INDUSTRIAL WASTEWATER MINISTRATION AND DESIGN

A CASE STUDY OF MARBLE INDUSTRY

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It is to be certified that the Research and Development work titled.

INDUSTRIAL WASTEWATER MINISTRATION AND DESIGN - A CASE STUDY OF SUGAR MILL

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ABBREVIATIONS

1.	EPA	Environmental Protection Agency
2.	Alk	Alkalinity
3.	BOD	Biochemical oxygen demand
4.	COD	Chemical oxygen demand
5.	WHO	World Health Organization
6.	TDS	Total Dissolved Solids
7.	DO	Dissolved Oxygen
8.	NTU	Nephelometric Turbidity Unit
9.	TSS	Total Suspended Solids
10.	mg/l	milligram per liter
11.	Ppm	Parts per million
12.	NEQS	National Environmental Quality Standards
13.	MIWW	Marble Industry Wastewater
16.	Ppt	Precipitates
17.	WWT	Wastewater Treatment

ABSTRACT

Marble is derived from a Greek word “*marmaron*” which means “crystalline rock “or “shining stone”. Marble is a rock formed from metamorphism of sedimentary carbonate rocks, most commonly limestone and dolomite. Marble stands as a significant item in our construction industry. When marble is being produced, large volume of effluents i.e., wastewater is generated because of marble processing and stone crushing. This wastewater has various parameters which defines its aptness before dispensing it into a water source. These variables include COD, BOD, pH, organic compounds, color, TDS etc. Wastewater without prior treatment has harmful effects for plants, animals & human being. This forms the basis for having a treatment unit in the industries for the treatment of wastewater.

The treatment of wastewater emphasizes upon Physio-Chemical & Biological treatment in order to bring the aforesaid variables within the permissible limits of NEQS. This study revolves around designing of a treatment unit through which wastewater would be made appropriate for releasing it into a nearby water source. This study would thereby include explanation and interpretation of basic yet salient concepts and parameters which will indicate the processes included in the treatment unit before discharging it. This study also aims at providing a vade mecum for those who wish to design a treatment unit. From the past papers it was found that treatment options with hypothetical analysis were discussed but the basic designing of treatment unit was not laid out. Moreover, no details are provided for treatment of marble factory effluent or the details are kept away from public, if practiced. Thereon, an endeavor has been made to provide a complete guideline of designing a treatment unit, preceded by all the basic concepts involved in it.

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CHAPTER NO: 1
INTRODUCTION

1.1 GENERAL

Modern era accentuates on rapid modernization and expeditious growth of industrialization. Continuance of nations largely depends on all kinds of industries. This rapid advancement around the globe comes with a cost as it has adverse effects which is depreciating and damaging the environment and ecosystem. Exponential demand and dependence on synthetic and industrial products have produced scarcity of natural resources, adding to environmental pollution. The byproducts of industrial utility include chemically harmful and biologically contaminated waste. The lives of human beings, plants, animals and marine are at stake.

We as natives of Mother Earth are purposely or unintentionally participating in diminishing the overall environment for our future generations. Annually South Asia is contributing about 1 billion tons of waste with an extensive increment of 10-15% per year. The rate of emission of contagious gases from everyday industrial production has increased resultantly making the preservation of environment are serious and major challenge for the World.

Water being a necessity of life is plentiful and vital source. Water amounts to about 70% of the earth's surface. Water contributes about 40-95% of plant's weight and about 65-70% of human body's weight. Even with the presence of water around ¾ of the globe, the clean drinking water remains scarce. Only 1% of clean water is available for use. Water, in all its forms, can be contaminated or polluted by various sources. The illegal disposal of wastewater contributes towards substandard quality of water. Most of the water bodies are being contaminated in developing countries due to effluents discharged from various industries. It has also been observed that wastewater coming from industries is highly polluting environment. An approximated 15-20% increase in registered and non-registered industrialization and associated contamination of water is expected. Industries and factories are major contributor in water pollution in Pakistan due to high degree of organic and toxic ingredients in their productions. Industries dispose off their wastewater directly into the nearby nullahs, Rivers or fields. For example, in Khyber Pakhtunkhwa, river Kabul receives over 80,000 cubic meters of industrial waste daily and contributes vastly to polluting the atmosphere.

Modern research show contaminations in water exceeding safe limits of WHO and other National Standards, water is said to be contaminated and and such water is harmful for human body and other forms of life. The industrial waste either flows out into Rivers/Seas and used for agriculture and domestic use including drinking or percolates down through soil to become part of ground water, which is again consumed by population for various purposes. To make it good for use effluents are essential to be removed through Chemical and Biological treatments. The Physio-Chemical characteristics of a water body not only reflect the type and diversity of aquatic life but also the water quality and related pollution (Birley and Lock, 1999).

1.2 PROBLEM STATEMENT

In Pakistan, environment and ecological system is polluting due to worst effects of industry. In modern era due to increase in demand of industrial products, environmental pollution, specifically water pollution, is increasing with very fast pace. Due to increase in industrialization, the water is getting polluted and so is air. Humans are at stake and so are animals, plants, and aquatic life. Additionally, there is a growing demand and shortage of quality water to meet population surge. Notwithstanding the fact that industry is essential to national growth and economy, there is a pressing need to harness the flawed design and treatment procedures of rendering industrial waste, specifically waste produced by Marble.

1.2.1 ENVIRONMENT PROBLEMS

Since present procedures and designs to ensure treated effluents are flawed and inadequate resulting in depreciating of environment. Environment is being polluted due toxicity of effluents being waived into water bodies or open lands, which are causing degradation. Foul smell and torn aesthetics are also caused by effluents being left into open or into water bodies (Kulkarni, 1979). The foul odor is a result of decomposition of waste material and this polluted water is eventually being used by population in one form or other.

1.2.2 HEALTH PROBLEMS

Wastewater essentially contains bacteria and parasites, which are forms of pathogenic microorganism. These pathogens have the tendency to cause harm to all forms of biological life. Human parasites particularly are of special importance, in this regard, as they prove to be most harmful. These need to be eradicated by treatment or else they cause many diseases.

Untreated waters used in agriculture cause diseases, specially, when the agricultural products are used by humans or consumed by soil. Recently, many deadly diseases found their root causes in polluted water used in agriculture.

1.3 LITERATURE GAP

To our knowledge, majority of previous research on similar topic have given vast analysis but guideline for designing of wastewater treatment unit including the calculation was missing. This study intends enabling us to design an effective treatment unit from which every sugar mill can seek help and can use it for designing a wastewater treatment.

1.4 OBJECTIVES

Primary objectives of this study include the following:

- To study the wastewater characteristics of Sugar Mills.
- To design wastewater treatment unit based on the data analyzed from previous researches.

1.5 SCOPE

Keeping in view the base of this study we shall analyze effluent of SUAGR Mill and basing on results obtained we shall suggest design and procedural recommendations for efficacy of existing treatment settings. The wastewater samples were collected from outlet of main drain of SUAGR Mill, as well as, from the inner drains. The Physio-Chemical properties like pH, alkalinity, BOD, COD, TSS, TS, TDS, Phosphates and Nitrates were studied. All the tests were performed in the Environmental Engineering Laboratories of MCE, Risalpur.

CHAPTER NO: 2
LITERATURE REVIEW

2.1 OVERVIEW OF SUGAR MILL IN PAKISTAN

Sugar Cane production in 2019-20 dependent on officially plantation areas of simply over 1.0 Mn hectares stayed at 67 mln tons. The region in 2019-20 came around about 5.6 % nonetheless, with no huge change in production. The territory drop in Punjab was around 9 % and in Sindh around 2 % with comparative impact on sugarcane production. The sugarcane production in the two years is practically something.

Table 2.1 Sugarcane crop Area & Production

Sugarcane crop area and Production 2019-20			
	Area	**Production**	**Yield**
Punjab	643,430	43,346,580	67.37
Sindh	286,090	17,233,832	60.24
KP	19,359	5,753,957	52.62
Total	1,038,879	66,334,369	63.85

Source: CRD-PG

Since end of year 2017-18 there has been persistent expansion in sugar costs which can be ascribed to the accompanying reasons:

1. Rupee depreciation
2. Expansion in deal charge from 8 % to 17%
3. Significant expansion in sugarcane costs
4. Early execution of axel load

Table 2.2 Area Production of Sugarcane Crop for last five Years

Area Production of Sugarcane crop for the last five years				
	Area (hectares)	**Production (Tonnes)**	**Yield (Tonnes / hectare)**	**Sucrose Recovery**
2015-16	1,131	65,451	57.88	10.16
2016-17	1,217	75,450	62.00	09.87
2017-18	1,341	83,289	62.11	10.02
2018-19	1,101	67,129	60.97	10.47
2019-20	1,039	66,334	63.85	09.90

Source: PG

The GDP of Pakistan regularly depends upon three areas i.e., farming, Industry, and administrations. The horticulture territory comprises of cultivating, domesticated animals, ranger service, poultry and fisheries, contributes around 18% to the GDP, utilizes around 45% of the total work pressure and is the high inventory of profit for more than 60% of the country's populace abiding in provincial territories. It contributes strikingly to the nation's fares, presents uncooked material to significant enterprises like material, sugar, dairy, calfskin, and other agro-based ventures and as pleasantly as market for mechanical items.

Industry is the second most noteworthy area of nation's economy and contributes around 38% in complete GDP. The primary areas in big business are little to medium scale producing, mining, quarrying, development, power, and gas dissemination.

In assembling, cotton yarn and cotton material are the primary area, noticed by means of suppers handling businesses to a great extent dependent on local crude materials. Different areas like designing zone are engaged with assembling of concrete and sugar plants, modern boilers, synthetic/petrochemical unit &equipment, building gear and force transmission towers, material related designing, car etc.

Services area is yet any other important area due to the fact of its large contribution in the country's financial system and contributes about sixty one percent of the total GDP. It by and large contains of Wholesale & retail trade, transport & storage, communication, community & social offerings, and private services. Other offerings are finance and insurance, ownership of dwellings, public administration.

The industrial share in the country's economy kept on fluctuating in the past few years. The industrial sector share was 5.8 percent in GDP growth during 2004-2005, however it increased to 13.1 percent during 2005-2006. It was at its lowest level during 2010-2019. In Pakistan, so far there are about 39 industrial estates that have been set up in all our provinces i.e., Punjab, Sindh, KPK and Baluchistan. The privatization has additionally promoted the industrial estates in Pakistan.

2.2 MAJOR ENVIRONMENTAL ISSUES OF INDUSTRIES

2.2.1 GLOBAL VIEW.

Countries in North & different parts of the world have gone through an extensive transition in controlling or influencing the effect of industrial activities on fitness and the environment. Initially, efforts have been focused on the formula of legislative and regularity constructions together with enforcement. The reaction of businesses used to be generally responsive. Businesses contributed "end-of-pipe" innovative answer for guaranteed consistence with the always expanding guidelines. Since, the mid-80's in northern nations, and more these days in the rising and dynamic financial of the south, businesses are taking more prominent protecting position. It is a mounted truth that some natural organization on intentional establishment can upgrade organization picture, grow benefits and seriousness, decrease charge, and forestall the need for additional administrative measure through the specialists. As the improvement of guidelines in the natural field, principally these being attempted via the worldwide business endeavor for normalization (ISO). The arising set of ISO 14000 prerequisites is the most complete natural top notch organization activity at any point attempted. These principles are anticipated to be the overall natural top notch seat marks for directing exchange the global market area of the 21st century.

The ISO 14000 will help in arriving at the organization longs for consistence with legitimate prerequisites, coordinating overall ecological superb strategies and overseeing market area assumption. The non-traffic change hindrances all around as to the climate angles, the fare item will pressure business endeavor out of world market. The execution of ISO 14000, which infers consistence to country wide ecological lawful rules and guideline, will serve to hinder the effect of exchange limit exuding from natural consideration. As a result of these powers, regardless of whether from pressure partnerships of worldwide economic situations, the modern zone especially, the fare district should try harder and start acting responsibly or out of business. The area, which would go through most, would be the fare area, with subsequent impacts on public economy. Pakistan has effectively investigated what should be coming up for its ventures with the restriction on careful merchandise, rugs and football sends out because of top notch creation guideline. The public authority be-recently at acceptable measured breadth haggled to make certain future consistence. Such frequencies, if no governmental policy regarding minorities in society is taken, can exclusively prompt an un-positive exchange balance.

2.2.2 NATIONAL VIEW

Demand for environmental solution received momentum in the industrial zone of Pakistan in 1990 and has been consistently increasing. In 1991, the authorities of Pakistan approved the Pakistan country wide conservation strategy. It is the environmental coverage of the country. During the identical period, the government hooked up federal and provincial environmental protection companies (EPA'S) underneath the Pakistan environmental protection ordinance, 1983. Natural movement got the genuine advance forward after the principal get together of Pakistan ecological security gathering (PEPC) in 1983. The gathering approved the public ecological top-notch prerequisites (NEQS) for mechanical emanation effluents. The licensed NEQS were even necessities material to a wide range of modern and public emanating. A beauty term of one a year for new and three years of old modern contraptions was provided for consistence with the proposed NEQS. The ventures set up after July 1994 had been viewed as new. For the current enterprises, the cutoff time was once consistent as July 1996. In 1994 the ecological moves got the political will through the declaration of Pakistan natural demonstration 1994. The proposed arrangement of lawful offense solidarity to checking organizations empowering them to assume a viable part in the execution of natural enactment. There are 32 imperatives proposing passable degrees of contaminations in fluid profluent while sixteen boundaries for vaporous release. Accordingly, some mechanical alliance like league of office of business and industry (EPPCI), and nearby chamber mounted its ecological sub advisory groups in 1993. By the stop of 1995, it became clear that EPA's have been managing intense issues of capacity and ability for the execution of natural enactment.

CHAPTER NO:3
PARAMETERS OF INDUSTRIAL EFFLUENT

3.1 PARAMETERS

This parameter analyzes the number of inorganic particles suspended in water. This shows its value because these substances may be mineral, or microbes make water look turbid. How safe may tests results declare this water for domestic or agricultural use, user will always hesitate while using it. It's human instinct to favor clear water. Aesthetically TSS makes water bodies look unpleasant makes its surroundings prone to garbage disposal eventually converting them into sewerage nullahs. These TSS could be eroded fine particle of rocks. This will eventually settle down and raise bed of water body. Rocks pores can get filled and cause microbe living in them homeless. These TSS can also be microbes i.e., bacteria, viruses etc. that may cause disease like cholera, dysentery, Nausea, kidney failure, diarrhea etc. therefore testing it is very important.

Another factor that is caused by these TSS is that they decrease the reach of light till bottom where aquatic plants are present. With no light there is no photosynthesis. This causes lack of DO in water. Which further will affect aquatic life like fishes, aerobic bacteria etc. Sun light when enters such turbid water, it gets absorbed and raise water temperature further threatening aquatic life existence. Lack of visibility makes it difficult to find food and even move through it. These TSS could be useful if minerals in it are known to be good for crops as soil needs it like a fertilizer.

3.1.1 CHLORIDES

Mostly water contains small amount of chlorides. Settlement of marine sediments can cause increase in the amount of existing chlorides due to pollution from sea water, salt water, industrial or domestic waste. Chloride with a sensible fixation is not harmful to people however more modest creatures and plants can get affected. In regions where salt water and mechanical water are released, chloride assurance gives magnificent front view for administrative purposes. The measure of chloride in the water used to inundate crops is by and large affected by the general saltiness of H2O. Saltiness and chlorides have propensity to ascend in rooftop regions or water system plants, making plants troublesome in water assimilation in view of contrasts in pressure (osmotic) between H2O outside the plant and inside its cells. That is the reason, chloride focuses and complete saltiness under drinking water boundaries are often decided for H2O used to flood salt-delicate plants. The fundamental seasoning specialists that produce salts present in H2O are sodium chloride and calcium chloride. This smell and taste is because of chloride particles and related particles in H2O. in some H2O with just 250 mg/L of chlorides can have genuine pungency if cations are in sodium water. Interestingly, even though water has an exceptionally raised chloride focus like 1000 mg/L, run of the mill saltiness may not be available. Chloride in water likewise has natural significance. Sodium chloride (NaCl) produces pungent when its focus is more noteworthy than 250 mg/L. Chloride is for the most part restricted to 250 mg/L in water supply proposed for homegrown water supply. At the point when water assets are scant in numerous pieces of the world, after the human body gets acclimated with water, sources containing 2000 mg/L are utilized for homegrown reason without unfavorable effects. Chlorides can likewise obliterate the solid. It is likewise vital to know the specific measure of chlorides in water to pick the sort of desalting gadget. Chlorides likewise meddle with the assurance of the requirement for compound oxygen (COD).

3.1.2 THE pH VALUE

We need PH test to check the acidity and alkalinity of water. These are measures of positive hydrogen ion and negative hydroxyl ion that are in concentration. The pH chart list 7 as neutral. Less than 7, acidity increases till one as the most acidic in nature like HCL and H_2SO_4 etc. Similarly, basic or alkaline behavior increases from 8 till 14. And 14 being the toughest base. Parameter of pH affects the efficiency of chlorine by determining the amount of hypochlorous acid i.e., freely available chlorine that is produced.

a. **pH 6.5:** 90% of the chlorine will be hypochlorous acid.

b. **pH 7.5:** 50% of the chlorine will be hypochlorous acid.

c. **pH 8.5:** 20% of the chlorine will be hypochlorous acid.

Around evening time water will in general get acidic due to ingest carbon dioxide in water to make carbonic corrosive because of oceanic plants. Acidic or fundamental sort of water is overpowering to life. No plant, fish or microorganisms can endure when it passes as far as possible. Wellsprings of such debasements are enterprises like cleanser makers, material units, leather tanning and Rubber producers. It gives severe taste and awful smell. Scents like spoiled eggs. Along these lines, makes water futile for agribusiness or homegrown utilization. Alkalinity's just benefit where soil or water is acidic.

3.1.3 TOTAL DISSOLVED SOLIDS

As visible from name TDS counts for total soluble material that exists in solution. They may include salts and other minerals, in fact anything other than pure water. We determined hardness of water through presence of cations. These cations are part of salts like sulfates and carbonate of Calcium and magnesium etc.

Generally, we calculate hardness of water by measuring the amount of calcium carbonate present in it as follow: -

Table 3.1: Concentration of $CaCO_3$(mg/L) Classification

Mg/L	Water hardness parameters
<75	Soft water
75-150	Moderately hard water
150-300	Hard water
>300	Very hard water

This calcium comes in water when in contact with limestone and so forth Different components like magnesium, iron and manganese source from soil and rock disintegration yet are in less focuses.

As a result of hardness utilization of such water gets restricted and costly. For transitory hardness we need to bubble water or further treat it. Hard water utilizes more cleanser and cleansers. It can cause infections in plants and creatures. Water channel through which such water passes by get stopped up and stores can be found away tanks.

Hard water has more inclinations to erode things it might get in contact with for example radiators, water warmers etc.

3.1.4 BIOCHEMICAL OXYGEN DEMAND (BOD)

It is the demand of dissolved oxygen required for microbial colonies to decompose organic matter/waste in wastewater. Industrial effluent may contain proteins, carbohydrates, and fats etc. These substances are readily biodegradable through the actions of natural microbial populations. Some of the organic matter is oxidized to carbon dioxide and water while the rest is assimilated and used for synthesis of new microbial cells. In due course, these organisms will also die and become food for other decomposers. Eventually all the organic carbon will be oxidized (Lamb,1985).

3.1.5 CHEMICAL OXYGEN DEMAND (COD)

It is a quick and effective way of decomposition of organic matter by oxidizing agent like potassium permanganate. Unlike BOD it is an effective process in which results can be obtained in hours rather than days. As it includes chemistry therefore, we can adjust things as per our desired results but that comes on a cost of economy.

Chemical oxygen demand test is most adjusted approach to in a roundabout way measure the measure of organic matter in water. Generally utilized use of COD is to decide the measure of organic matter as toxins found in surface water like waterways and lakes and so forth, making COD a helpful proportion of water quality, it is communicated in milligrams mg per liters (mg/L), which showed the mass/measure of oxygen consumed per liters of solution.

COD relies upon a reality that generally the entirety of the organic matter can be completely oxidized to make carbon dioxide CO_2 with a solid oxidizing specialist under lower pH levels. For a long time, the solid oxidizing specialist was potassium per tycoon ($KMnO_4$) utilized for estimating compound oxygen demand. Estimations were called oxygen consumed for permanganate, as opposed to the oxygen demand of assortment of organic matter that has the wide reach and as rule BOD estimations were regularly a lot higher than results from COD estimations. This showed that potassium permanganate could not viably oxidize all organic matter in H_2O, demonstrating it to be a moderately poor oxidizing specialist for deciding synthetic oxygen demand.

This led to other oxidizing specialists like potassium dichromate and potassium iodide, which were utilized subsequently for deciding of COD. From these specialists, potassium dichromate ($K_2Cr_2O_7$) is the best for example it is generally simple to get, efficient to decontaminate and can intently finish oxidizing larger part organic matter.

3.1.6 TEMPERATURE

Temperature is a physical parameter in determining the effluent characteristics but largely effects other parameters of effluent. Wastewater temperature is usually higher than that of clean water (H_2O) for domestic use. It is important to measure temperature because mostly treatment schemes of wastewater include biological lives which are dependent on it. The wastewater temperature changes depending upon weather conditions and climate of the region. Temperature will vary from -14 to 25 degree Celsius in cold places, while temperature will vary from 12 to 45 degree Celsius in warmer regions (Ron and George, 1998). Bio-chemical reactions of aquatic life are dependent upon temperature.

3.1.7 PHOSPHATES

According to perry *et al*, (2007) phosphorus may cause aquatic biological productivity to increase, resulting in low dissolved oxygen in lakes, rivers, estuaries, and marine waters. Other than adding to nutrient-content of the water, option of certain kinds of phosphorus will build BOD and COD (Mahdieh and Amir hossein, 2009). The investigation completed on sedimentation and Georgia's fishes uncovered that nitrogen concentration of 0.5 mg/L are harmful to rainbow trout (Barnes et al, 1998). Normally phosphorous never exist in pure structure and accessible as phosphates. Phosphorous is a key development component for of animals and plants. Phosphorus in its pure structure it exists in white color which is incredibly noxious. Enterprises utilize white phosphorous to make different synthetic substances and when the military uses it as ammo. Phosphates are utilized in uncommon glasses, in steel make, sodium lamos, in military applications like exceptional ammo for example distraction and incendiary bombs and so on, and in different applications like toothpaste, detergents, fireworks and pesticides. Phosphates enter streams from creature and human waste, clothing cleaning, fertilizer spillover and significantly mechanical effluents. These phosphates become hazardous when they are in abundance in oceanic plants. Effluents have more phosphorous mixtures. Creatures utilize phosphorous as a nutrient for their development. This occurs in wastewater and regular clean water bound to oxygen to shape phosphates. Phosphates come from assortment of mechanical sources like horticultural fertilizers, homegrown wastewater, land developments, Mill's waste cycle and detergents. This may cause green growth development at a quick speed diminishing DO. High phosphorus amount causes awful scent and taste issues in drinking water. In the event that the presence of phosphate is higher in H2O, the green growth and weeds will develop quickly, may impede the waterway, and may utilize extreme measure of valuable oxygen (within the sight of photosynthesis and as the green growth and plants pass on and are consumed by high-impact microbes). The outcome might be the finish of lives of numerous amphibian life forms (USEPA, 1986) like the fish. That is the reason it is basic to test for phosphorous emanating in light of the fact that phosphorous evacuation is a fundamental job of wastewater treatment unit. Phosphates are named organic Phosphates, orthophosphates, and polyphosphates separately.

3.1.8 NITRATES

The most oxidizing nitrogenous compounds are commonly present in the surface and ground water because it is the byproduct of aerobic decomposition. The EPA (1995) states that "Forman environmental perspective, nitrate is the most basic type of nitrogen. Its solvency, versatility and soundness imply that it promptly infiltrates to groundwater, it has a functioning part in the eutrophication process and in drinking water, it presents danger to human and plant." Nitrates are not steady mixtures since it is promptly consumed by plants and microorganism and used as a component of their protein. It very well may be separated to nitrogen gas, nitrous oxide or nitric oxide through de-nitrification measure. The poisonousness of nitrate to human is believed to be exclusively because of the decrease to nitrite. The major natural impact of nitrite in humans is its inclusion in the oxidation of typical hemoglobin to meet hemoglobin which cannot ship oxygen to the tissues. This condition is called met-hemoglobinemia or blue infant disorder. Young infants are more susceptible to met-hemoglobin than older children and adults” " (Australian Drinking Water Guidelines ADWG, 1996).

CHAPTER NO 4
EXPERIMENTAL PROCEDURE

4.1 STUDY AREA

Versatile data was required on marble industry wastewater parameters for designing of required treatment plant to be used as guidelines. The effort was brought to collect data from different marble factories located in KPK province . we have collected different samples from marble factories located in Mardan city, which have biggest factories in the region

4.2 METHODOLOGY OF CONDUCT

We have analyzed data from experimental results of all samples (water values before the process and values of wastewater after the process) for designing of treatment unit. These design steps and guidelines may be used as reference and on-ground parameters value may be used for designing for a particular factory. This chapter includes all experimental procedures and their requirements which are required to obtain different parameter values used in designing of wastewater treatment unit.

4.3 SAMPLING

It refers to the collection of different wastewater samples from a region to determine its different specification. Wastewater samples can be collected from different resources like treatment units, landfills, and contaminated rivers or soils. Sampling has significance importance in wastewater analysis. Samples to be collected according to requirement for analysis to ensure that the most representative model is obtained. To minimize the impact of the pollutants, sampling should be as close as possible to discharge point. The container having sample should be filled slowly to avoid air bubbles. In general, the time should be kept smallest as elapse between the collection and execution of the analysis. According to nature of the test, special precautions may be implanted when handling samples to avoid natural disturbances, such as loss or increase of organic growth or dissolved gases. Sewage samples can be taken in glass bottle or plastic bottles, these jars should be washed in advance with any detergent with tap water several times, immersed in HCl (concentrated) and finally rinsed with distilled water, and then the bottle is room dried. Different sampling procedures are used according to types of water, and all precautions must be taken. To obtain accurate results, the samples must be analyzed on the same day.

4.4 GENERAL CONSIDERATION

Modern wastewater mainly has many type of pollution profiles. There are a lot of interest in the variety, transition and proficiency of the assigned test. Samples should be collected and stored in a room temperature to protect against contamination, taking into account the circumstances like location, type, frequency and duration of on-site sampling. Prior Knowledge of every process to ensure that all samples collected show real-world conditions. It is important to process sampling, considering factors such as the impact of production and property changes, daily or seasonal variations, size of sample for specific analyses, additional preservatives required, and allowable residence times.

Samples should be collected without contanimations and stored in 1.5-liter plastic containers completely clean, washed with distilled water prior to use and then sealed. Before taking the final sample, the bottles were washed with significant sample. Final Samples to be placed in the refrigerator, kept below 4 °C, and transferred to the lab for analysis.

4.5 SELECTION OF SAMPLING LOCATION

The accompanying thought ought to be considered while choosing area for inspecting:

1. At areas upstream and downstream of marble processing plant, having critical discharges into a streaming stream.
2. At most delegate focuses, for example, prior to entering tank 1 and subsequent to entering into leave channel.
3. Required data was acquired from different release focuses.
4. Keeping in view the force of stream and temperature, examining area may change.
5. Keeping in view the above thought we have chosen the fundamental channel and leave focuses from processing plant.

4.6 METHOD OF SAMPLING

Samples can be taken manually or automatically. Sample results of success or failure is directly proportional to sample handling.

4.6.1 MANUAL SAMPLING

Manual sampling has fewer initial costs. Manual sampling software is useful for small-scale sampling, regardless, it is exorbitant and expensive for both regular practice and huge extension testing applications.

4.7 VOLUME OF SAMPLE

Examination to be performed using satisfactory volume of test, with volumes open to meet quality control, test transport, or review necessities. The vital model size will depend upon the assessment performed, yet the volume expected for a complete genuine examination is, generally speaking, around 2 liters. Testing research offices should be used for unprecedented quantitation necessities. Each piece of the mixed model should be somewhere near 200 mL to restrict contrasts in model solids. The total illustration of the mixed model should be something like 2 liters depending upon the looking at repeat and test size.

4.8 HANDLING AND PRESERVATION OF SAMPLES

After collection, immediate analysis should be start and samples must be stored in containers with preservatives to maintain sample integrity. 100 % sample storage and sanitation of industrial waste or general water is near to impossible. Guaranteed consistency of all parts cannot be achieved regardless of the type of sample. At best, preservation techniques can only prevent chemical and biological changes in samples removed from their original source. Correct container selection, container purification, and storage time are important segment of a sample storage program to avoid sample errors.

The storage time and material belonging to the sample depend on the parameters analyzed. In general, as less the time between sampling and analysis, the more accurate the analysis results. We cannot say exactly how long it will take from collection to analysis. It depends on the nature of the sample, the specific analysis performed and the storage conditions.

4.9 METHODS OF PRESERVATION

The purpose of preservation is limited to:

1. Slow down biological processes.
2. Inhibit hydrolysis and chemical reactions .
3. Make constituents less volatile.
4. Preservation techniques include freezing, pH control, chemical addition, and pH regulation. Sometimes it may be essential to combine the preceding methods..

4.9.1 CHEMICAL ADDITION

The best technique of storing samples is chemical preservation, which may be applied to sample vials before sampling. The preservative instantly disperses upon the addition of the sample, stabilising the preservation throughout time. Additional samples should be acquired for any other criteria that the added preservative may be assessed by. For instance, strong nitric acid used to retain certain minerals may influence BOD, necessitating the collection of extra samples for BOD.

4.9.2 THE pH CONTROL

Chemical additions are necessary for maintaining PH in storage. For instance, lowering the pH to less than 2 by adding strong nitric acid will retain the metal ions in the transition phase.

4.9.3 FREEZING

Numerous insurance studies have covered freezing. Some people accept that cryopreservation is a method for extending support duration and gather individual models for thorough analysis. Nevertheless, when freezing and thawing out, the extra solid (filtered and crude) model components alter. In light of this, it is crucial to reach consensus before doing the evaluation and to act quickly after homogenization.

4.9.4 REFRIGERATION

Additionally, different outcomes have been seen when cooling or freezing has been considered. In field evaluations, this sophisticated method frequently affects test results. This doesn't guarantee the accuracy of any limitations and has no bearing on the evaluation process.

4.10 TYPES OF SAMPLES

The type of test administered will depend on the type of drainage, the type of waste, the level of precision necessary, and the level of resource availability anticipated to support the programme for assessing and examining.

The kind of the guide will depend on a number of factors, such as

1. The analysis purpose, which includes the aspects of interest and the requisite accuracy and precision.

2. The qualities of the system being examined and nonpoint information sources and homogeneity of the structure.

3. The available resources, such as work, time, equipment, and materials, etc.

There are three key categories:

I. Grab testing,
II. Composite test
III. Integrated testing

4.10.1 GRAB SAMPLE

Grab samples were taken for analysis from the following selected localities of mill:

1. **Factory Water.** Factory Water is coming from crushing plant of the factory. It is that water which has been used in removing mud and clay attached to marble stone also carrying oil and grease. It is usually sprinkled over the stone in crushing plant.
2. **Injection Water.** Injection water is used for cooling of boilers and after two or three cycles when it becomes dirty and hot, is discharged to the main drain. During circulation through boilers in pipes, it gets polluted due to leaching and corrosion of pipes.
3. **Feed Water.** Feed water is mixture of distilled water in combination with various chemicals like NaCl and NaOH etc., used for purification purpose. All the drains carrying these three types of water, combined together in a single drain leading to the nearby canal.

4.10.2 COMPOSITE SAMPLE

Composite models are test moulded by combining single models collected at regular intervals or at a constant rate. The number of unique occurrences of a chemical varies according to mobility variations and contamination hotspots. Supported bond is depicted as a progression of conventional models, placed in distinct holders and amassed over a significant amount of time. The model may be altered using six processes. The programme, as well as the general traits and limitations of each form of blend, influence the choice of blend.

4.10.3 INTEGRATED SAMPLES

A planned model may be a composite over significance of a system instead of time. The grab test accumulated at better places and at different regions across the width may be mixed regarding relative streams at these spots. The results of the examination will give typical characteristics. In such cases, persuade tests should be analyzed autonomously rather than planning them.

4.11 EXPERIMENTS PERFORMED

4.11.1 COLOUR

General condition of wastewater can be assessed using its tone. Light dim wastewater has a future of under 6 hours, yet light brown to medium gritty hued wastewater debases fairly or stays in the variety structure for a surprisingly long time. Finally, faint brown or dull wastewater can't avoid being wastewater that typically corrupts exceptionally by microorganisms under anaerobic conditions. This happens when Hydrogen sulfide conveyed under anaerobic conditions gets together with a divalent metal like iron.

4.11.2 ODOUR

In the marble industry, decomposition of different gases in stones cause unpleasant odour . The most common odor is of calcium carbonate and sulfur oxide. In addition, dissolved organic matter in the atmosphere and carbon dioxide from the decomposition of nitrogen also cause odors. Odor control is becoming increasingly important in the planning and operation of wastewater collection, treatment and treatment systems. Odor is a major concern for people in the wastewater treatment process. Often, the psychological stress caused by smell outweighs the harm to human health.

4.11.3 TEMPERATURE

Temperature is especially huge in marble plant conditions, on account of the effect of explicit compound pillars like lime. The temperature of the untreated wastewater supposedly was 40 °C and the temperature of the disinfected wastewater apparently was 30 °C. The power source temperature shouldn't outperform 35 °C. The higher the temperature, the milder the wastewater compound and the staining of the openings in the real line. High temperatures accelerate the compound reaction of oxygen.

4.11.4 pH

The hydrogen particle focus' negative logarithm represents the pH value. The range was 0 to 14, 7 neutral, less than 7 acidic, and 7 or more basic. The organic components and resistance of various bacteria can be affected by the specific history of the pH of wastewater. Specific particle appearance or absence can be directly correlated with the pH of the effluent. This effluent may have an impact on the soil's quality.

4.11.5 DISSOLVED OXYGEN

It is one of the most crucial standards for assessing the quality of the water. Oxygen that has been dissolved in water serves as a marker for its biological and physical activities. Dissolved oxygen is absolutely necessary for aquatic habitats. Numerous biochemical alterations and how they affect microbial metabolic activity have been extensively studied. At 35 °C and 0 °C, atmospheric solubility of oxygen in fresh water is approximately 7.0 mg/L and 14.6 mg/L, respectively. Since it is an incompressible gas, the temperature and air pressure are what determine how soluble it is.

4.11.6 TOTAL SOLIDS

A refined or porous material that remains as a remnant at a specific temperature following burning, evaporation, and subsequent drying is referred to as a solid. In wastewater, contaminated solid particles such bicarbonate, chloride, sulphate, nitrate, calcium, magnesium, sodium, potassium, manganese, sludge, organic matter, etc., make up the majority of the total solids, total soluble solids, and total suspended solids.

4.11.7 TOTAL SUSPENDED SOLIDS

Water's ability to reflect light is probably due to suspended particles, which have an effect on the clarity and turbidity of wastewater. Different endeavor’s have varying ratios of strengths for of, whether it is suspended materials or quickly separated particles.

4.11.8 TOTAL DISSOLVED SOLIDS

The colloidal design and degradation range are addressed by the outright solids centre in the waste spouting. The value of separated solids is a direct outcome of typical accidents of influencing particles, depending on how much the instabilities or potential gains of the emerging solids. The pH of these effluents also has an impact on the accident speed of the total mix. The full scale separated solids centre got is lower in the turbulent season because the waiting sewage is weakened by water.

4.11.9 CHLORIDES

Commonly found in regular water are chlorides. The release of wastewater from substance modern tanks and oil wells, floods contamination, and the dissolving of salt stores in stream water are factors adding to the event of chlorides in normal streams.

4.11.10 BIOCHEMICAL OXYGEN DEMAND (BOD)

Under active waste conditions, it is the amount of oxygen that microorganisms anticipate to settle decomposable natural matter. The amount of oxidizable natural matter in the water and the amount of oxygen necessary to oxidise inorganic substances (such as sulphides and ferrous particles) are both indicated by the natural oxygen request. Oxidizable compounds enter the biogeochemical cycle from regular sources.

4.11.11 CHEMICAL OXYGEN DEMAND (COD)

The COD test makes use of sizable solid regions so that an expert in oxidation may determine the amount of oxygen required for the designed oxidation of common chemicals. The COD test is used to assess the level of contamination from current wasterwater. The assumption that oxygen will regularly oxidise waste and produce carbon dioxide and water is used to evaluate waste. The combination of BOD and COD examinations aids in determining safe and normal flexibility.

4.11.12 SULPHATE

Sulphate is a polyatomic molecule found in ordinary water that has been employed in a variety of processes. Additionally, some organisations' wastewater may be a significant source of sulphate for purifying water. In marine systems, sulphur has never been a limiting element. When the regular waste in the water is too much to the point of deoxygenation, the smell conditions are conveniently prolonged. However, the average sulphate level is sufficient to address the problems of plants. Thus, SO_4 is frequently employed as an electron acceptor for the weakening of ordinary matter, transmitting H_2S and odour.

4.11.13 OIL AND GREASE

Obsessions with oil and organised fat (OG) place severe restrictions on the safety and purity of water. The most surprising pollutants to be eliminated are oils and fats, which are often found next various contaminants. Conclusion: The presence of oil or fat in a wastewater sample does not indicate the presence of a specific component; rather, it indicates the presence of a group of compounds that can be excluded from a particular wastewater test. Wax, fat, and oil are separated from liquid state in a reasonable dissolvable container. The dissolvable layer then disperses and the development is weighed into fats and oils from that point forward.

4.12 PARAMETERS FOR EXPERIMENT

Table 4.2: Water quality parameters analyzed and technique used

PARAMETRES	TECHNIQUE
COD	Open Reflux
pH	pH meter
BOD	Dilution method
TSS	Gravimetric meter
TDS	Gravimetric meter
Arsenic and Chromium	electrochemical reactor (EC).
Chemical Coagulation	Jar Test

4.13 EXPERIMENTAL METHODS

4.13.1 ANALYTICAL PROCEDURE

All physical and chemical parameters such as COD, color, solids, total soluble solids, total suspended solids, sulfate, chloride, etc. are determined using standard analytical methods. The color of the samples was measured as absorbance using a 420 nm UV spectrophotometer. Residual organic matter in the treated wastewater was analyzed through temperature analysis.

4.13.1.1 EXPERIMENT NO: 1

Determination of “pH

Apparatus & chemicals:

1. Stand
2. Beaker and colorimetric paper and water sample
3. Probe pH meter
4. Standard pH solution
5. Buffer tables (pH4, pH7)

Procedure:

Colorimetric Method

1. Dip the calorimetric paper in water sample.
2. Compare the color of pH of water against the color of pH value for sample.

Electrometric Method

1. Turn the meter in working condition by pressing key 1 on the pH meter.
2. Calibrate so that is shows 00.00 readings on meter by pressing the pH key and calibrate key.
3. The screen will show reading of 7 after dipping the probe in standard solution pH=7 and “Standard Key” pressed.
4. After dipping the probe in sample press ‘Dispersed Key’. This will give pH of the sample.
5. Read the value of pH from the screen.

4.13.1.2 EXPERIMENT NO: 2

Determination of Biochemical Oxygen Demand

Apparatus

1. B.O.D bottle
2. Burette
3. Pipit
4. Pipit filter
5. Graduated cylinder
6. Alkali iodide acid
7. Star itch indicator
8. Concentrated h_2so_4
9. Manganese sulphate

Procedure

1. fill two B.O.D tubes half with distilled water.
2. Use pipit to add 3ml of wastewater to the B.O.D tubes.
3. Fill tube completely with distilled water and fix stopper on it.
4. Place 1x tube in an incubator for 5 days at 20^o C.
5. Add 2ml of Manganese sulfate (MnSo4) with help of pipet for other tubes.
6. Add 2 ml of alkali iodide oxide and shake well (the color will change into brown with presence of oxygen otherwise white)
7. Add 2 ml of concentrate H2SO4 and shake well, the solution colour will turn into mustard oil.
8. Take 200 ml of this solution in a graduated cylinder and add 1 ml of a starch indicator to it which will give a yellowish color.
9. Note the initial reading and put the graduated cylinder below the burette containing standard solution of sodium sulfate.
10. Fill dissolved oxygen by substituting initial reading from final reading.
11. The dissolved oxygen is found in similar ways after incubation of first tube

12. B.O.D can be calculated using:.

B.O.D (mg/L) = (Zero-day D.O -5 days D.O) X 300/ml of sample

4.13.1.3 EXPERIMENT NO: 3

Determination of suspended solids

Apparatus

1. Filter glass
2. Suction motor and pumps
3. Filter media paper

Procedure

1. Take a filter glass of known size and weight. Name weight of filter glass be W1.
2. Switch on the water pump.
3. Now weight filter glass with sample in it. Let it would be W2.
4. Suspended solids can be calculated using below formula.
5. Weight of suspended solids:

{(weight of filter + sample)- (weight of filter) X 100}/W1

$$V = ((W_2 - W_1) \times 100)/W_1$$

4.13.1 .4 EXPERIMENT NO:4

Determination of total dissolved solids.

Apparatus:

1. Water bath
2. Oven
3. graduate cylinder
4. Analytical balance
5. Evaporation dish
6. Filer
7. Dish tongs
8. Crucible tongs
9. Desiccators
10. Vacuum pump
11. Forceps smooth-tipped

Procedure:

1. Empty evaporating dish is to be weight by using analytical balance. Let its weight be W1.
2. Use pipet to transfer unfiltered sample in porcelain dish. Mix sample well and pour into a funnel with filter paper. Filter approximately 80 -100 ml of sample.
3. Regulate the oven to 105°C.
4. Place sample in oven. Avoid splattering of the sample during boiling.
5. Dry for 1 to 2 hours for elimination of necessity to check for constant mass.
6. Cool the container in a desiccator.
7. Weight the dish as it has cooled to avoid absorption.

4.13.1.5 EXPERIMENT NO: 5

Determination of COD

Apparatus and Chemicals

1. COD reactor
2. Potassium dichromate $K_2Cr_2O_7$
3. Silver sulphate $AgSO_4$
4. Sulphuric acid H_2SO_4
5. Ferrous indicator
6. Standard ferrous ammonium sulphate Fe $(NH_2)_2(SO_4)_6H_2O$

Procedure

1. Measured amount of wastewater sample to be taken in one tube and distilled water in another tube.
2. Add 1.5ml amount of potassium dichromate (K2Cr2O7) in both the tubes in the presence of sulfuric acid (H2SO4) and boil them 2 hours at 120 ‘C.
3. Cool the samples to room temperature and transfer them conical flask.

4.13.1.6 EXPERIMENT NO: 6

Removal of Arsenic and Chromium

Apparatus:

1. Electrochemical reactor (EC).
2. Copper electrode
3. DC power source

Procedure:

Electrocoagulation Experiment.

1. Electrochemical reactor (EC) which is used to conduct this experiment is made of transparent fiber glass having capacity of 1.5 dm^3 (10.7×10.7×13.7 cm).
2. Copper squared electrode with dimension 7.5 cm x 7.5 cm x 2 mm (effective area 56.25 cm^2) to be used in the reactor.
3. Spacing between the two electrodes is 1-2.5cm and 1.5 cm of gap from the bottom of the reactor for the movement of magnetic stirrer.
4. DC power in range of 0–30 (V) and 0–5 (A) current to be supplied respective terminals in parallel arrangement.
5. Analyze and Record the amount treated at the given time.

4.13.1.7 EXPERIMENT NO: 7

Chemical Coagulation Experiment

Apparatus:

1. Jar Test Apparatus
2. Sample Wastewater
3. Glass beaker

Procedure:

1. For Chemical coagulation process Jar test apparatus is used.
2. Take 500 ml of glass beaker and add 200 ml of wastewater sample.
3. Record the first pH of the sample and adjust initial pH by adding aqueous sodium hydroxide or sulfuric acid solution.
4. Add a coagulant with measured weight to the sample, agitate at 110 rpm for 5 min, and then agitate at 60 rpm for 30 min.
5. Let the wastewater sample settle for 6 hours.
6. Analyze clean liquid for color removal and chemical oxygen demand (COD)
7. The percentage removal of COD and color can be calculated by below equation. The experimental setup for treatment of marble factory wastewater is shown in Fig. 4.5.

Removal % = ((Ci-Cf) x100)/Ci

Where,

Ci= Initial concentration (mg/l).

Cf= Finial concentration (after treatment; mg/l).

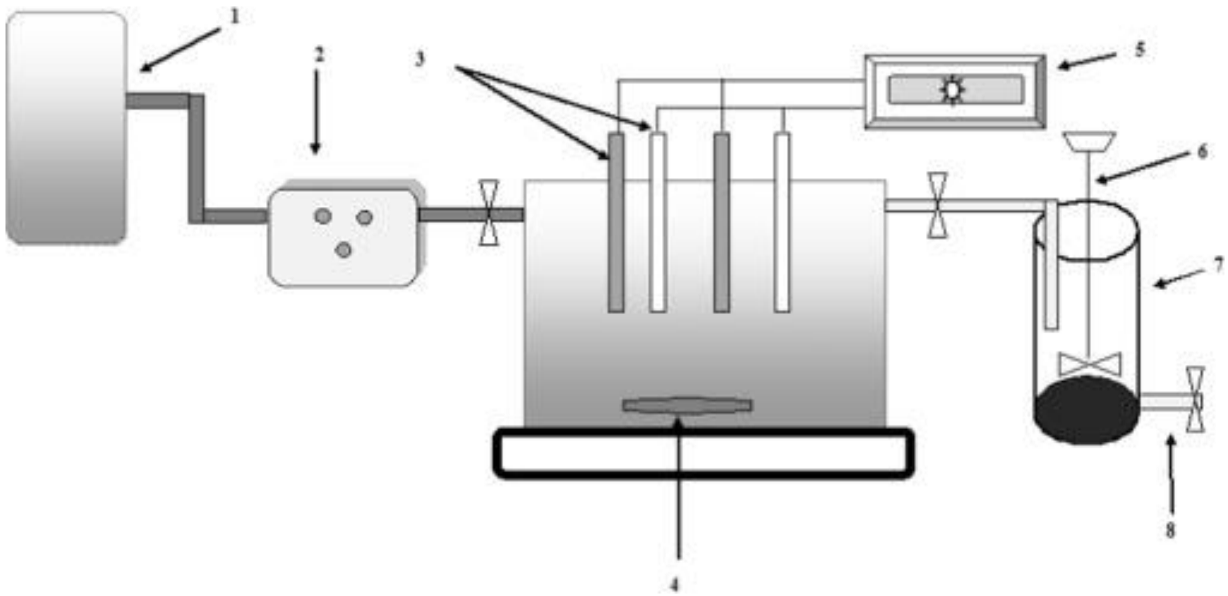


Fig. 4.5: Experiment setup (1) wastewater sample, (2) pump, (3) electrode, (4) magnetic stirrer, (5) DC supply, (6) agitator, (7) beaker for coagulation, (8) discharge.

CHAPTER NO 5
RESULTS & DISCUSSION

Note: All Sample values are the depiction of trends found in studies of Wastewater treatment in Marble factories of Pakistan.

5.1 THE pH OF WASTEWATER.

"pH is the logarithmic value of hydrogen ion concentration in water. It ranges from 0-14. 7 is the neutral value whereas less than 7 is acidic and greater than 7 till 14 would be basic".

Table 5.1

S/No	Sample	Before use	After use
1.	W1	7.35	7.10

Discussion

a. The average value of pH is above to neutral value this means wastewater is basic in nature

b. This basic nature is due to active biomass produced as a result of nitrification during treatment of wastewater.

c. This basic behavior will affect the biological activity in water bodies and slow down important biological process and kill essential microorganisms.

5.2 BOD OF WASTEWATER

"Biochemical oxygen demand is the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic conditions." (Tuser, 2020)

Table 5.2

S/No	Sample	Before use	After use
1.	W1	29.41	86.96

Discussion

a. Values of all the samples are above the standard values of even the untreated wastewater (200-600 mg/l). This indicates that either the samples were not treated at all or were treated using improper techniques. (NEQs Standard = 80 mg/l)

b. These low values also indicate the poor water quality as less oxygen is being removed from water.

5.3 COD OF WASTEWATER

"Chemical Oxygen Demand (COD) analysis is a measurement of the oxygen-depletion capacity of a water sample contaminated with organic waste matter. Specifically, it measures the equivalent amount of oxygen required to chemically oxidize organic compounds in water." (Monegotto, 2017)

Table 5.3

S/No	Sample	Before use	After Use
1.	W1	1480 mg/l	1207mg/l

Discussion

- **a.** The sample values indicate that all the samples are untreated due to high COD values. **(Range 75-150 mg/L)**
- **b.** High COD values of samples also indicate the presence of oxidizable organic matter.
- **c.** COD test can be used alternatively to BOD test due to less time required for testing.
- **d.** Such high values create anaerobic conditions which are harmful for aquatic life

5.4 TSS OF WASTEWATER

" TSS stands for total suspended solids and refers to waterborne particles that exceed 2 microns in size. Any particle that is smaller than 2 microns, on the other hand, is considered a total dissolved solid (TDS). Most total suspended solids comprise of inorganic materials; however, algae and bacteria may also be considered TSS." (Campbell, 2021)

Table 5.4

S/No	Sample	Before use	After use
1.	W1	20 mg/l	260 mg/l

Discussion

- **a.** We can see that a variation exists in the samples in case of TSS. Samples 1,5,6,7 are within the acceptable range of TSS. Other samples exceed the limit of 400 mg/L. (NEQs standard 200-400 mg/L)
- **b.** The above trend shows that the marble factory did not filtered the waste before discharging it into the sewerage line.
- **c.** These pollutant materials will mix with solid particles i.e., Clay, metals etc. and will be discharged into mainstream with storms.

5.5 TDS IN WASTEWATER

"Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water." (Oram, n.d.)

Table 5.5

S/No	Sample	Before use	After use
1.	W1	1375 mg/l	1494 mg/l

Discussion

- **a.** We see that generally all samples are within range of the required standards **(250-3500 mg/L).**
- **b.** High value of TDS effect the treatment unit operation capability, it can also cause salinity issues if the wastewater is discharged into irrigation water.
- **c.** This high value of TDS can also be attributed to less rainfall in winter season in Pakistan which results in low level of surface runoff and vice versa.

5.6 SUMMARY

Marble factories in Pakistan has been major contributor towards promoting the economic growth of country but the marble processing waste deteriorates the surface water and soil bodies to degree where human, aquatic life and microorganisms are all affected. Results from above samples show that all Parameters are relatively higher than the permissible standards. factories claim to treat the effluents but results show that the industrial waste is discharged without treating them. Hence, there is a dire need to treat these effluents properly.

CHAPTER NO 6
DESIGN OF TREATMENT UNIT

6.1 DESIGN OF WWT UNITS FOR SUGAR MILL

Treatment unit is a combination of various units having unique function which collectively gives us the desired output. These units are designed based on the design parameters given in Associate Professor Dr Arshad Ali's book **"A TEXTBOOK OF ENVIRONMENTAL ENGINEERING"**. Following units are designed here:

6.1.1 Collection Sump
6.1.2 Pumping station
6.1.3 Screening chamber
6.1.4 Grit Chamber
6.1.5 Skimming Tank
6.1.6 Primary Sedimentation tank
6.1.7 Activated Sludge System (Biological Treatment Unit)
6.1.8 Summary of complete Design

Based on average value of the data, which is consulted for our research, a design is proposed. There can be many possibilities of treatment units that can be installed based on various factors like budget, waste quality, ease of operation, maintenance & monitoring. We have proposed the very basic treatment unit which is easy to operate and gives out the reasonable output. In Pakistan only 1 % of Wastewater receives treatment. Water quality that originates from sugar mills of Pakistan is very poor therefore, a very basic treatment unit or a minimum possible treatment unit is proposed that works efficiently and gives out the optimum result.

The design values which are being considered are as following:

Table-6.1: Marble factory Effluent of Selected Marble Factory

Parameters	Before use	After use
pH	7.35	7.10
BOD	29.41	86.96
COD	1480	1207
TSS	20	260
TDS	1375	1494

We considered the mean value of these results to design the treatment unit.

Capacity of stone crushing = 3400 Tons (Discharge of waste @ 0.3 – 0.5 m^3 / Ton of stone crushed)

Discharge Rate, $Q_{avg.\ ww}$ = 3400 * 0.5 m^3 / Day = 1700 m^3 / Day = 0.0197m^3 / sec

BOD Concentration = 86.96 mg / Lits = 0.08696 kg / m^3

Q_{pk} = 2.75 * 1700 = 4675 m^3 / Day = 0.0541 m^3 / sec {$Q_{avg.\ ww}$ = 2.75 Q_{pk}}

6.1.1 COLLECTION SUMP

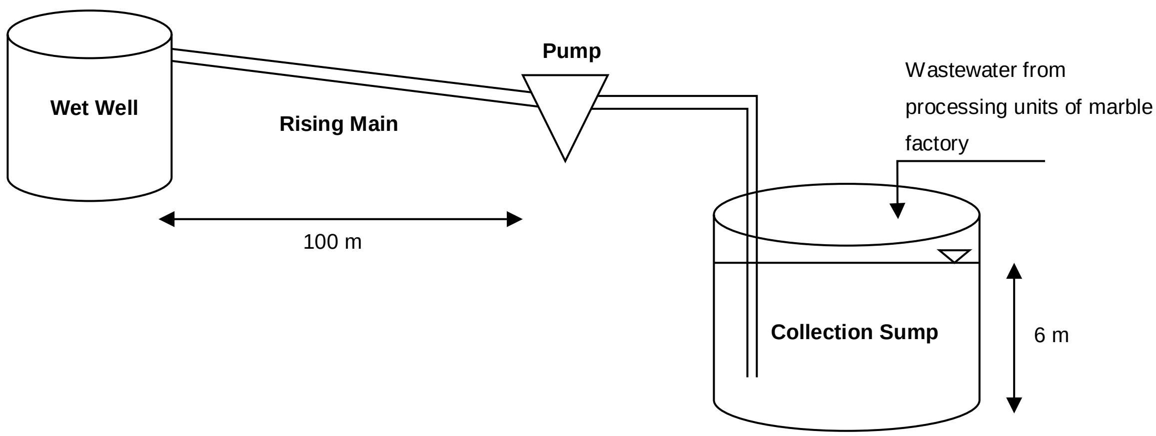
Volume in a single day = 1700 m^3 / Day Assuming Depth of sump = 6 m

Area of collection Sump = 1700 m^3 / 6 m = 283.5 m^2

Diameter of Sump = 19 m ≅ **62.5 ft**

Considering two options with the given results, we have two options, either to one sump of 62.5 ft or two sumps of 31.25 ft each. Wastewater from the processing units of marble factory would be collected in this sump firstly and subsequently would be sent to screening chamber using a pumping station.

6.1.2 PUMPING STATION



Design of pumping station requires designing of following: -

- Collection Sump
- Suction Pipe
- Pump
- Rising Main
- Wet Well

Step 1: Rising Main Diameter Design

Assuming Velocity through Rising Main = 0.75 m / sec

We know that we use Peak Discharge for calculation of Pipe Diameter

∴ Area of Rising Main $= Q_{pk}$ / Velocity

$= (0.0541\ m^3 / sec) / (0.75\ m / sec)$

$= 0.0721\ m^2$

As it is a Circular Pipe

∴ Area $= \pi * D^2 / 4$ $= 0.0721\ m^2$

Diameter = D = 0.303 m

= 1 ft = 12 in

≅ **12 in** = 0.3048 m

So, Volume of Rising main $= (\pi * 0.3048^2 / 4) * 100\ m = 7.3\ m^3$

Step 2: Dimensions of Wet Well

Wet well will be designed for the volume of peak discharge and volume in Rising main

∴ Volume $= (Q_{pk} * t_D)$ + Volume of Rising Main

Assuming, t_D = 25 min

$= (0.0541\ m^3 / sec * 1500\ sec) + 7.3\ m^3 = 88.45\ m^3$

Assuming, Wet Well Depth = 4 m

Surface area of Wet Well $= 88.45\ m^3 / 4m$ $= 22.1125\ m^2$

Diameter = 5.307 ≅ **5.5 m**

Step 3: Diameter of Suction Pipe

Assuming, velocity through suction pipe = 1 m / sec

Surface Area $= Q_{pk}$ / Velocity = 0.0541 / 1

$= 0.0541\ m^2$

Diameter = 0.263 m = 0.863 ft = 10.35 in ≅ **12 in**

Step 4: Design of Pipe

Power, P $= (\gamma_{ww} * Q * H_T / (75\eta_{Pump})$

$= (1000 * 0.0541 * 6.094) / (75 * 0.65)$

$= 6.76\ h_p$

$\cong$ **7 h_p**

$\gamma_{ww} = 1000\ Kg/m^3$

$\eta_{Pump} = 60\text{-}65\ \%$

$H_T = H + H_L$

H = 6 m (Collection Sump)

Where,

$H_1 = f*L*V^2 / 2gD$

$= 0.01*100*0.75^2 / 2*9.81*0.3048$

$= 0.094$ m

Step 5: Summary of Design

SUMMARY	
Rising Main Diameter Design	12 in
Dimensions of Wet Well	Diameter x Depth = 5.5 m x 5 m {including Sludge storage & Freeboard}
Diameter of Suction Pipe	12 in
Pipe	7 h_p

6.1.3 SCREENING CHAMBER

This chamber requires designing of following:

- Approach Channel
- Bar Size of Screens

Step 1: Design of Approach Channel

Assuming, Velocity in Channel = V = 0.75 m / sec

Surface Area = A = Q_{Design} / Velocity

= (0.0197 m^3 / sec) / 0.75 m / sec

= 0.02626 m^2

Assuming, W: D:: 1 : 1

So, width = Depth = W = D = 0.162 m = 0.531 ft ≅ 0.6 ft = **0.183 m**

Actual Area = 0.183* 0.183 = 0.0335 m^2

CHECK

Velocity, V_a = Q / A= 0.0197 / 0.0335 = 0.58 m/sec ≅ 0.6 m/sec > 0.45 m /sec **OK!**

Step 2: Selecting Bar Size of Screen

We will keep, Inclination of bar = 45°

Clear Opening = 40 mm

Square Bar = 20 mm x 20 mm

Clear Opening (n+1) + Width of Bar (n) = Width of Channel

0.04 (n + 1) + 0.02 (n) = 0.183 m So, n = 2.38 ≅ **3**

So, if there are 3 x Bars then, **Clear Opening = 41 mm**

Length of Bar , L_b = Depth /sin θ = 0.183 / sin 45°= **0.259 m**

Step 3: Effective Cross Section of Channel

Effective Width W_e = W – (n * Single Bar Width) = 0.183 m – (3 * 0.02 m) = 0.123 m

Effective Cross Section A_e = W_e * Depth = 0.123 * 0.183 = 0.0225 m^2

Velocity through Screens, V_s = 0.0197 / 0.0225 = 0.875 m / sec

Head Loss H_L = $0.08 (V_s^2 – V_a^2) = 0.08(0.875^2 – 0.6^2)$

= 0.03245 m {< 0.3 m, **OK!**}

Step 4: Quantity of Screen Produced

Assuming, Frequency of removing screens = 4 Days

Amount of wastewater flowing in four days = 4 * 1700 m^3 / Day

= 6800 m^3 = 1.79636 MG

Assuming, amount of screens are produced at the rate of 0.05 m^3 per million Gallons of wastewater.

∴ = 1.79636 * 0.05 = 0.0898 m^3

Step 5: Perforated plates

They are installed above the surface of wastewater

Assume, Height = 6 in = **0.152 m**

Length = (L_b / cosθ + $L_{perforated\text{-}plate}$+ 30-50% addl on both side)

Where,

$L_{perforated\text{-}plate} \leq$ 1.6 Length of bar

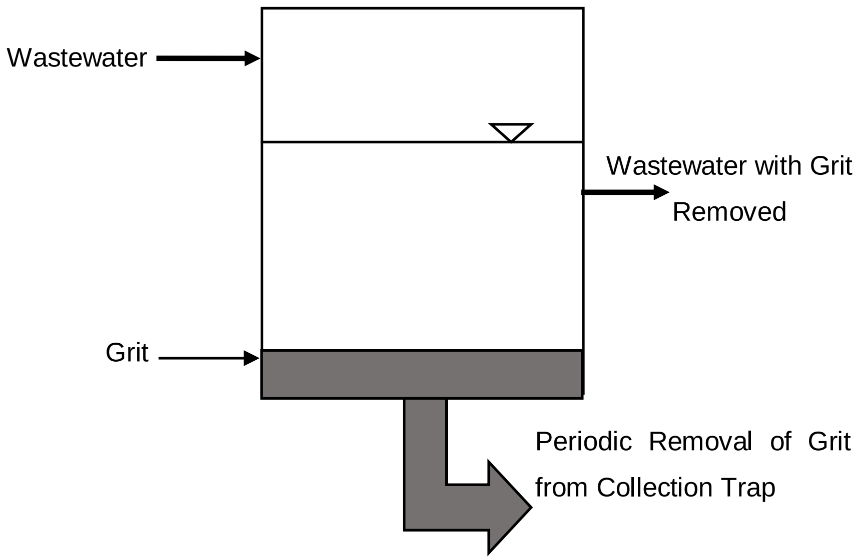
= (0.259 / cos 45° + 1.6 * 0.259 + 2*0.3*0.0259) = 0.936 m

≅ **1 m**

STEP 6: Summary

SUMMARY	
Clear Opening	41 mm
Inclination of bar	45°
Length of bar, L_b	0.259 m
Amount of screens	0.0898 m^3
Bar Size	20 mm x 20 mm
Perforated Plate L * W * H	1m x 0.183m x 0.152m

6.1.4 AERATED GRIT CHAMBER



STEP 1: Dimensions

Assuming a detention time, t_D = 5 min

Volume of Basin, V = $Q_{Design} * t_D$ = 1.182 m^3 / min * 5 min = 5.91 m^3

Assuming Depth of Tank = **4 m** (Add 1 m for freeboard at the end)

Surface Area = 5.91 m^3 / 4 m = 1.4775 m^2

L: W :: 1 : 2

W = 0.86 m ≅ **1 m**

L = 1.72 m ≅ **2 m**

Actual Area, A_s = 1 * 2 = 2m^2

Actual Volume = 2 m^2 * 4 m = 8 m^3

STEP 2: Check Surface Loading Rate (SLR)

SLR $= Q_{Design} / A_s$

$= 1.182\ m^3 / min / 2\ m^2$

$= 0.591\ m^3/ m^2.min$

$= 1120\ m^3/ m^2.Day$ {1100-1700 **NOT OK!**}

We will therefore reduce the area, L= 1.8 m W= 0.9 m

Amended actual area $A_s = 1.8m*0.9m = 1.62\ m^2$

Volume would be $V = 1.8\ m * 0.9\ m * 4\ m = 6.48\ m^3$

So, SLR $= 1.182\ m^3 / min / 1.62\ m^2$

$= 0.73\ m^3/ m^2.min$

$= 1150\ m^3/ m^2.Day$ {1100-1700 **OK!**}

STEP 3: Amount of Grit Required

Assuming,

Cleaning Freq = 4 Days & Grit Produced @ $0.04\ m^3$ / ML of Wastewater

Waste Produced $= 0.04\ (4\ days * 1700\ m^3 /Day * 1000\ L * 10^{-6})$

$= 0.272\ m^3$ {$1m^3 = 1000\ L$}

STEP 4: Amount of Air Required

Assuming, @ $0.4\ m^3$ /meter. min

Thus, Air Requirement $= 0.4\ m^3$ /meter. min * 5 m = $2\ m^3$ /min

STEP 5: Summary

SUMMARY	
Dimensions, L * W * D	1.8 m * 0.9 m * 5 m (Including Freeboard)

SLR	1150 m^3/ m^2.Day
Amount of Grit req	0.272 m^3
Amount of air req	2 m^3 /min

6.1.5 SKIMMING TANK

Assuming Retention Time = 15 min

Vol of Tank = V = $Q_{Design} * t_D$

= 1.182 m^3 / min * 15 min

= 17.73 m^3

Assuming Depth of Tank = 4 m

@ 250 m^2 of surface area for 1 m^3 / sec of wastewater

$\therefore$ For, 0.0197 m^3 / sec of wastewater discharge = 250 * 0.0197 = 4.92 m^2

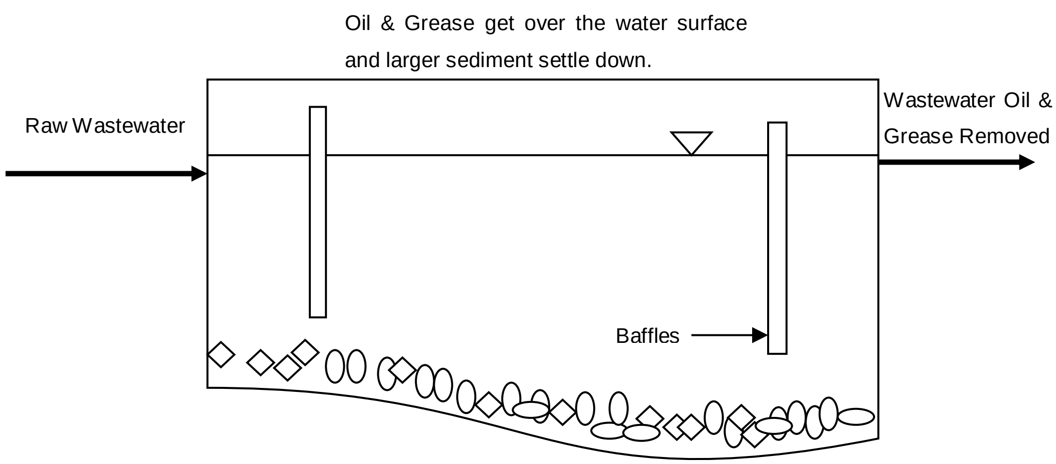
L : W :: 1 : 2,

W = 1.57 m $\cong$ **1.75 m** L = 3.14 m $\cong$ **3.5 m**

Actual Area, A_s = 1.75 * 3.5 = 6.125 m^2

Depth of Tank = 17.73 m^3 / 6.125 m^2 = 2.89 m

$\cong$ **3.5 m** {Including Freeboard}



6.1.6 PRIMARY SEDIMENTATION TANK (PST)

Step 1: Selection of surface

SOR_{avg} = 1.8 m^3 / m^2 . hr (Assumption)

Q_{avg} = 70.92 m^3 / hr

Area = Q_{avg} / SOR_{avg} = 70.92 m^3 / hr / 1.8 m^3 / m^2 . hr = 39.4 m^2

SOR_{pk} = 4 m^3 / m^2 . hr (Assumption)

Q_{pk} = 194.76 m^3 / hr

Area = Q_{pk} / SOR_{pk} = 194.76 m^3 / hr / 4 m^3 / m^2 . hr

= 48.69 m^2 {Greater value of surface area governs}

Step 2: Dimensions of Circular PST

A = π * D^2 / 4 = 48.69 m^2

Dia = 7.87 m $\cong$ **8 m**

Vol = π * D^2 / 4 * Depth = π * 8^2 / 4 * 3

= 150.72 m^3 {Assume, Depth = 3m}

CHECK t_D & WLR

t_D = Vol / Q_{pk}

= 150.72 m^3/ 194.76 m^3 / hr

= 0.773 hr = 46.43 min {20 min- 3 hr}

WLR = Q_{pk} / Peripheral Circumference

= 194.76 m^3/hr / $\pi * 8\, m$ = 7.75 m^3/ m. hrs

= 7.75 * 24 hrs

= 186.076 m^3/ m. Day {WLR Range is 125 – 500 m^3/ m. Day – OK!}

Step 3: Percentage Removal of SS & BOD

Corresponding to SOR_{pk}, we have 16 % BOD removed and 33 % SS removed.

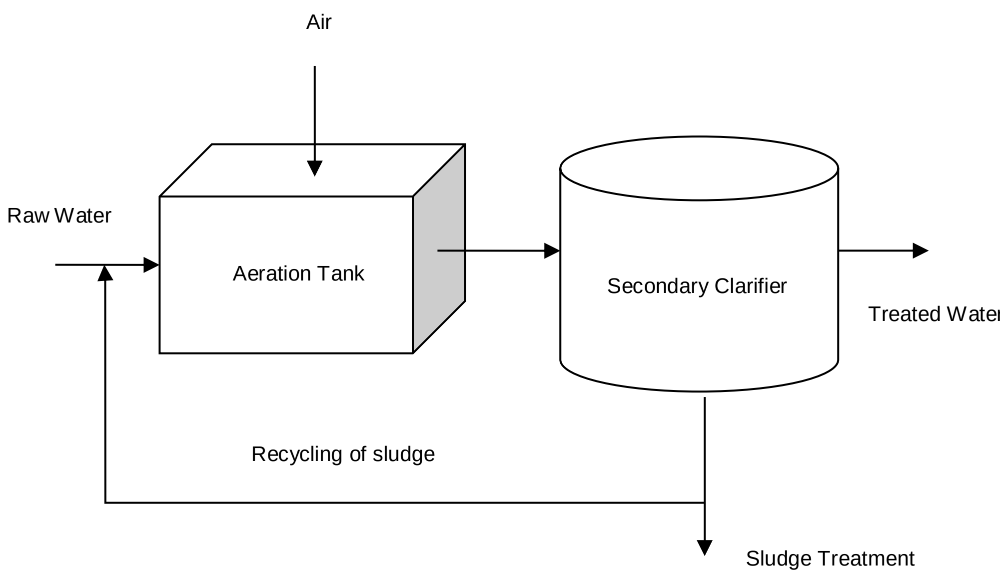
Step 4: Summary

SUMMARY	
Dia * Depth	8 m * 4 m {including Sludge storage & Freeboard}
SOR_{avg}	1.8 m^3 / m^2 . hr
SOR_{pk}	4 m^3 / m^2 . hr
WLR	186. m^3/m . Day
BOD Removed	**To be mentioned** %
SS Removed	33 %

16 % of BOD is removed in primary sedimentation tank and the remaining 84 % will be removed in the biological treatment unit.

6.1.7 ACTIVATED SLUDGE SYSTEM (BIOLOGICAL TREATMENT UNIT)

This system has aeration tank and settling tank as shown:



Step 1: Aeration Tank Dimensions

Assume, t_D = 6 hrs

Vol = Q Design x t_D

= 70.92 * 6 = 425.25 m^3

Assume, Depth = 4 m

Surface Area = 425.25/ 4 = 106.38 m^2

Say, L : W :: 3 : 1 {Rectangular Tank}

∴ Width = 5.96 m ≅ **6 m**

Length = 17.86 m ≅ **18 m**

So, Actual Area = 6 * 18 = 108 m^2

Actual Vol = 108 * 4 = 432 m^3

CHECK

∵ BOD applied per Day = Q * BOD Concentration

= 1700 m^3/Day * 0.08696 kg / m^3

= 147.832 Kg-BOD / Day

VLR or OLR = BOD applied per Day / Volume of Basin

= 147.832 Kg-BOD / Day / 432 m^3

= 0.34 Kg-BOD / m^3.Day {0.8 – 3.2 NOT OK!}

So, organic matter applier over a unit surface area of treatment basin exceeds the limit so we will decrease the surface area of basin. By trial we have the following dimension of Aeration Tank:

Volume = 12 x 3 x 4 = 144 m^3

{L = 12 m, W = 3 m, Depth = 4 m}

VLR or OLR = 147.832 Kg-BOD / Day / 144 m^3

= 1.0266 Kg-BOD / m^3.Day

{0.8 – 3.2 OK!}

Step 2: Secondary Sedimentation Tank

Assume,

SOR_{avg} = 20 m^3 / m^2 . Day Assumption {16 – 32 m^3 / m^2 . Day}

Q_{avg} = 1700 m^3 / Day

Area = Q_{avg} / SOR_{avg}

= 1700 m^3 / Day / 20 m^3 / m^2. Day **= 85 m^2**

SOR_{pk} = 50 m^3 / m^2 . Day Assumption {40 – 64 m^3 / m^2 .Day}

Q_{pk} = 4675 m^3 / Day

Area = Q_{pk} / SOR_{pk}

= 4675 m^3 / Day / 50 m^3 / m^2. Hr

= 93.5 m^2 {Greater value of surface area governs}

Diameter = 10.91 ≅ 11 m {Circular Tank}

Actual Areal = π * D^2 / 4 = π * 11^2 / 4 = 95.03 m^2

Actual Vol = 95.03* 3 = 285.1 m^3 {Assuming, Depth = 3 m}

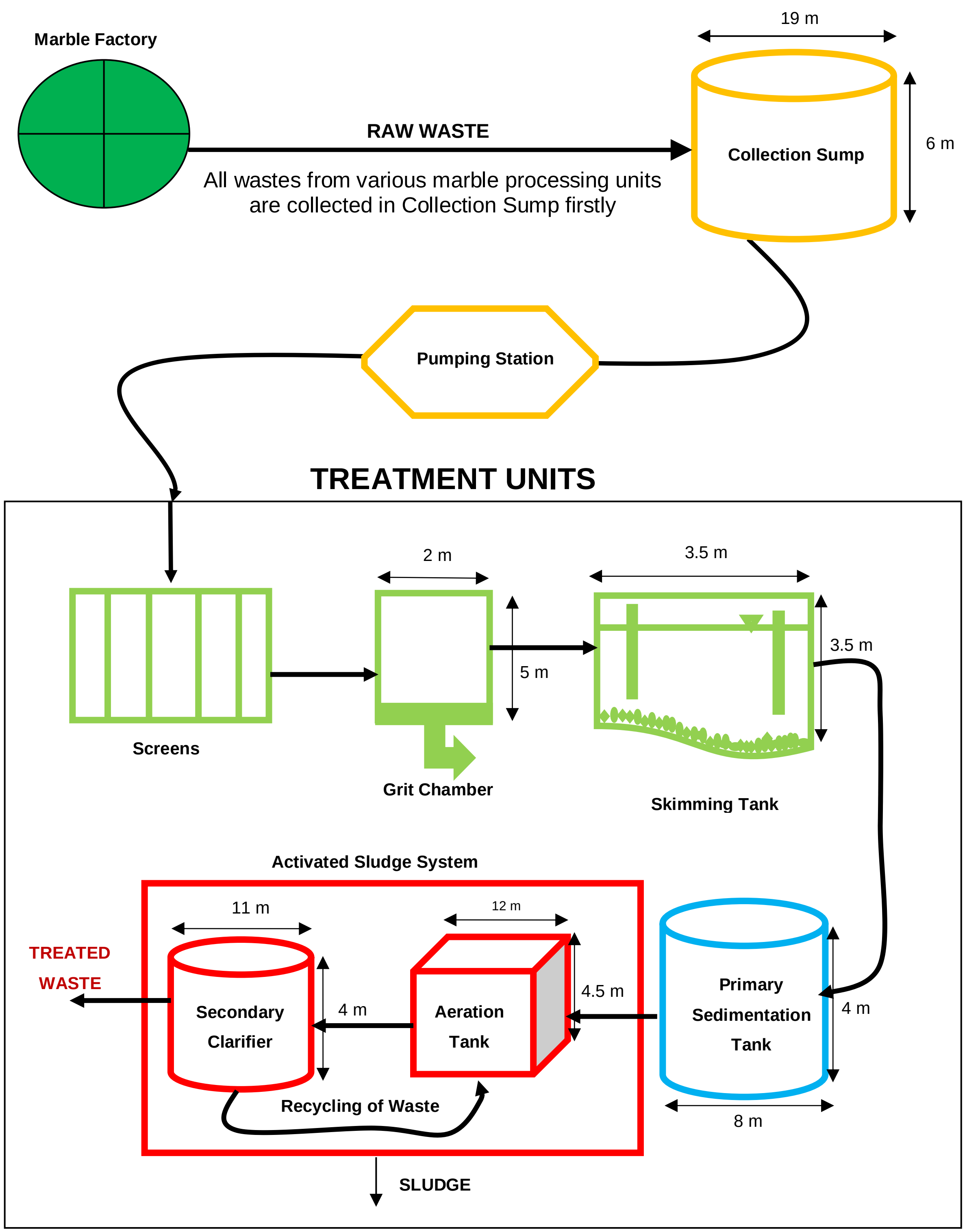
CHECK

t_D = Vol / Q_{pk} = 285.1 / 4675= 0.061 Day

= 88 min {60 – 90 min OK!}

SUMMARY	
Aeration Tank	
L x W x D	12 m x 4 m x 4.5 m {including Sludge storage & Freeboard}
VLR	1.0266 Kg-BOD / m^3.Day
t_D	6 hrs
Secondary Sedimentation Tank	
Dia * Depth	11 m x 4 m {including Sludge storage & Freeboard}

6.1.8 SUMMARY OF COMPLETE DESIGN



CHAPTER NO 7
RECOMMENDATIONS & CONCLUSION

7.1 CONCLUSIONS

Excessive quantity of water is produced because of marble processing methods adopted by the concerned factories. The effluent water from the marble factory has shown high values of parameters i.e. BOD, COD, TDS, and TSS; the values of which are exceeding the limits specified by NEQS. Following a nominal or no ministration, the discharge of wastewater into the water source is imparting huge danger to marine life as well as minimizing the amount of fresh water available for save use. An appropriately fashioned, preserved and supervised treatment unit, if installed, can dilute the alarming and damaging effects of wastewater.

The above study brings forward a design of WWT unit minimizes the levels of the mentioned variables to within the safety limits. An immaculate yet conventional unit has been put forward which does not required extensive expertise for its regular working. The values and mathematical calculations are done keeping in view the testing of the samples obtained from marble factory.

7.2 RECOMMENDATIONS

Following is recommended for all marble factories: -

- All senior staff of factories need to synthesize themselves with sound sense of discipline,moral & social sense of responsibilities to keep effluents in compliance for humanity and Earth itself.
- Govt and Environmental department need to provide uncompromising poilicies with enhanced circles of check and balance to hinder depletion effects of environment by industries.
- Sense of cooperation must be inculcated in the industries with research and analysis teams so to improve the linkage between fresh minds resulting in innovative ideas which further would increase the production of industries vis-à-vis reduction in the waste.
- This research did not touch upon environmental impacts of gaseous matter being let into atmosphere during Bagasse Combustion. Being of main cause of air pollution, a separate research should be conducted to evaluate implications of such emissions.

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