 Normal H_2SO_4, that the base turbidity expulsion has been acquired at 2 ml/L portion of Sludge Reagent Product fermented with 0.02 mililitrel/mililitre of 2.5 Normal H_2SO_4; anyway the most extreme turbidity evacuation happened at 10 mililitre/Litre portion of Sludge Reagent Product fermented with 0.12 ml/ml corrosive. As the coagulant portion builds, the turbidity expulsion likewise increments monotonically for various paces of corrosive. Considering different perspectives, for example, adequacy in turbidity evacuation, cost regarding corrosive utilized and safe as far as pH of treated water; the ideal pace of 2.5 Normal H_2SO_4 has been seen to be 0.05 mililitre/mililitre. Hence, 0.05 mililitre/mililitre portion of 2.5 Normal H_2SO_4 has been chosen for the fermentation of slime. The ideal muck focus for setting up the Sludge Reagent Product is taken as 1%, as it very well may be additionally observed from Fig. 13; the most extreme turbidity evacuation (96.7%) has been accomplished at 8 ml/L portion of coagulant containing 1% ooze fermented with 2.5 N H_2SO_4. In all the cases (Fig. 13) the turbidity evacuation increments with increment in coagulant portion and arrives at its most extreme incentive at higher dosages. Subsequently, slop delivered at the ideal alum portion of 30 mililitre/Litre is isolated and weakened to 1% ooze fixation, at that point fermented with 2.5 Normal H_2SO_4 at the pace of 0.05 ml/ml ooze to get ready Sludge Reagent Product. Presently, this Sludge Reagent Product is utilized as coagulant for the purpose of turbidity expulsion of PST profluent from JUIT's SWTP at different pH conditions.

5.5 Changes in performance of Sludge Reagent Product with pH

The rate turbidity expelled from the PST emanating by the above arranged Sludge Reagent Product has been estimated at different pH running from 2 to 7. The water test's pH is brought down by utilizing H_2SO_4 and the cluster tests have been done for every pH condition. Fig. 14 exhibits the turbidity expulsion (%) at different pH of water that has not been treated and for variable measurement of Sludge Reagent Product. Least turbidity evacuation (22.9%) has been acquired at 2 mililitre/Litre portion of Sludge Reagent Product at pH count 3 of water that has not been treated; anyway the most extreme turbidity expulsion (98.6%) happened at 12 mililitre/Litre portion of Sludge Reagent Product at pH level 7. About 94.21 percent turbidity expulsion is accomplished at the pH 6 and 7 for Sludge Reagent Product dose of 8 mililitre/Litre. It very well may be envisioned structure Fig. 14 that when the coagulant portion in-wrinkles, the turbidity evacuation ceaselessly increments. Whatever be the case, if there should be an occurrence of pH 4 rate turbidity evacuation is found to nullify at Sludge Reagent Product measurement of 4 mililitre/Litre and 6 mililitre/Litre yet further increments. pH under 4 causes negative impact by disintegration of aluminum and compelling pH go for adsorption instrument is accounted for as 4 to 6. In this manner, rate turbidity evacuation has lower an incentive at pH 2, 3 and 7 when contrasted with pH 5 and 6 for lower Sludge Reagent Product portion. Be that as it may, turbidity expulsion increments at higher measurements of SRP as clear floc system prevails when contrasted with process of physisorption and neutralization of charge.The execution of Sludge Reagent Product in expelling turbidity from the PST emanating at higher pH condition is assessed for the increasing pH scope of 8 to13. The pH of the water test is raised by utilizing NaOH and the group tests have been completed for every pH condition. The rate turbidity expulsion for variable measurements of Sludge Reagent Product at different pH condition is examined in Fig. 15.In general, the bend pattern in the Fig. 15 have shown that as the coagulant portion expands, the turbidity expulsion likewise increments, aside from at the pH 11 where rate turbidity evacuation diminished fundamentally for the Sludge Reagent Product portion of 12 mililitre/Litre in any case, the most extreme turbidity evacuation (99%) happened for 12 mililitre/Litre Sludge Reaction Product portion at pH level of 13. Higher turbidity evacuation rates are seen at pH 12 and pH 13 that might be ascribed to clear floc instrument. At higher pH, nearness of bigger grouping of hydroxyl particle (OH-) may have caused the development of insoluble metal hydroxides and encouraged the precipitation of suspended colloidal particles by enmeshment into clear flocs .The pH run 6 to 8 is most appropriate for the utilization of arranged Sludge Reagent Product in the research facility for the treatment of PST profluent. The pH of gathered water tests and the endorsed pH esteems likewise lies in the above range (6 to 8). Be that as it may, the ideal Sludge Reagent Product portion could be taken as 8 mililitre/Litre, remembering different calculates, for example, viability turbidity expulsion, financially savvy regarding reagents utilized and safe as far as pH of water that has been treated.Therefore, arranged Sludge Reagent Product is applied at the pace of 8 mililitre/Litre to go about as a coagulant in the treatment of PST profluent which has the pH around 6.8 and the nature of the treated water is contrasted and the nature of water got after the coagulation/flocculation process

utilizing ideal alum portion of 30 mililitre/Litre. Table 2 exhibits the correlation between the aftereffects of different parameters investigated to decide the nature of the water treated with ideal dose of alum and SRP independently. Extensive decrease in different parameters has been accomplished utilizing both alum and SRP.

Table 2: Respective examined values of various treated waste water trait parameters.

Parameters	Initial Concentration	Concentration after treatment with Alum	Concentration after treatment with SRP
TDS(mg/L)	431	208	72
Turbidity(NTU)	58	8	5
pH	6.85	6.8	6.85
Alkalinity(mg/L)	246.6	123	131
Total Hardness(mg/L)	181	139	125

CHAPTER 6

CONCLUSIONS

- After examining the area it is clear that the characteristic traits of the water flowing in Domehar is really near to the potable water standards used in India. So it is fit to be consumed as potable water but not without the proper treatment because the concentration of turbidity is very high due to presence of higher suspended solids. This water can be utilized for any other purpose eg. for purpose of irrigation, bathing purpose subjected to its fulfillment of standards. The assessment of the hand pumps in the following area must be made a compulsion and the result of the assessment must be recorded properly and published for awareness among people.

- The pH of all the samples ranges between 7 and 8. It exhibits the alkaline nature of water and is fine in the standard limit of 6.5 and 8.5.

- Alkalinity caused due to the bicarbonate can be seen in every sample appearing last estimation of 77.2 mg/L. Permissible limit for alkalinity is 600mg/L (BIS, 2003). High alkalinity can lead to terrible taste and is also dangerous and life taking for the living organisms in occurrence with high pH, TDS and hardness.

- The assessment of waste water from JUIT WAKNAGHAT STP shows that it does not matches to the BIS values and should not be disposed without proper treatment.

The ideal portion of alum compound required for the treatment of Domehar's water source was found out to be 30 mililitre/Litre. The slop created in the coagulation/flocculation method at the ideal portion of alum has 4.2% solid matter in which 9.62% is Aluminium and 7.48% is iron. The Sludge Reagent Product arranged from the developed slop at 1% fixation and fermented with 0.05 mililitre/mililitre muck of 2.5 Normal of sulphuric acid performed well in the rate turbidity expulsion from PST profluent of JUIT's STP. The pH scope of 6 to 8 is most useful for the method of coagulation in any case, rate turbidity expulsion increments with expanding the SRP portion. The turbidity evacuation rate at pH 12 and 13 is extraordinarily high and could be credited to the enmeshment of colloidal and suspended particles into bigger groupings of hydroxide flocs framed at higher pH esteems. The application pace of 8 mililitre/Litre picked as the ideal Sludge Reagent Product portion for the waste water treatment has given amazing outcomes. The greater part of the water traits parameters for water that has been treated fulfill the ideal norms consequently, SRP can possibly substitute the regular coagulants in squander water treatment plants. The arrangement of SRP from the treatment of water muck through fermentation process gives achievable choice to water treatment slime the board, offering both monetary and ecological manageability.

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ANNEXURE

Table 3: Alkalinity content of raw water

Sample No.	Volume of Sample(mL)	Burette Reading (mL)		Vol. Of Sulphuric Acid (mL)
		Initial	Final	
1.	50	0	3.8	3.8
2.	50	3.8	7.8	4.0
3.	50	7.8	11.6	3.8

Table 4: Turbidity level in raw water

Sample No.	Temperature of Sample.(°C)	Turbidity (NTU)
1.	20	88
2.	20	85
3.	20	84

Table 5: Chloride content of raw water

Sample No.	Volume of Sample(mL)	Burette Reading (mL)		Vol. Of $AgNO_3$ (mL)
		Initial	Final	
1.	50	0	2	2
2.	50	2.6	3.8	1.2
3.	50	3.8	5	1.2
Blank (B)	50	2	2.6	0.6

Table 6: Hardness level in raw water

Sample No.	Volume of Sample(mL)	Burette Reading (mL)		Vol. Of EDTA (mL)
		Initial	Final	
1.	50	0	5	5
2.	50	5	9.6	4.6
3.	50	9.6	14.2	4.6

Table 7: Acidity content in raw water

Sample No.	Volume of Sample(mL)	Burette Reading (mL)		Vol. Of NaOH (mL)
		Initial	Final	
1.	100	0	3	3
2.	100	3	5	2
3.	100	5	7.5	2.5

Table 8: Total Solids in Raw water

Description		Weight (g)
Initial weight of Crucible (g)	W_1	18.1435
Final weight of Crucible + Sample (g)	W_2	18.2528
Weight of Residue (g)	W	0.1093
Volume of Sample (mL)	V	100
Total Solids (mg\L)	**TS**	1093

Table 9: Total dissolved solids in raw water

Description		**Weight (g)**
Initial weight of Crucible (g)	W_1	18.9763
Final weight of Crucible + Sample (g)	W_2	19.0014
Weight of Residue (g)	W	0.0251
Volume of Sample (mL)	V	100
Total Dissolved Solids (mg\L)	**TS**	251

Table 10: Optimum Coagulant(Alum) dosage

Beaker #	**Alum Dosage (mg)**	**Turbidity (NTU)**
1.	5	56
2.	10	32
3.	15	8
4.	20	6
5.	25	5
6.	**30**	**2**
7.	35	3
8.	40	3
9.	45	4
10.	50	5

Table 11: Turbidity of waste water sample

Sample No.	Temperature of Sample.(°C)	Turbidity (NTU)
1.	20	60
2.	20	56
3.	20	58

Table 12: Electrical Conductivity of waste water sample

Sample No.	Temperature of Sample.(°C)	Conductivity (mMhos/cm)
1.	20	0.620
2.	20	0.624
3.	20	0.616

Table 13: Chloride content of waste water sample

Sample No.	Volume of Sample(mL)	Burette Reading (mL)		Vol. Of $AgNO_3$ (mL)
		Initial	Final	
1.	50	0	4.7	4.7
2.	50	4.7	8.8	4.1
3.	50	8.8	13	4.2
Blank (B)	50	13	13.6	0.6

Table 14: Total Alkalinity of waste water sample

Sample No.	**Volume of Sample(mL)**	**Burette Reading (mL)**		**Vol. Of Sulphuric Acid (mL)**
		Initial	Final	
1.	50	0	12.5	12.5
2.	50	12.5	24.5	12
3.	50	24.5	37	12.5

Table 15: CO_2 Acidity in waste water sample

Sample No.	**Volume of Sample(mL)**	**Burette Reading (mL)**		**Vol. Of NaOH (mL)**
		Initial	Final	
1.	50	0	6.6	6.6
2.	50	6.6	13.6	7
3.	50	13.6	20.1	6.5

Table 16: Total solids in waste water sample

Description		**Weight (g)**
Initial weight of Crucible (g)	W_1	20.4901
Final weight of Crucible + Sample (g)	W_2	20.5332
Weight of Residue (g)	W	0.431
Volume of Sample (mL)	V	100
Total Solids (mg\L)	**TS**	431

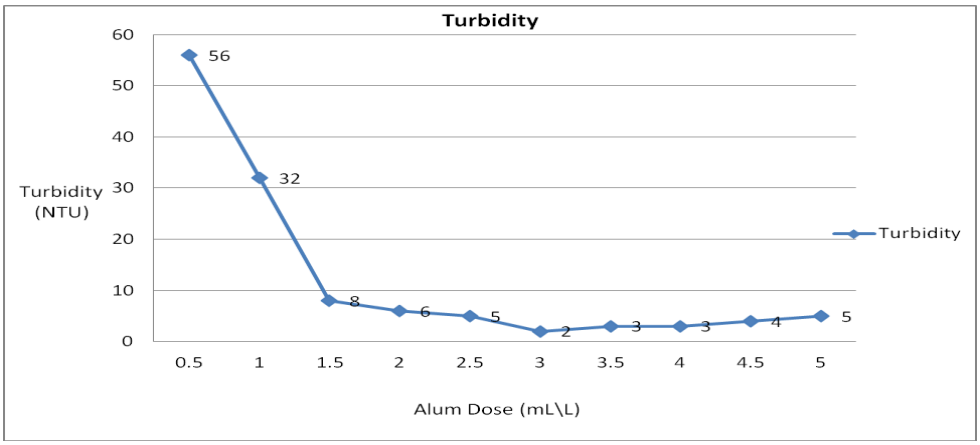

Figure 10: Optimum coagulant dosage of alum.

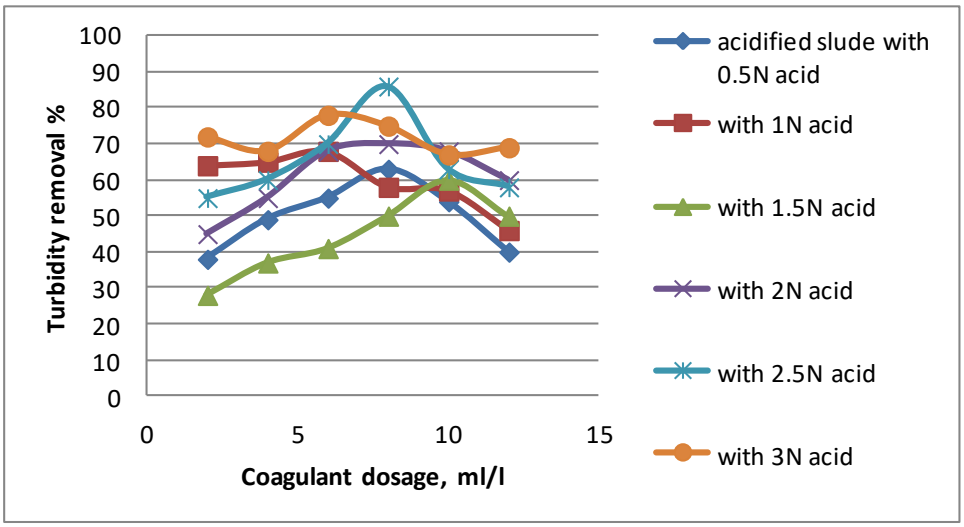

Figure 11:Turbidity removal at variable dosage of SRP prepared with different normality of H_2SO_4

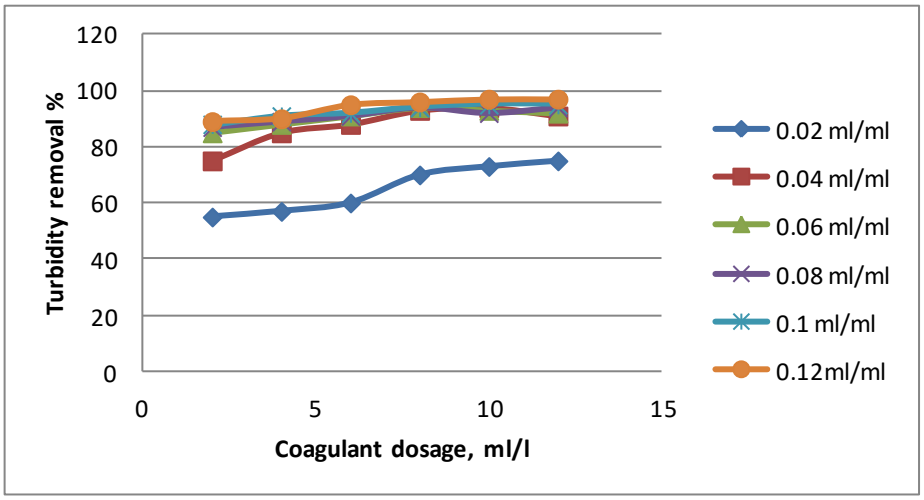

Figure 12:Percentage Turbidity removal at variable dosage of SRP prepared with different dose of 2.5 N H_2SO_4

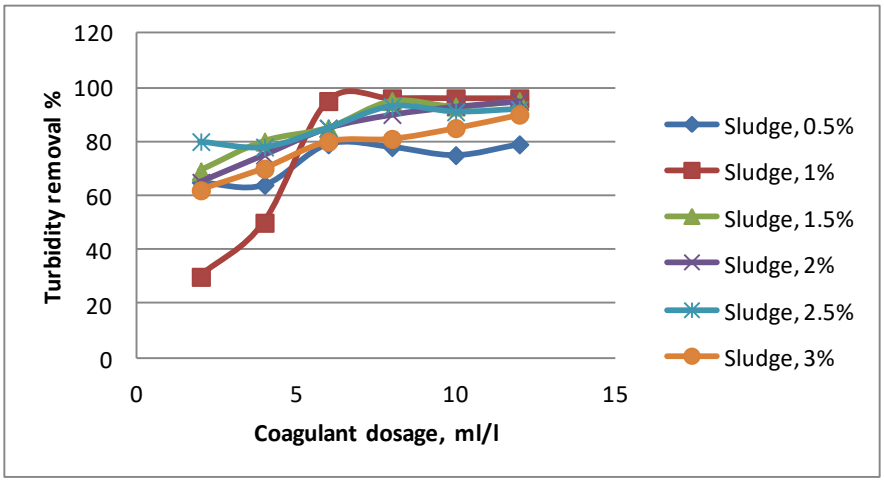

Figure 13: Effect of sludge thicknesses (%) used for preparation of SRP on Percentage Turbidity Removal

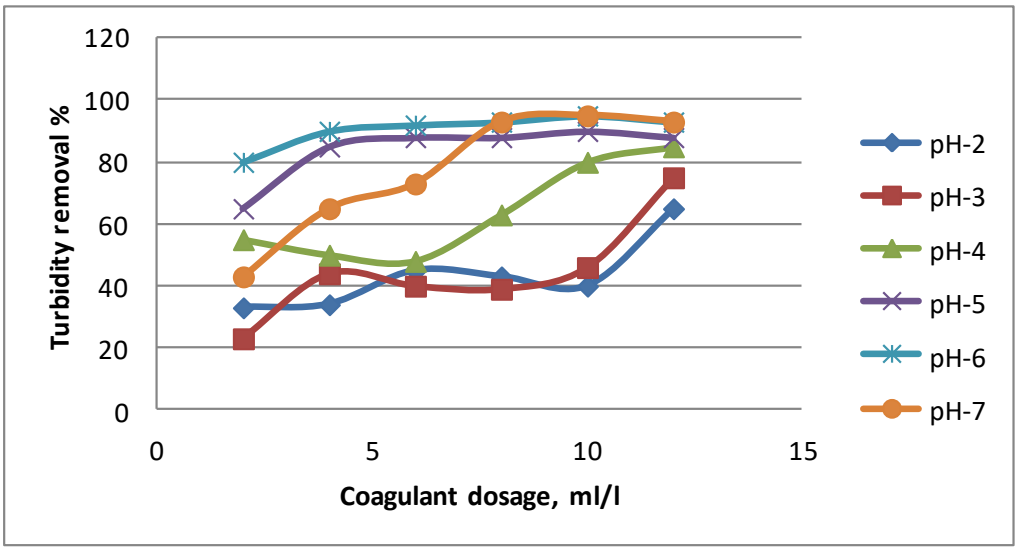

Figure 14: Percentage turbidity removal from PST effluent from JUIT'S STP at variable dosage of SRP in the pH range of 2 to 7.

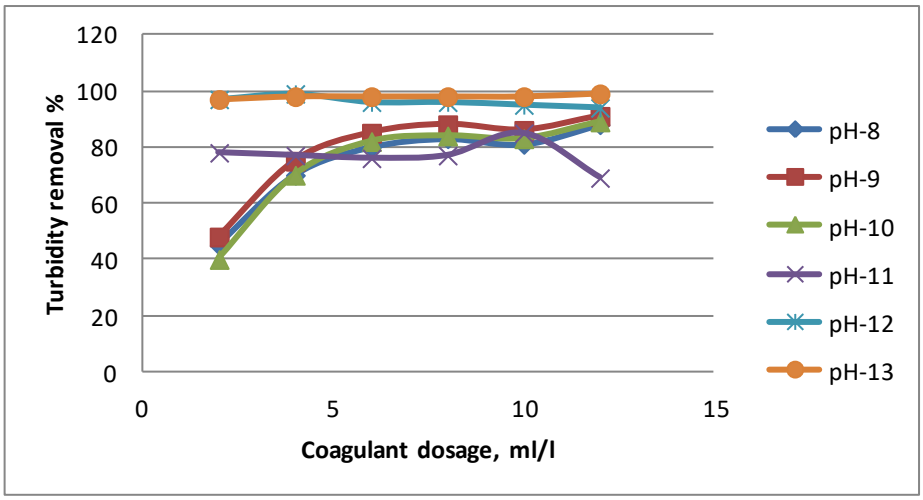

Figure 15: Percentage removal of turbidity from waste water at variable dosage of SRP in the pH range of 8 to 13.

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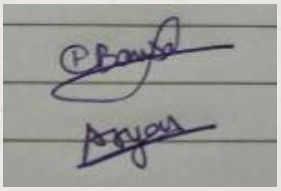

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