Sonargaon University (SU)

COMPARISON OF EQUALIZATION TANKS OF DIFFERENT EFFLUENT TREATMENT PLANTS FOR WET PROCESSING TEXTILES INDUSTRIES IN BANGLADESH

A project

By

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A project submitted to the Department of Civil Engineering Sonargaon University, Dhaka in partial fulfillment of the requirements for the degree

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A Project report is submitted to the Department of Civil Engineering of Sonargaon University in the partial fulfillment of the requirements for the degree of Bachelor of Science in civil Engineering.

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Fall – 2019

DEDICATION

This thesis is dedicated to:

The sake of Allah (swt) most Magnificent & Gracious, our Creator and our Master,

Our great teacher and messenger, Mohammed (May Allah bless and grant him), Who taught us the persistence of life,

Our motherland Bangladesh, the biggest part of heart;

The great martyrs of our freedom fight, the symbol of sacrifice;

Our phenomenal parents, who are the great establishment of our life;

Our beloved brother and sister, the great source of inspiration;

Our friend, who encourage and support to believe that,

All the people in our life who touch Our heart,

We dedicate this research

Letter of Transmittal

January 2020

To
Md. Lutfor Rahman
Assistant Professor & Head of the Department
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Dhaka, Bangladesh.

Subject: Submission of Project Report.

Sir,

We are hereby very pleased to submit the project paper on **"Comparison of Equalization Tanks of Different Effluent Treatment Plants for Wet Processing Textiles Industries in Bangladesh"**. This report will give an overview on Equalization tank comparison & design. It has been great pleasure for us to work on such an important topic. The project work has been done according to the requirement of the Sonargaon University of Bangladesh. In the partial fulfillment of the requirements for the degree of B.Sc. in civil Engineering.

We would be very happy to provide any assistance in interpreting any part of the paper whenever necessary.

Thinking you,

Sincerely Yours

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DECLARATION

It is stated the project work on **"Comparison of Equalization Tanks of Different Effluent Treatment Plants for Wet Processing Textiles Industries in Bangladesh"** has been performed under the supervision of Md. Lutfor Rahman, Assistant Professor of the Department, Department of civil Engineering, (SU) Dhaka. To the best of our Knowledge and belief, the project report contains no materials previously published person except Where due reference is made in the report itself.

We further undertake to identify the university against any loss or damage arising from breach of foregoing obligations.

Signature:

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CERTIFICATION

This is certifying that the project report "**Comparison of Equalization Tanks of Different Effluent Treatment Plants for Wet Processing Textiles Industries in Bangladesh"** is the confide record of project work done by Md. Istadul Miah, Md. Masud Kha, Md. Nazmul Hasan, Md. Abu Tarek and Abdul Kuddus in the partial fulfilment of the requirements for the degree of B.Sc. in civil Engineering from the Sonargaon University of Bangladesh (SU).

This project work has been carried out under our guidance and is a record of successful work.

Supervisor

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ABSTRACT

Textile industries produce wastewater as a bi-product of their production mainly due to wet processing. The effluent contains several organic pollutants and color producing substances, which cause severe environmental hazards on both aquatic life and human health. These pollutants can be reduced down to the permissible limit with the help of an Effluent Treatment Plant (ETP). Equalization tank is the beginning part after screening which is very important portion of ETP for homogenization, shock elimination, p^H stabilization, constant flow maintaining etc.

Equalization tank capacity is depended on the retention time, when the retention time is varying then the volume of tank is changed. As well as the sensitivity analysis capacity of Equalization Tank also depending on retention time.

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LIST OF ABBREVIATIONS

AF	:	After Treatment
ASPs	:	Activated Sludge Plants
BF	:	Before Treatment
BOD	:	Biochemical Oxygen Demand
COD	:	Chemical Oxygen Demand
CSR	:	Corporate Social Responsibility
DO	:	Dissolved oxygen
DoE	:	The Department of Environment
EC	:	Electro-Coagulation
ECA	:	Environment Conservation Act, 1995
ECC	:	Environmental Clearance Certificate
ECR	:	Environmental Conservation Rules, 1997
EF	:	Electro-Flotation
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan (EMP)
EO	:	Electro-Oxidation
ETP	:	Effluent Treatment Plant
IEs	:	Industrial Effluents
IRD	:	Internal Resource Division
O&M	:	Operation & management
pH	:	Hydrogen Ions in the Wastewater
RMG	:	Ready-made Garments
TDS	:	Total Dissolved Solids
TSS	:	Total Suspended Solids

CHAPTER-1
INTRODUCTION

1.1. INTRODUCTION

In Bangladesh, many textile industries have set up ETPs. These ETPs have been designed by international design firms without considering the local facts. These are simply designed on the basis of some generalized data and involve use of technologies and chemicals which are cost prohibitive. But choosing appropriate and cost effective treatment option is one of the major steps toward reducing pollution from textile industries. In this study wide investigation of proper treatment method and design evaluation of an existing ETP has been made in order to suggest optimum and cost-effective way of wastewater treatment.

A large number of industries have wastewater with very important flow and/or composition variations throughout the day, due to batch processes, operation hours, type of production, etc. These variations may produce malfunction of process steps or, in the design of the treatment plant, they may lead to oversizing.

In the case of a system with continuous treatment, if the variation of inlet flowrates is very pronounced, any subsequent transfer process is difficult whether it is biological, physical or chemical. Something similar happens with the pollutant load.

1.2. BACKGROUND OF THE STUDY

Waste water treatment method which is particularly designed to purify industrial waste water for its reuse and its aim is to release safe water to environment from the harmful effect caused by the effluent.

Generally, equalization tanks for wastewater treatment plants refer to a holding tank that allows for flow to be equalized over a specific period of time. During the peak hours ETP comes at high flow rate. The inlet pipe of equalization tank carries filtered effluent from cooling tower.

Effluent from the collection tank comes to the **equalization tank** in wastewater treatment. The main function is to act as buffer. To collect the incoming raw effluent that comes at widely fluctuating rates and position to the rest of the ETP at steady (Average) flow rate.

In order to avoid these difficulties, chambers (tanks, basins or ponds) which can act as water “lungs” are designed. Wastewater flows can be accumulated in these chambers, and then may be dosed (usually by pumping) to the rest of the system with a relatively constant flow rate, thereby avoiding the peaks of flow and load.

The equalization tank can achieve two objectives: flow control (equalization) and/or homogenization of contaminated flows.

Bangladesh is an agriculture centered country, but now a day the industrial sector is playing a vital role in the development process of the country [1]. Bangladesh is rapidly growing especially, in its Ready-made garments (RMG) sector with a motto ―Made in Bangladesh Textile & RMG sector is the leading source of earning foreign currency and thus it became the backbone of the economy of Bangladesh. Apart from its agrarian identity our country had a great heritage of textile. As for instance the famous Muslin from Dhaka was exported in different foreign countries [2]. From that ancient time the textile sector has been participating in the country ‘s development process.

Industrial effluents (IEs) are unavoidable by-products of industrial production activities. One of the major industrial effluents is the effluent or water pollutant. The dyeing factories are discharging wastes in the form of liquid waste which is burden with varieties of hazardous containing various harmful elements and these dissolved solids and are damaging the water reservoirs. These impurities are directly discharged into the adjacent water reservoirs likely river, lake, stream, and lagoon and contaminate these sources [10]. The main source of this contamination of the water bodies are the industries established nearby. It can also be observed that most of the pollution parameters in the textile areas are beyond the national standards and immediate attention needs to be paid in treating them. The Effluent Treatment Plant (ETP) is planned to screen these produced wastes that were generated in their manufacture processes and thus to control the damage done to the environment. Based on the effluent characteristics, the type of treatment plant is selected and installed [11]. Most commonly ETPs are generally chemical, biological or combination of both. Recent days another type of ETP namely electrochemical or electro-coagulation are also being operative [12]. The functionality of these plants is measured based upon their restricting the pollution parameters within the set limit by DoE (The Department of Environment) and generally attempting to maintain the Dissolved oxygen (DO) in the treated water.
The treatment plants supposed to reduce the cost of operations by decontaminating the water so that it can be reusable [13] and this can help in recycling as well as to meet the governing related to the conservation. Inefficient or lack of treatments of wastewater, insufficient monitoring, and lack of awareness to run

treatment plants are making the pollution situation more adverse day by day. There are variety of treatment preferences are available for the treatment of textile wastewater [14]. However most of them are expensive and therefore the industry owners are reluctant to install any of the treatment options. It is expected that, by developing a comparatively cost effective treatment method it is possible to encourage the industry owners to treat the effluent of their industries and thus help to improve the quality of water bodies in Bangladesh [15]. Presently garments industries have become the backbone of the economy of Bangladesh. To support those garments industries hundreds of full-scale textile industries have been set up in the past few years and lot more are going to be setup within short time. These textile dyeing industries are contributing in the development of Bangladesh. But at the same time, they are causing some serious water pollution. In recent times textile industries having water bodies close to their site, are polluting the water severely. Most textile industries do not have any ETP. Most industries those have ETPs run their ETP occasionally. Again, most of those ETPs are not correctly designed.
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1.3. OBJECTIVES:

The main objectives of this research work are

1. Compare the different parameters (p^H, Temperature, TDS, TSS, BOD and COD) equalization tanks of different textile ETP in Bangladesh.
2. Compare flow rate and retention time of different equalization tanks.
3. Design the storage capacity for different equalization tanks based on flow fluctuations.
4. Perform Sensitivity Analysis capacity of Equalization Tank depending on retention time.

1.4. MAIN ACTIVITIES OF EQUALIZATION TANK

- ✓ To reduce the temperature in Equalization tank
- ✓ For homogeneous mixing
- ✓ To give the optimum dosing of HCl for neutralizing
- ✓ To increase the Bacteria growth in FBBR
- ✓ To reduce the insoluble BOD and COD in the System
- ✓ To avoided the solids cloaking in the air distribution system in Equalization tank
- ✓ To increase the air volume in equalization tank in wastewater treatment
- ✓ To remove the odor in Equalization tank due to anaerobic reaction
- ✓ To increase the efficiency of Biological system
- ✓ To reduce the current and electrode consumption in EC system

1.5. SCOPE OF THE THESIS

The aim of this research project was to evaluate the equalization tank of effluent treatment processes for their ability to recover the national environmental standard for all parameters, the results to develop a novel approach to prefer the appropriate treatment plant of textile wastewater which provides high efficiency in terms of water purification at low cost and environmental impact. Textile industry is in fact in great need to reduce its negative impact on the environment and to become more ―green‖. Improved treatment of textile wastewater is one of the ways to pursue this objective. To achieve this goal, textile effluents were analyzed from the secondary data of before treatment and after treatment lab results of the respective factories and three different treatment plants financial analysis was done using different analyzing parameter to archive the cost effectiveness.

Chapter-2
LITERATURE REVIEW

2.1. BASIC PRINCIPLES OF EQUALIZATION TANK

The main principle of this thesis is to develop a control strategy for the operation of an equalization tank upstream of a wastewater treatment plant which utilizes the available equalization hold-up volume in such a manner that it reduces, optimally, diurnal fluctuations in both influent flow and load rates. The influent to a wastewater treatment plant generally exhibits wide diurnal variations in both flow rate and concentration, and consequently in load rate (defined as the product of flow rate and concentration). Deviations of these parameters from steady state cause plant operating problems in ·areas such as aeration control (due to load rate fluctuations)' settling tank overloading 1: due to flow rate fluctuations) and/ or over- or under-aeration which affects settling properties, and others. Adverse effects of both flow and load rate fluctuations can be minimized either by (1) suitable in-plant control, or (2) installing an equalization (or balancing) tank upstream of the plant.

2.2. EQUALIZATION

From a theoretical viewpoint, complete or near complete equalization of both flow and load would either eliminate the need for in-plant control or reduce the required in-plant control to the simplest level, within the competence of the plant operator. In addition to providing a solution for the control problem, equalization can reduce plant capital costs; for example, (1) aeration capacity to be provided will be determined essentially by the mean influent COD load instead of the peak load, (2) settling tank areas can be reduced to cope with the mean inflow rate, and not the peak flow rate. Two main features have detracted from equalization as a method for controlling treatment plant operation:

(1) Traditionally the objective ih operating an equalization basin was to attenuate flow rate variations. Little emphasis was placed on the deliberate attenuation of load rate variations; the degree of load attenuation that automatically accompanies flow equalization was considered * rather as a secondary bonus - equalization, as practiced

*The primary interest in flow equalization alone is understandable: Flow equalization generally was tested only on plants operated at short sludge ages (< 3 days). From kinetic considerations, the response of parameters such as oxygen utilization rate is largely attenuated in this situation; therefore the need for Zoad equalization is not as crucial as for plants operated at long sludge ages whe·re these parameters respond sensitively to influent load rate variations. That is, flow equalization sufficed in overcoming the operating problems in the past,, does not necessarily supply an effective control tool because, even where flow equalization is accomplished, the associated degree of load equalization might not be sufficient to overcome the control problems arising from load rate fluctuations.

(2) Difficulties have been encountered in the successful operation of flow equalization facilities. Operational procedures reduce to setting the tank outflow rate, each day on the basis of an estimate (by the plant operator) of the expected inflow over the ensuing 24-hour cycle. This approach can, at best, be described as only moderately successful: because the inflow is seldom constant from day to day, particularly between

2.2.1. THE MAIN ADVANTAGES OF HAVING AN EQUALIZATION TANK:

- ✓ It improves overall processes yields, working with more homogeneous flows and loads.
- ✓ Biological treatment is enhanced, because shock loadings are eliminated or can be minimized, inhibiting substances can be diluted, and pH can be stabilized.
- ✓ The effluent quality and thickening performance of secondary sedimentation tanks following biological treatment is improved through improved consistency in solids loading;
- ✓ Effluent filtration surface area requirements are reduced, filter performance is improved, and more uniform filter-backwash cycles are possible by lower hydraulic loading.
- ✓ In chemical treatment, damping of mass loading improves chemical feed control and process reliability. It minimizes neutralizing agents for reactive dosing in pH control.
- ✓ Installation control is facilitated
- ✓ It helps operation and maintenance activities scheduling.
- ✓ The life of the facilities is increased by working under constant conditions.
- ✓ It optimizes the size of the installation and avoids over-sizing of the treatment plant as it should be dimensioned, for example, at maximum flow conditions.
- ✓ The size and cost of processing units located downstream are reduced.

2.2.2. EQUALIZATION TANK OPERATION

- Keep air mixing on at all times.
- Ensure that the air flow /mixing is uniform over the entire floor of the tank. Adjust the placement of diffusers and the air- flow rate needed.
- Keep the equalization tank in wastewater treatment nearly empty before the expected peak load hours (otherwise it will over flow)
- Check and clean clogged diffusers at regular intervals.
- Manually evacuate settled much/sediments at least once in a year.

S.NO	Problems	Cause
1	Insufficient mixing/aeration	Poor maintenance of diffuser cleaning and blower maintenance
2	Excessive odor	Insufficient air supply, poor maintenance and operation
3	Insufficient capacity to handle peak flows	Constant outflow pumping, do not maintained.
4	Usable capacity reduced due to solids accumulation	Poor maintenance.

2.2.3. EQUALIZATION TANK MAINTENAMCE

1. PUMPS:
2. SUCTION PIPE:
3. DELIVERY PIPE
4. BYEPASS LINE:
5. VALVES:

- Switch between the main and standby pump (every 4 hrs. approximately).
- Check oil in the pump every day. Top up if necessary.
- Check motor to pump alignment after every dismantling operation.
- Check condition of coupling and replace damaged parts immediately.
- Check for vibration and tighten the anchor bolts and other fasteners.
- Check condition of bearing, oil seals, mechanical seal and replaced if necessary.
- Completely drain outoil and replace afresh as per manufactures recommendation.
- Always keep safety guard in its proper position.
- Follow the LOTO safety principle while performing maintenance activities.

2.2.4. CONSTRUCTION OF COARSE BUBBLE DIFFUSERS IN EQUALIZATION TANK.

- If keeps the raw effluent aerated thereby avoiding septicity and suppressing odor generation.
- If keeps said in suspension and prevents setting of said in the tank, thereby reducing frequency
- Of manual cleaning of the tank.
- If membrane diffusers are used, they will fail frequently, due to the repeated cycles expansion and contraction caused by fluctuating water levels in the equalization tank. Therefore, only coarse bubble diffusers must be used in the equalization tank in wastewater treatment.

2.3. OBJECTIVES OF EQUALIZATION

Traditionally, the primary objective of equalization basins for wastewater treatment plants has been to reduce the diurnal variation in the inflow pattern, i.e. flow equalization. For example, Ungirths (1979), in a comprehensive evaluation of equalization in wastewater treatment, defines equalization as "any facilities and procedures for minimizing variations in the flow through treatment plants". The optimal situation is regarded as that where the downstream process receives a constant flow (EPA, 1974; Foes, Meenah an and Bough, 1977). Attenuation of variations in pollutant concentration and mass loading resulting from the mixing of streams of varying concentration in the equalization basin has been regarded as a desirable by-product or, as a secondary objective. Generally, in the literature, very little importance has been attached to load equalization per se. The benefits to be derived from flow equalization have been variously set out. The U.S. EPA (1974) considers equalization of flow rate as one of the alternatives available for upgrading existing wastewater • treatment plants for one or more of three major reasons:

(1) To meet more stringent treatment requirements: equalization may help improved effluent quality to be attained through:

- permitting process optimization and improving performance of existing treatment components

- improving reliability by minimizing flow and load peaks

- reducing effects of shock loading and slugs of toxic material.

(2) To increase hydraulic and organic loading capacity: equalization may allow continued operation in treatment units that have reached capacity under peak flow conditions.

(3) To correct or compensate for performance problems resulting from improper plant design and/or operation: equalization may overcome design deficiencies and reduce operational problems through:

- being more economical than correcting the actual deficiencies
- providing for simplified operation, and thus minimizing the possibility for operational errors.

Specific benefits accruing from flow equalization in activated sludge treatment plant operation have been identified by a number of authors (La Grega and Keenan, 1974; Wallace, 1968; Spiegel, 1974; Ongerth, 1979):

(a) Improved performance of primary sedimentation basins and secondary clarifiers.

(b) Increased capacity of sedimentation and clarification units in existing plants and specification of smaller units for new plants.

(c) Improved biological process response through a partial reduction in food/micro-organism loading peaks.

(d) Simplified control of in-plant flow rate dependent operations such as chemical dosing and recycle pumping.

(e) Lower energy tariff charges by reducing peak power demands for pumping and aeration.

(f) Lower capital costs by not having to supply the Oxygenation capacity to match the peak load requirement.

(g) Reduction in shock loading effects by discharging recycled concentrated waste streams such as digester supernatant and sludge dewatering filtrate to the equalization basin.

Before evaluating the extent to which these benefits have been realized in existing equalization facilities it necessary to consider (1) the types of equalization configuration used, and (2) design methods for equalization facilities; these two features have a bearing on the discussion that follows.

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2.4. ORGANIZATION OF THE THESIS

The literature review is accessible in Chapter 2 and begins with a brief introduction to the development of wastewater treatment. A brief overview of some common ETPs currently in operation is provided to show how changes in conditions affect their performance. This includes an overview of various international water pollution and effluent treatment acts that lead to the water quality regulations that are in place today. Chapter 3 presents the methodology adopted for the study beginning with an

overview of the rationale for choosing the systems that were to be included in the study. Chapter 4 section presents the financial analysis and related cost information. Chapter 5 presents details of biological, physicochemical and electrochemical operational efficiency and comparison with national standard and recovery rate of each process. Chapter 6 presents the decision of the method and results to achieve national environmental standard and cost effectiveness and Chapter 7 presents the conclusions, thesis contributions, and further work.

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2.5. IN-PLANT CONTROL

In the application of in-plant control, problems are encountered particularly in the South African context. Effective control of nutrient removal processes (which include anaerobic, anoxic and aerobic zones) requires (i) sophisticated models for the kinetics of the activated sludge process and the settling tank behavior - it is doubtful whether an adequate model exists as yet; and (ii) sophisticated monitoring equipment - in many areas of South Africa the technical infrastructure and manpower requirements, necessary to maintain a sophisticated in-plant control system,

The selection of load, instead of concentration, as a parameter to be equalized, requires some comment. The selection is justified from the kinetic behaviour of the activated sludge process. In terms of the process model developed by Dold, Ekama and Marais (1980), at long sludge ages process response is controlled principally by the variation in load rate (i.e. concentration x flow rate), not by the variation in concentration alone.are not available. For the above two reasons it was deemed that in-plant control of nutrient removal

Processes in South Africa was simply not feasible. ·In addition, even if in-plant control under the cyclic inputs of flow an~ load was successful, the level of process performance attainable would still not be as high as that which can be· attained when a plant is operated under constant inputs. For example, the efficiency of nitrification under cyclic conditions can neve.r be as high as that observed under constant inputs as a consequence of the process kinetics. These considerations provided the motivation for enquiring into the second approach to control of wastewater treatment plants.
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weekday and weekend, the approach relies heavily on operator ingenuity and experience. That is, flow equalization has suffered from a lack of an efficient operational strategy.

With the advent of low-cost microcomputers· it was considered feasible to devise an on line control strategy that will (1) minimize diurnal deviations in both flow and load rates from their respective mean values within the volume_ constraints of the particular system on a continuous basis, and (2) overcome the difficulties inherent with operation of equalization facilities by human agency. Development of this control strategy was the principal objective of this thesis.
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2.6. REQUIREMENTS FOR CONTROL

The essence of the control problem in equalization is to determine, for a specified installation, under the daily cyclic inputs of flow and load, the appropriate tank outflow rate at any instant so that variations in both the flow and load rates are optimally minimized, yet ensuring that the equalization tank neither overflows nor empties over the daily cycle. To solve the control problem, the approach adopted in this investigation was to predict influent flow rate and concentration (and hence load rate) patterns over the ensuing 24-hour period; then compute the outflow profile (for the ensuing 24-hour cycle) that gives the least error in terms of some flow and load optimization criterion. The first portion Of the outflow rate profile specifies the optimal outflow rate for an ensuing short interval (of, say, half an hour). By repeating this procedure at regular short intervals, to account for differences between actual and predicted inputs, operation of the equalization facility is optimized continuously.* Attainment of these objectives devolved into seeking solutions to two questions:

1. If the complete influent flow _rate and concentration patterns for a 24-hour cycle are known, how is the outflow rate pattern for optimal equalization determined? The solution to this problem requires the development of an equalization algorithm.

2. If the influent flow rate and concentration patterns and the mean flow and mean load per day are. not constant from day to day, how are the influent patterns to be predicted, and how is this variability

accommodated to achieve real-time optimal equalization? The solution to this problem requires application of the equalization algorithm in an appropriate control strategy.

2.7. EQUALIZATION ALGORITHM

The solution to the first problem involves the application of an equalization algorithm by means of which, given a specified influent flow rate and concentration pattern and a specified size of equalization tank, successive incremental adjustments are made to an initial outflow pattern until the resultant pattern, when considered with the associated effluent load rate pattern, yields optimal equalization of flow and load. The optimal condition is identified by minimizing an empirical error function that expresses the integrated daily deviation of both flow and load rates from their respective mean values. The relative importance of flow as against load equalization may be varied through applying a weighting factor, a., to the errors for flow, Ef' and load, E1d, respectively, as shown in Eq (1):

* This approach is very different from the traditional one where the objective, theoretically at least, was to accept some fixed daily cyclic influent flow rate pattern and determine the tank volume required to allow the tank outflow rate to be held constant equal to the mean inflow rate. In contrast, the approach here is to accept the tank volume and then to control the outflow rate to give the minimum deviation from the mean; that is, the approach makes allowance for variability in the daily cyclic influent pattern - a feature observed in practice and which leads to problems in applying the traditional method. Therefore, even if the available volume is too small to allow complete equalization, that volume is utilized optimally.

where

Ee = total equalization error due to flow and load rate fluctuations.

An implicit part of the general optimization problem involves ensuring that, under the specified input of flow over the day, the optimal outflow pattern gives rise to a tank hold-up (or volume) profile which at no time exceeds specified upper and lower volume limits. Satisfaction of this constraint was resolved by introducing a penalty error, Elm' that increases rapidly as the tank hold-up attains values outside of the specified limits. This ensures the development of an optimal tank outflow rate profile that, under the 24-hour

inflow rate pattern, results in an associated tank hold-up profile over the day which does not exceed the specified tank hold-up limits of the selected equalization tank.

The combined effect of the equalization error and the penalty error for volumetric limits introduced a further problem: "spikiness" in the 24-hour tank outflow profile could develop when the tank was near full or empty, particularly for tank retention times of less than 3 hours (based on the mean inflow rate). This problem in the optimization procedure was resolved by incorporating a second penalty error, E , s to constrain the rate of change of the tank outflow rate. This penalty has an additional benefit; rapid changes in the outflow rate profile not adequately reflected in the equalization error are damped. Consequently, the total error, Et' used as the objective function in the optimization procedure consists of three components:

E = E + E + E t e lm s

The equalization algorithm, once established, was used to assess the effects of various relevant parameters such as configuration, size, etc. on equalization performance. For this analysis, to compare the different, equalization results on a general basis, a measure of the equalization efficiency was required. This was provided by a relative error~ Er, defined as the ratio of the equalization facility effluent equalization error (Eq 1) to the influent stream equalization error (also calculated from Eq 1, but utilizing the influent flow and load rate patterns). The analysis was carried out assuming fixed daily cyclic influent flow and load rate patterns that closely approximated those encountered at full-scale wastewater treatment plants and covered the following aspects:

l. In-line equalization was analyzed with regard to (i) equalization tank retention time; (ii) the form of the influent flow rate and mass loading patterns; and (iii) the equalization error weighting factor, a, (see Eq 1).

2. Side-line equalization (with flow division either by 11 splitting" or "topping") was analyzed with regard to (i) equalization tank retention time; and (ii) the value of the flow division factor.

The analysis provided certain useful guide-lines for the design of equalization facilities; from the results it was found that: -

The efficiency of equalization improves with increasing tank size: however, the rate of improvement decreases with increasing tank size. Optimal equalization requires a tank with a mean retention time in the region of 4 to 6 hours; little is gained in equalization efficiency for retention times greater than 6 hours.

A reduction in excess of 90 percent on flow and load rate fluctuations can be obtained with a tank retention time of 4 to 6 hours.

In the region of effective equalization, whereas the uncontrolled load rate in the influent cycle may fluctuate between one quarter and four to five times the mean (with consequential low and high oxygen demands in the downstream process), the equalized load rate remains virtually constant, with a small drop once every 24 hours. This behavior will simplify aeration rate control considerably, and bring about a substantial reduction in the aeration capacity required to match the peak load rate - a factor of particular importance for processes operated at long sludge ages.

Comparison of in-line and side-line equalization indicates that, in the region where effective equalization is achieved; neither scheme results in a reduced tank volume requirement over the other. Side-line equalization, however, has one adverse feature in practice; rapid, random variations in the influent flow and load rate patterns: will be transmitted in part to the downstream process in the stream bypassing the balancing tank. (With in-line equalization the tank acts as a buffer for these variations).

The only motivation for utilizing side-line in preference to in-line equalization is a possible saving in pumping costs in situations where gravity flow to and from the equalization tank is not possible - results of the study under fixed input patterns show that as much as 60 percent of the influent flow can bypass the equalization tank with only a marginal reduction in equalization efficiency.

2.8. CONTROL STRATEGY

In real-time operation the daily cyclic influent patterns change from day to day both in the form of the patterns and. The mean daily input values. Incorporation of the equalization algorithm in a control strategy for the real-time, continuous operation of an equalization facility involves the prediction, at any point in time, of the expected influent patterns for the ensuing 24-hour cycle. The prediction is based primarily on historical inflow and concentration data, but also incorporates differences between actual

and historical inflow rates for the period prior to the prediction. Historical data is stored in the computer memory, and is continually updated as and when information is available.

For application of the control strategy, the day is divided into a number of, say, half-hour control intervals. At the beginning of an interval, the expected influent patterns for the ensuing 24-hour cycle

are set up and utilized by the equalization algorithm to compute the optimal simulated tank outflow profile for the 24 hours ahead. The outflow value determined for the first interval in the 24-hour cycle is

then applied as the actual output for the duration of that interval. By repeating this procedure at the start of each control interval (i.e. ' every half-hour in this case) performance of the equalization tank is continuously optimized.

An important aspect of the control strategy is that the algorithm differentiates between influent patterns for weekdays and weekend days. From a comparison of data collected at several treatment plants in South Africa it was apparent that the influent patterns for weekdays and weekend days differ sharply in (1) the forms of the flow and load rate patterns, and more important, (2) a reduction (of approximately 30 percent) in the mean daily influent flow and load rates from week to weekend. By distinguishing between the two types of pattern, the strategy optimally reduces the effect of the transition from week to weekend, and vice versa.
(Ref: file:///C:/Users/88019/Desktop/Thesis%20Issue/Thesis/thesis_ebe_1982_dold_pl.pdf)

2.9. DESIGN METHODS FOR EQUALIZATION

In an EPA publication (1974) the design of an equalization basin is stated to require the selection and/or evaluation of the following factors:

(i) In-line versus side- line basins

(ii) Basin Volume

(iii) Types of Construction-earthen, concrete or steel

(iv) Mixing equipment

(v) Pumping and control method

(vi) Location of equalization basin within treatment system. In the literature consideration has generally been limited to the determination of volume requirements; the other factors listed above have been largely disregarded.

With regard to computing equalization volume requirements, traditionally there have been two approaches: (1) for constant volume equalization and (2) for variable volume equalization.

(Ref:file:///C:/Users/88019/AppData/Local/Temp/Temp3_Flow_Equalization_and_Neutralization.zip/thesis_ebe_1982_dold_pl.pdf)

2.10. EVALUATION OF FLOW EQUALIZATION EXPERIENCE

If the premise is accepted that flow equalization should lead to both improved process performance and simplified operation as indicated by theoretical considerations, then there is most likely one (or more) of three possible reasons why contrary opinions have been voiced; either

(1) The process parameters used to evaluate performance under equalized and unequalized flow periods were not appropriately selected; and/or

(2) The tests were conducted on plants where the biological process operating parameters (i.e. sludge age, etc) tended to mask the expected beneficial effects of flow equalization; .or

(3) Difficulties were encountered in operation of the equalization facility, resulting, in fact, in a poor degree of flow equalization.

The control strategy was tested by simulation of the controlled equalization tank response under a wide range of influent conditions using both (1) ·influent data measured on full-scale treatment plants and (2) unusual inputs (e.g. simulated storm patterns) so as to stress the strategy to the extreme. By comparing response under real-time inputs with invariant inputs it was also possible to check whether the conclusions regarding equalization performance obtained under fixed diurnal input patterns also hold true under real-time inputs. In all cases the conclusions (with regard to tank size, configuration, etc) obtained under fixed diurnal input patterns were found to hold under real-time inputs.

(Ref:file:///C:/Users/88019/AppData/Local/Temp/Temp3_Flow_Equalization_and_Neutralization.zip/thesis_ebe_1982_dold_pl.pdf)

2.11. METHODS FOR IMPLEMENTING EQUALIZATION

Any equalization method necessarily must involve the principle of retaining flow (and load) during peak periods, and distributing the stored flow (and load) at times during the cycle when the actual inputs drop below the mean daily values; in this manner, the flow and load rates passing to the biological process are maintained as close as possible to the respective mean values. One means of achieving this has been to utilize the hold-up capacity of the sewer system, and then regulating the pumping rate to the plant appropriately. This approach has three principal drawbacks:

Implementation most likely will involve extensive modifications to the sewer system; for example, underground sumps and pumping installations probably will be required at a number of points in the sewer network.

There are difficulties in providing a generalized' system for widespread application because many of the problems will be specific to particular situations.

The effective working life of such a system could be affected dramatically by, say, housing or factory development along the sewer network.

The most logical method for implementing an equalization scheme appears to be the installation of a holding tank (generally referred to as a balancing, or equalization tank or basin) at the treatment plant, up stream of tJ.1e biological process. Allowing the cyclic input of flow and load to enter the tank, it should IJe possible to attenuate fluctuations in both flow and load to a considerable degree by regulating the flow from the holding tank, thereby reducing the requirements for control within the plant needed to achieve satisfactory operation.

A number of full-scale treatment plants have incorporated equalization tanks in the inflow circuit (EPA, 1974; Ongerth, 1979). Generally the objective in including these tanks in plant design has been to reduce the daily cyclic fluctuations in the influent fZOlJ rate to reduce problems stemming from variations in the hydraulic flow through the plant. With flow equalization the hold-up provided in the equalization tank necessarily induces some attenuation of the influent load variations. However, the load equalization aspect has been viewed as a secondary objective only, in the nature of a benefit consequential to flow equalization rather than as an end in itself. Nevertheless, flow equalization with its associated degree of load equalization should have substantial benefits in terms of ·plant

performance and operation. Examples of specific benefits which should accrue from flow equalization, and which have been quoted in the literature, are:

Improved performance of secondary settling tanks due to more constant solids loading.

Improved biological process performance through a partial reduction in food/micro-organism loading peaks.

Simplified control of in-plant flow rate dependent operations such as chemical dosing and recycle pumping.

Simplified control of aeration rate due to attenuation of influent load rate variations.

It would appear from the above list that flow equalization can only have positive consequences. However, studies on the effect of flow equalization on plant operation and performance have led to conflicting conclusions. Some studies report both improved performance and simplified operation; others, analyzing the performance of plants operated under equalized and unequalized flow conditions, have concluded that there is little, or no benefit to be derived from the inclusion of an equalization tank in the system - a conclusion which contrasts sharply with that indicated from the theoretical analysis of plant performance under constant and cyclic flow conditions. In order to evaluate and/or explain these conflicting opinions on the merits of flow equalization, it is necessary to enquire critically into the basis on which the conclusions were formulated. This will be dealt with in detail in Chapter 2; however, brief consideration is merited here as it gives relevance to the discussion on equalization.
(Ref: file:///C:/Users/88019/Desktop/Thesis%20Issue/Thesis/thesis_ebe_1982_dold_pl.pdf)

Chapter-3

METHODOLOGY

3.1. METHODOLOGY

By successive visits to ten different textile composite and dyeing factories in Bangladesh, the necessary data related to the economic, technological and environmental aspects of the project were collected for this study. A detail overview of the existing information and literature on ETP equalization tank operation, management and governance issues was conducted to identify information and knowledge gaps. This secondary information review helped identify focus areas for data collection.

3.2. OUTLINE OF METHODOLOGY

The following step by step methodology has been applied to this research project:

- Study on various equalization tank which are functioning in various textile industries.
- Similar type of research works has been studied to know how similar cases were solved, in different demographic patterns, and also to identify the limitations and scopes for improvements.
- Ten factories were randomly selected for data collection. and data has been collected from those factories.
- Consecutive visits our selected factories and data has been collected from those factories.
- Analyzing the data and made comparison with design capacity based on retention time.
- Comparison the relation between design capacity and retention time.

3.3. SELECTION OF FACTORIES

As of 2011 Bangladesh was second largest ready-made garments (RMG) manufacturer after China, by the next five years Bangladesh will become the largest ready-made garments manufacturer.[31] Bangladesh was the sixth largest exporter of apparel in the world after China, the EU, Hong Kong, Turkey and India in 2006.[In 2006 Bangladesh's share in the world apparel exports was 2.8%. The US was the largest single market with US$3.23 billion in exports, a 30% share in 2007. Today, the US remains the largest market for Bangladesh's woven garments taking US$2.42 billion, a 47% share of Bangladesh's total woven exports. The European Union remains the largest regional destination - Bangladesh exported US$5.36 billion in apparel; 50% of their total apparel exports. The EU took a 61% share of Bangladeshi knitwear with US$3.36 billion exports. In Bangladesh, many textile industries have set up ETPs. These ETPs have been designed by international design firms without considering the local facts. These are simply designed on the basis of some generalized data and involve use of technologies and chemicals which are cost prohibitive. But choosing appropriate and cost effective treatment option is one of the major steps toward reducing pollution from textile industries. Based on above discussion we have selected top categories ten different factories exist in Bangladesh.

3.4. FACTORY VISIT

As a part of our thesis work we have visited the selected some factories, these factories are in the following:

Factory 1. Thermax Group Limited

Factory 2. Hoorain HTF Ltd - Jamuna Group

Factory 3. ACS Textile Limited

Factory 4. SF Washing Limited

Factory 5. Aboni Knitwear Limited

Factory 6. Jannath Washing Limited

Factory 7. Executive Hi Fashion Limited

Factory 8. Garments Export Village Limited

Factory 9. Beximco Limited

Factory 10. Safa Sweater Limited

These Selected factories were visited by the scrutinizers, with a structured questionnaire. The complete questionnaire was designed and standardized for collecting the information. Email, phone calls and personal visits were conducted to get their wastewater before treated and after treated laboratories 'result and data sheets completed. One to group meetings was held to for necessary information. Manager (accounts & finance), maintenance manager, general manager operations, manager research and development, supervisor of ETP; the officials of the company were interviewed to collect the preliminary and general information about effluent treatment plant. The costs of different chemicals, lubricants etc. were acquired from the maintenance manager of ETP.

The study was conducted secondary sources of information included RMG and textile project reports from ten different textile factories. Those were studied to identify textile effluent management and treatment issues, pollution load, financial implications, operations and management challenges in ETP operations.

3.5. DATA COLLECTION

Particularly for this study mainly Temperature, pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Suspended Solid (TSS) & Total Dissolved Oxygen (TDS) was considered. But color consideration was also incorporated also. For these seven (Temperature,

pH, DO, COD, BOD, TDS, TSS and Color) parameters the appropriate method of treatment and the optimum condition has been studied to achieve maximum possible reduction. The Winkler test was used to determine the concentration of dissolved oxygen in wastewater samples. Then BOD of a sample was obtained from the determination of dissolved oxygen (DO).From two bottles of completely filled wastewater sample, DO of one sample was measured immediately. Another bottle was kept in dark at 20°C for five days before determining dissolved oxygen. BOD_5 was the difference between DO of these two bottles. COD of the sample was measured by 'Closed Reflux-Colorimetric method' (SM 5220 D) using COD digestion vial (digested for 2 hours and cooled down), COD digester /reactor & DR-2010 Spectrophotometer. The concentration of suspended solids in the aeration tank, commonly referred to as the Mixed Liquor Suspended Solids concentration (MLSS), is a crude measure of the biomass within the aeration tank. It was measured in the same way as suspended solids in wastewater by altering a known volume of the mixed liquor sample through filter paper and weighing it after drying in an oven at 105°C. The MLSS is a basic parameter used in the calculation of a number of other operating parameters in mg/l. Some of the MLSS may be inorganic, and under certain circumstances, this may represent a significant proportion of the solids present. To remedy this, many operators estimate the organic fraction of the sludge by measuring the combustible matter present in the MLSS by burning the dried sludge in a muffle furnace at 500°C. If a Gooch crucible is used, after filtering operation remove crucible and filter combination. Dry in an oven at 103 to 105°C for 1hour. If volatile solids are to be measured, ignite at 550°C for 15 min in a muffle furnace. Cool in desiccators to balance to balance temperature and weigh. Repeat cycle of drying or igniting, cooling, desiccating and weighing until a constant weight was obtained or until weight change was less than 4% of the previous weighing or 0.5 mg, whichever was less. This is also expressed in mg/l and is termed the Mixed Liquor Volatile Suspended Solids (MLVSS). But in biological treatment process it is generally assumed that all the solids remain in the mixed liquor is organic and the portion of inorganic solids is negligible;

As first approach to the treatment of the wastewater of the Textile mill, laboratory arrangement was made for aeration of the wastewater. The raw wastewater was aerated for different time period to obtain the required detention time by which the effluent of the industry can be treated up to the standard set by DoE. In case of color removal the efficiency of the biological treatment is not so high. On the other hand presence of toxic metal inhibits the growth of the bacteria in the aeration basin, which can be removed effectively by chemical treatment. The chemical treatment approach includes the selection of type of coagulant, optimum coagulant dose and the need of using any coagulant aid. As third approach biological treatment prior to chemical treatment was performed to investigate the maximum color removal possible.

As fourth treatment option Chemical Treatment Process Prior to Biological Treatment Process was considered to reduce COD, BOD and color of the effluent. The effects of toxic metal (if any) for this particular wastewater and effects of pre-treatment of the effluent by chemical process on biological treatment is observed by this setup.

3.6. ANALYSIS AND COMPARISON:

After completion of data collection we have analyzed properly using different methods and compared the above mentioned parameters in line of the mentioned objectives among the factories.

Chapter-4

OPERATIONAL EFFICIENCY ANALYSIS

4.1. OPERATIONAL EFFICIENCY ANALYSIS

Equalization of wastewater tanks is a vital part of waste management systems and for the minimization and control of inconsistencies in wastewater. Both primary types of equalization tanks; equalization of contaminants and equalization of flow are engineered to deliver a constant rate of flow and contaminants to water treatment systems. In general, larger equalization tanks provide greater absorption and more effectively reduce the impact of batch dumps and unwanted discharges.

Figure: Equalization tank View

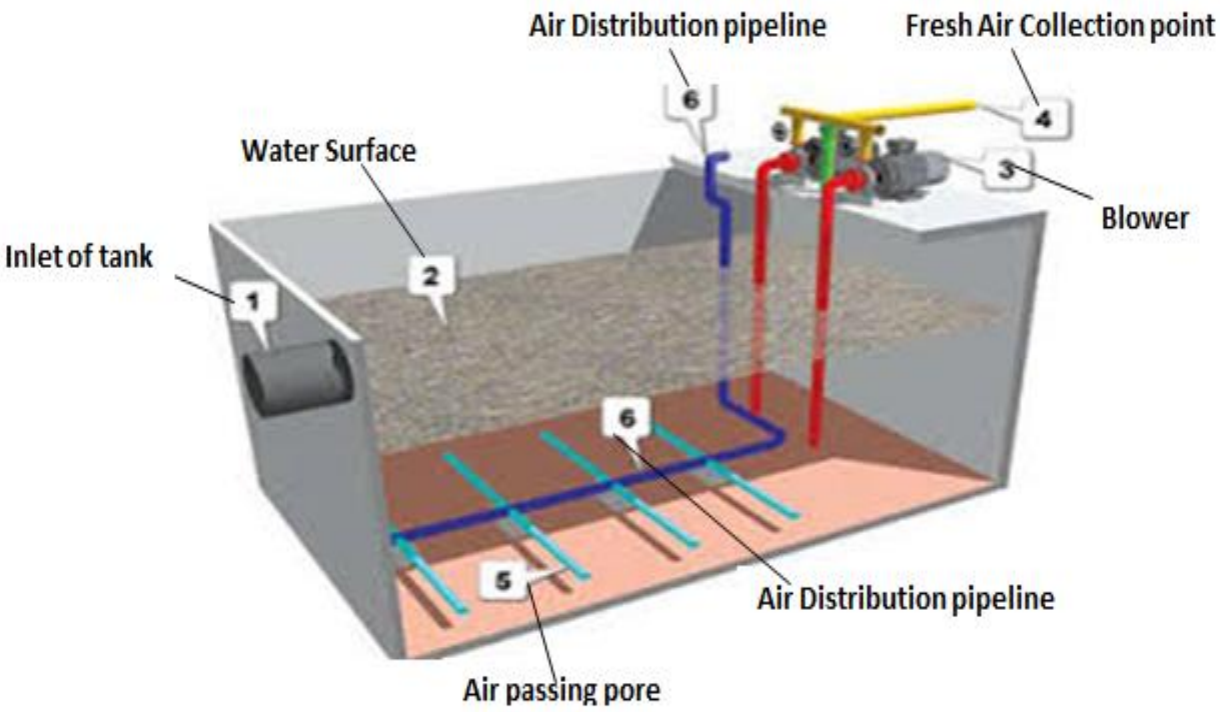

Figure: Equalization tank with different parts

The equalization tank(s) must be large enough to absorb and dampen the pick flow or possible spills during the process. The engineering issue is deciding how large an equalization basin is required to allow the treatment processes to operate with a steady, average flow.

The first method relies on computing the equalization volume, based on the excess daily average flow storage. The required volume is also graphically determined by constructing a hydrograph (Rippl Diagram). The function of the basin is to store exceeding daily flow and divert it during times, when the inflow is less that the average daily flow.

The second method computes the volume based on mass loading variations.

The aeration in the equalization vessel can reduce the BOD from 10 up to 20 %. To simplify the analysis, it is assumed that it is thoroughly mixed with no chemical or biological reaction.

For small treatment plants, where daily flow pattern is not known, a very simple approach is possible. The minimum equalization volume is equal from 20% up to 40% of the daily volume.
The smaller the plant, the higher percentage is normally recommended.

An equalization chamber is always provided by electric pumps; two pumps are normally installed as back-up solution and for maintenance. Pumps usually work with constant flow controlled by a normal on/off timer or with a variable flow (inverter motor) controlled by a flow meter, fairly expensive solution. The system must have a logical control to decide which pumps are on and to add back the surplus wastewater at rates that keep the rest of the plant operating at nearly constant conditions

Placement of an equalization tank following primary treatment minimizes operation and maintenance, and minimizes requirements for solids removal, aeration, and odour control equipment.

Pretreatments are able to manage variable pollutant rates and they also protect pumps and mechanical parts from sand and solids.

Mixers are often installed in equalization basins to achieve homogeneity and to aerate wastewater preventing septic condition. In small plants solution, aerators and mixers can be the same system (Venturi system).

(Ref:https://www.azuwater.com/category/industrial-wastewater-treatment/equalization-homogenization/)

4.2. MIXING AND AERATION REQUIREMENTS

Mixers are often employed in equalization basins to achieve homogeneity in and to aerate the wastewater. Various types of mixers are available. The classification of mixers depends on the flow pattern the mixers produce. The commonly used mixers have either axial or radial patterns, with axial mixers most prevalently used in industries (8). Axial mixers can further be subdivided into other categories, the most common of which are propeller mixers and turbine mixers. Propeller mixers are used primarily when rapid mixing is needed. The axial propeller mixer can be either fixed or portable, depending on the mixer size and application. The size of top-entering propeller mixers range from 0.37 to 2.24 kW, although many industrial designs limit the size to 0.75 kW and a maximum shaft length of 1.83 m (8). Propeller mixers are usually mounted angularly off center. The advantage with this type of arrangement is that complete top to bottom mixing can be achieved. Typically the maximum water volume that is recommended for a propeller mixer is 3.785 m3 (1000 gal). As shown in Fig. 3, the mixer shaft should enter at 15º from vertical and at a point off the centerline. The speed ranges for both portable and fixed mounted propeller mixers are 1750 rpm and 350–420 rpm, respectively. The high speed provides a high degree of shear with low draft velocity, causing instant mixing. Low speeds provide less shear force and may allow selective setting of larger and heavier particles.

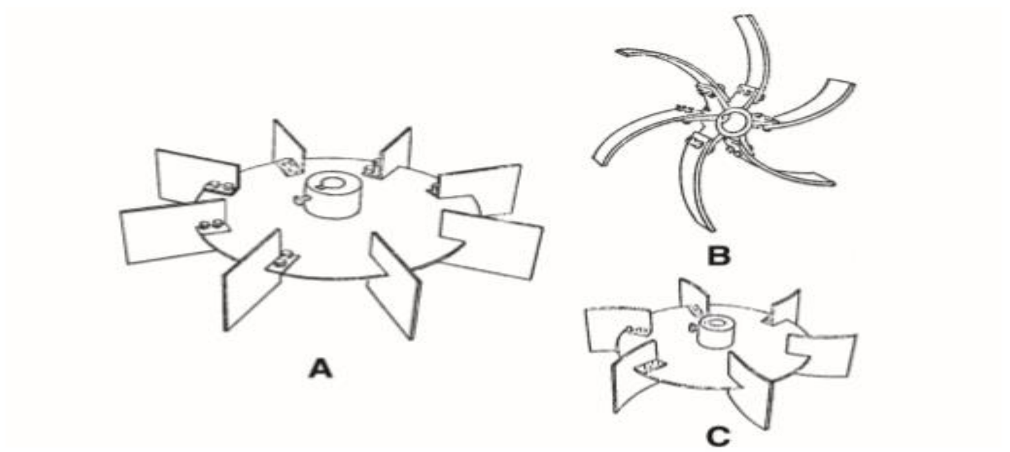

Fig. 4. Typical Radial Turbine Impeller: (a) flat blade; (b) spiral backswept; (c) curved Blade (9).

Figure: Typical Radial Impeller

Other classes of axial mixers include turbine mixers. They can induce both axial as well as radial flow. Axial turbine impellers are pitched blade or fan turbines, whereas radial turbine impellers are flat blade, curved blade, or with a spiral backswept blade (shown in Fig. 4). The curved and spiral backswept impellers are used in high viscous applications such as sodium hydroxide or soda ash neutralization. Axial turbines are used for large scale mixing involving liquid solid suspensions. Turbines mixers are usually fixed mounted, vertically in fully baffled tanks. Turbine impeller diameters are generally one third of the tank diameter

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Chapter- 5

RESULTS & DISCUSSIONS

5.1. RESULTS

The results obtained from the analysis of biological, physicochemical and electrochemical wastewater treatment plants of textile dyeing industry and detailed discussion on this study have been presented here in the following categories

Operational efficiency of after treatment results of the ten different treatment plants of ten factories according to the recovery percentage compared with the national standard.

After completing the overall assessment for all the ten different -biological, physicochemical and electrochemical treatment plant. From the overall performance of the biological treatment plant is the most preferred among the physicochemical and electrochemical treatment plant. On the other hand, the role of the equalization tank is mostly involved to governing the performance of ETP to economic.

5.2. RESULT OF OPERATIONAL EFFICIENCY

The result of operational efficiency of BOD5, COD, TSS, TDS, DO, pH, TEMP is presented in table 5.1-5.11 of ten different treatment plants of ten different factories according to the recovery percentage compared with the national standard.

Table 5.1. Standard Permissible Limit for waste water are given following.

SL No.	Parameters	Test Results	Bangladesh Standard Limit according to ECR 1997, Schedule-10			Result meet BD standard ECR 97 (Yes/ No)
			Inland Surface Water	Public Sewerage system	Irrigated Land	
1	pH	8.69	6 – 9	6 – 9	6 – 9	Yes
2	Dissolved Oxygen (DO)	7.7 mg/L	4.5-8 mg/L	4.5-8 mg/L	4.5-8 mg/L	Yes
3	Biochemical Oxygen Demand (BOD_5)	42 mg/L	50 mg/L	250 mg/L	100 mg/L	Yes
4	Chemical Oxygen Demand (COD)	118 mg/L	200 mg/L	400mg/L	400 mg/L	Yes
5	Total Dissolved Solid (TDS)	2017 mg/L	2100 mg/L	2100 mg/L	2100 mg/L	Yes
6	Total Suspended Solid (TSS)					

Table 5.2: Values of Different Parameters before Equalization Tank are given in below

Name of Factory	Values of Different Parameters Before Equalization Tank						
	Tem (^{0}C)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	TSS (mg/l)
Hooroain HTF Ltd.	37	9.6	0.2	354	1200	1344	2022
ACS Textiles ltd.	39	9.0	0.0	545	1320	1088	1456
Thermax Group	41	10.1	0.3	512	1280	1221	1334
SF Washing Ltd.	40	10.8	0.3	478	1056	1109	1435
Aboni Knitwear Ltd.	40	11.2	0.3	669	1498	989	1200
Jannath Washing Ltd.	38	11.1	0.0	709	2002	1099	1231
Executive Hi Fashions Ltd.	39	10.8	0.2	459	1378	998	1109
Garments Export Village ltd	41	10.4	0.0	564	1567	1235	1456
Beximco Ltd.	42	11.4	0.1	603	1788	1126	1367
Safa Sweater Ltd.	40	9.9	0.1	778	1980	1423	1564

Table 5.3: Values of Different Parameters after Equalization Tank are given in below

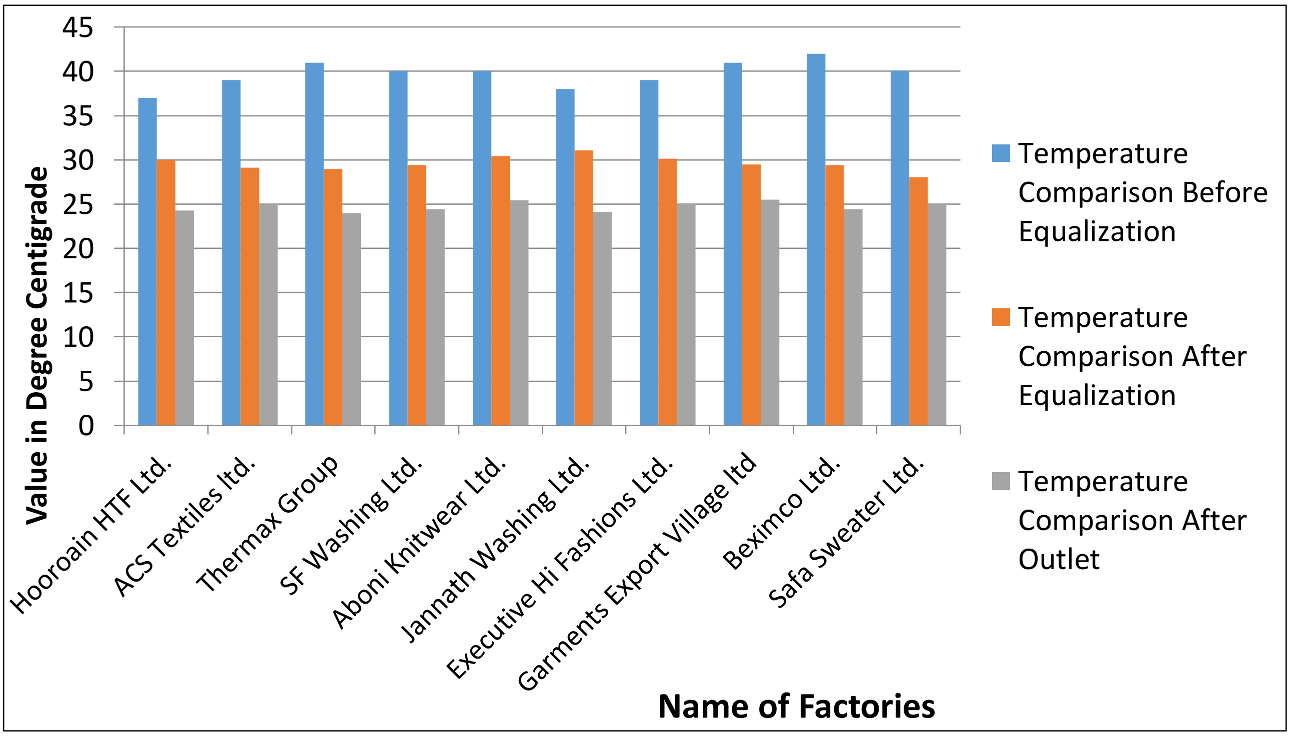
Name Of Factory	Values of Different Parameters After Equalization Tank						
	Tem (^{0}C)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	TSS (mg/l)
Hooroain HTF Ltd.	30.0	8.9	1.9	324	1040	1014	1933
ACS Textiles ltd.	29.1	8.3	1.9	515	1250	928	1234
Thermax Group	29.0	9.1	1.8	462	1150	1021	1034
SF Washing Ltd.	29.4	9.9	1.9	408	976	909	1211
Aboni Knitwear Ltd.	30.4	10.6	1.9	589	1248	879	998
Jannath Washing Ltd.	31.1	10.7	2.0	629	1802	929	1011
Executive Hi Fashions Ltd.	30.1	9.9	1.2	389	1248	878	998
Garments Export Village ltd	29.5	9.8	1.4	504	1147	1031	1256
Beximco Ltd.	29.4	10.9	1.1	543	1688	1006	1178
Safa Sweater Ltd.	28.0	8.9	1.8	718	1750	1216	1212

Table 5.4: Values of Different Parameters after final treatment (Outlet) are given in below

Name Of Factory	Values of Different Parameters After final treatment (Outlet)						
	Tem (^{0}C)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	TSS (mg/l)
Hooroain HTF Ltd.	24.3	7.21	4.90	46	175	456	133
ACS Textiles ltd.	25.0	7.19	5.20	39	184	563	104
Thermax Group	24.0	6.98	5.01	51	165	321	114
SF Washing Ltd.	24.4	7.17	5.48	48	185	409	211
Aboni Knitwear Ltd.	25.4	7.56	6.0	29	164	379	98
Jannath Washing Ltd.	24.1	6.89	4.98	46	199	429	111
Executive Hi Fashions Ltd.	25.1	7.09	5.40	31	134	278	99
Garments Export Village ltd	25.5	7.90	5.0	38	147	331	120
Beximco Ltd.	24.4	7.23	5.10	37	153	206	117
Safa Sweater Ltd.	25.0	6.90	5.21	44	163	316	122

Table 5.5: Temperature level Comparison of ten factories are given in below

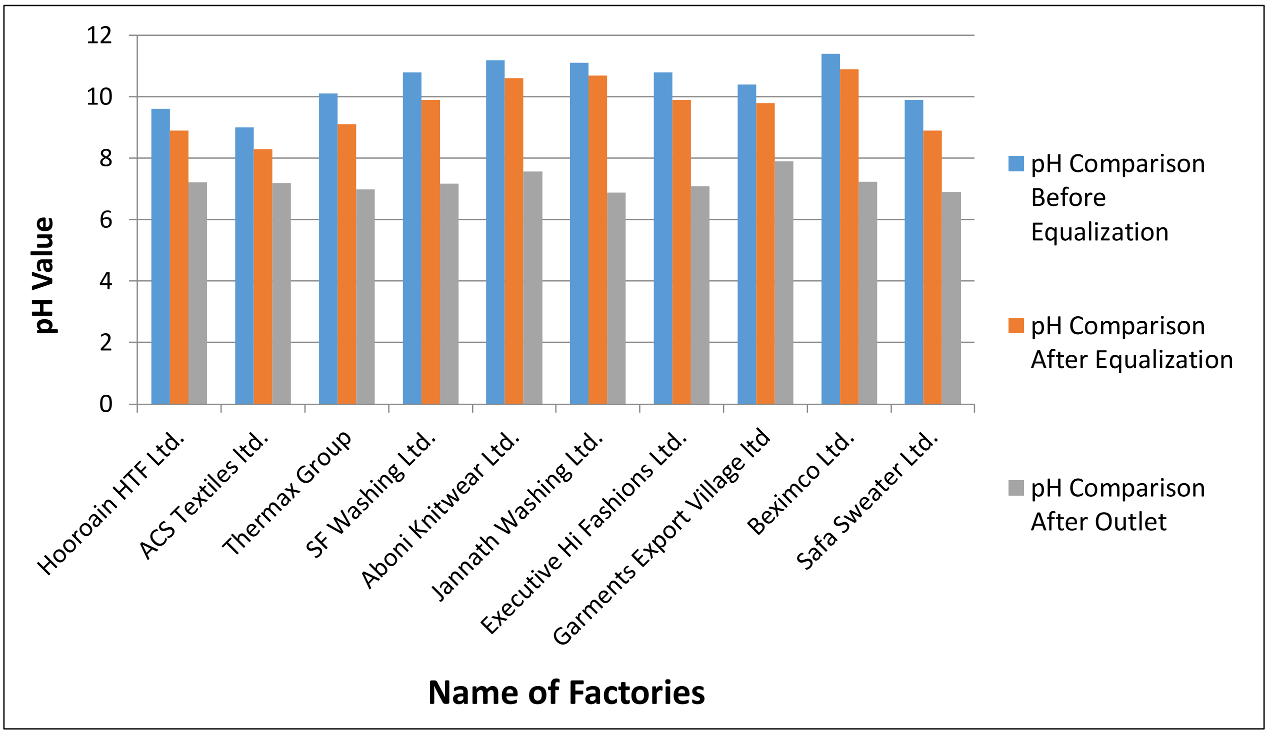
Name Of Factory	Temperature Comparison		
	Before Equalization (^0C)	After Equalization (^0C)	After Outlet (^0C)
Hooroain HTF Ltd.	37	30.0	24.3
ACS Textiles ltd.	39	29.1	25.0
Thermax Group	41	29.0	24.0
SF Washing Ltd.	40	29.4	24.4
Aboni Knitwear Ltd.	40	30.4	25.4
Jannath Washing Ltd.	38	31.1	24.1
Executive Hi Fashions Ltd.	39	30.1	25.1
Garments Export Village ltd	41	29.5	25.5
Beximco Ltd.	42	29.4	24.4
Safa Sweater Ltd.	40	28.0	25.0



Graph 5.1. Temperature level Comparison of ten factories

Table 5.6: pH level Comparison of ten factories is presented in the below table

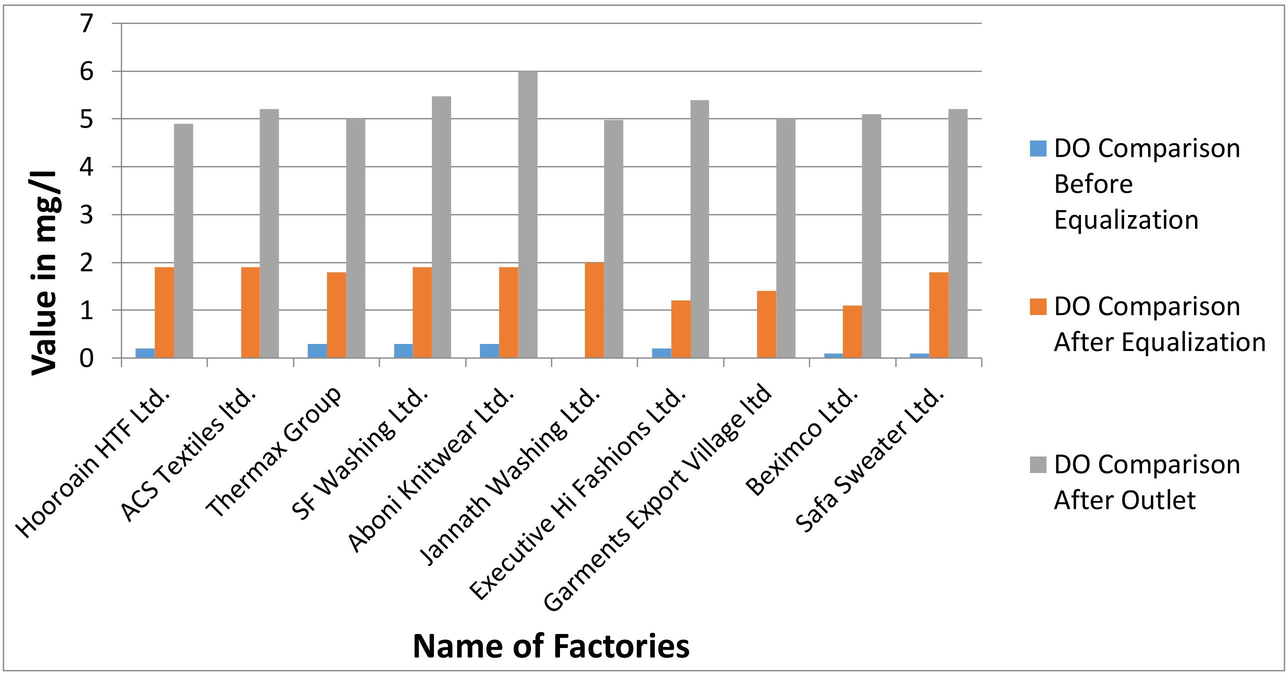
Name Of Factory	pH Comparison		
	Before Equalization	After Equalization	After Outlet
Hooroain HTF Ltd.	9.6	8.9	7.21
ACS Textiles ltd.	9.0	8.3	7.19
Thermax Group	10.1	9.1	6.98
SF Washing Ltd.	10.8	9.9	7.17
Aboni Knitwear Ltd.	11.2	10.6	7.56
Jannath Washing Ltd.	11.1	10.7	6.89
Executive Hi Fashions Ltd.	10.8	9.9	7.09
Garments Export Village ltd	10.4	9.8	7.90
Beximco Ltd.	11.4	10.9	7.23
Safa Sweater Ltd.	9.9	8.9	6.90



Graph 5.2. pH level Comparison of ten factories

Table 5.7: DO level Comparison of ten factories is presented in the below table

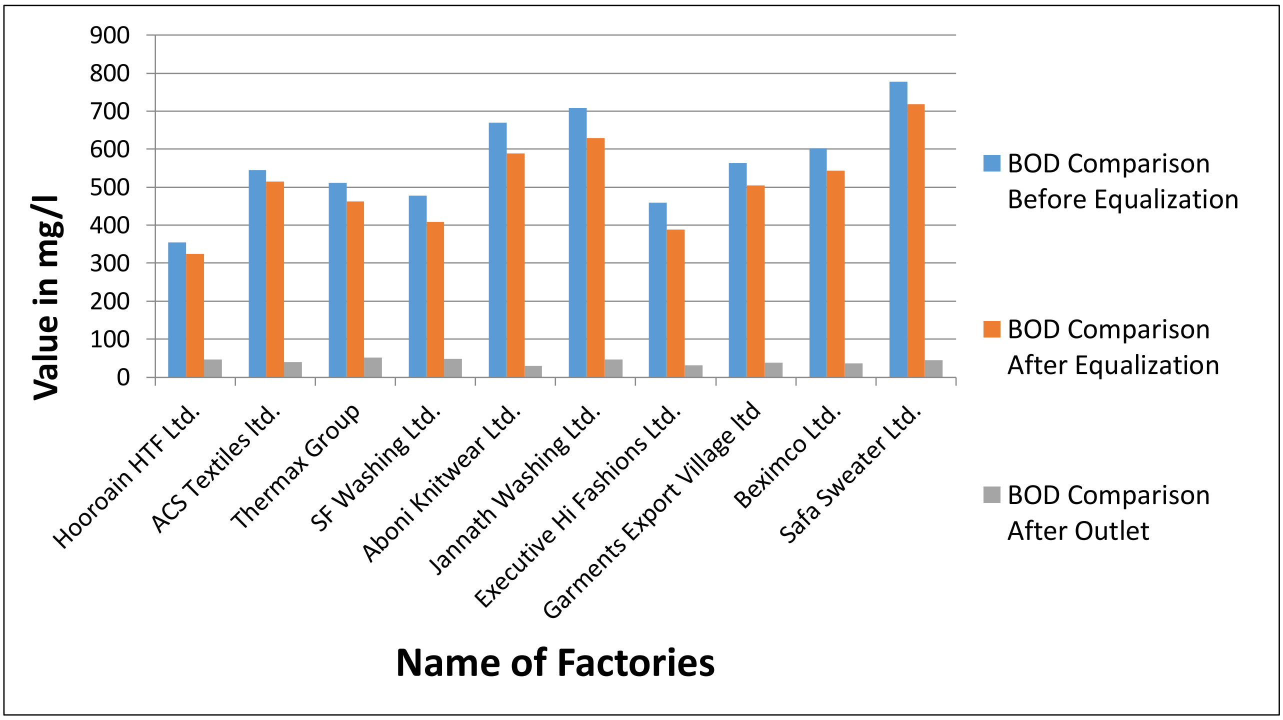
Name Of Factory	DO Comparison		
	Before Equalization (mg/l)	After Equalization (mg/l)	After Outlet (mg/l)
Hooroain HTF Ltd.	0.2	1.9	4.90
ACS Textiles ltd.	0.0	1.9	5.20
Thermax Group	0.3	1.8	5.01
SF Washing Ltd.	0.3	1.9	5.48
Aboni Knitwear Ltd.	0.3	1.9	6.0
Jannath Washing Ltd.	0.0	2.0	4.98
Executive Hi Fashions Ltd.	0.2	1.2	5.40
Garments Export Village ltd	0.0	1.4	5.0
Beximco Ltd.	0.1	1.1	5.10
Safa Sweater Ltd.	0.1	1.8	5.21



Graph 5.3. DO level Comparison of ten factories

Table 5.8: BOD level Comparison of ten factories is presented in the below table

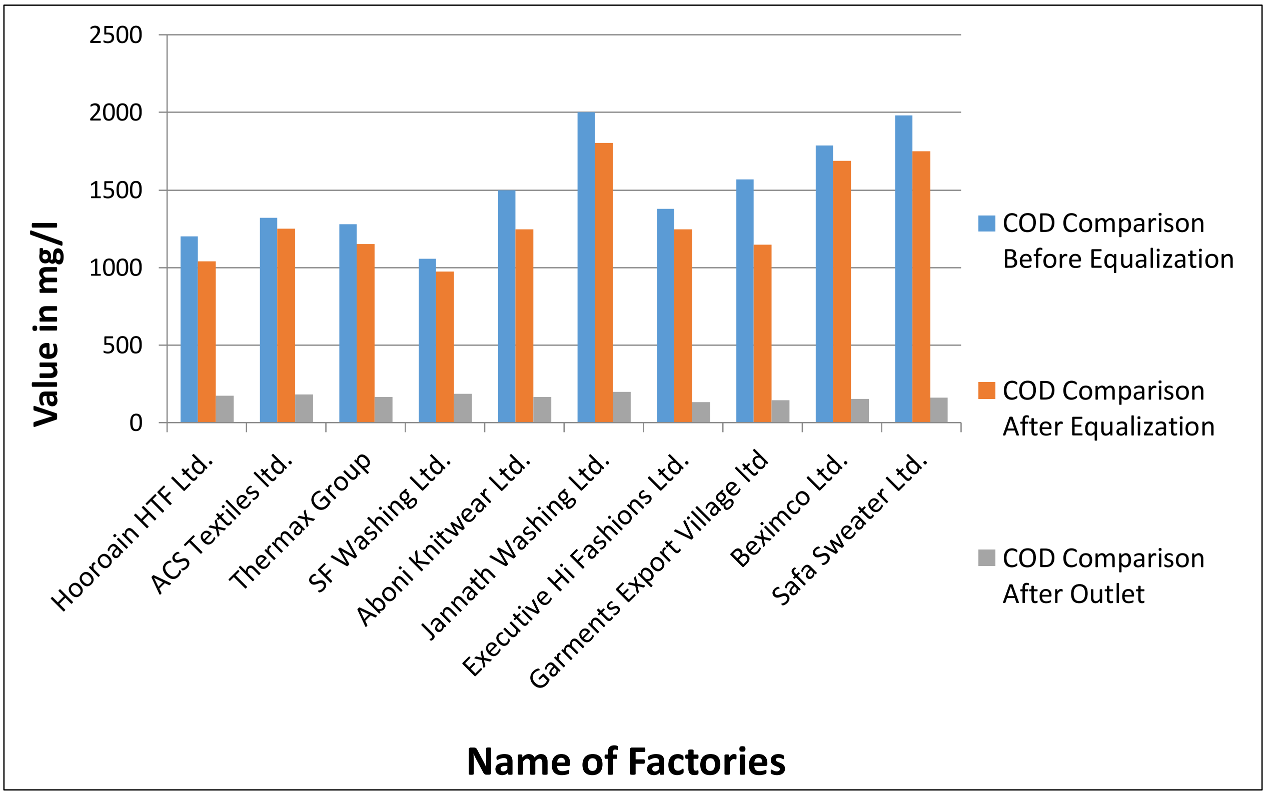
Name Of Factory	BOD Comparison		
	Before Equalization (mg/l)	After Equalization (mg/l)	After Outlet (mg/l)
Hooroain HTF Ltd.	354	324	46
ACS Textiles ltd.	545	515	39
Thermax Group	512	462	51
SF Washing Ltd.	478	408	48
Aboni Knitwear Ltd.	669	589	29
Jannath Washing Ltd.	709	629	46
Executive Hi Fashions Ltd.	459	389	31
Garments Export Village ltd	564	504	38
Beximco Ltd.	603	543	37
Safa Sweater Ltd.	778	718	44



Graph 5.4. BOD level Comparison of ten factories

Table 5.9: COD level Comparison of ten factories is presented in the below table

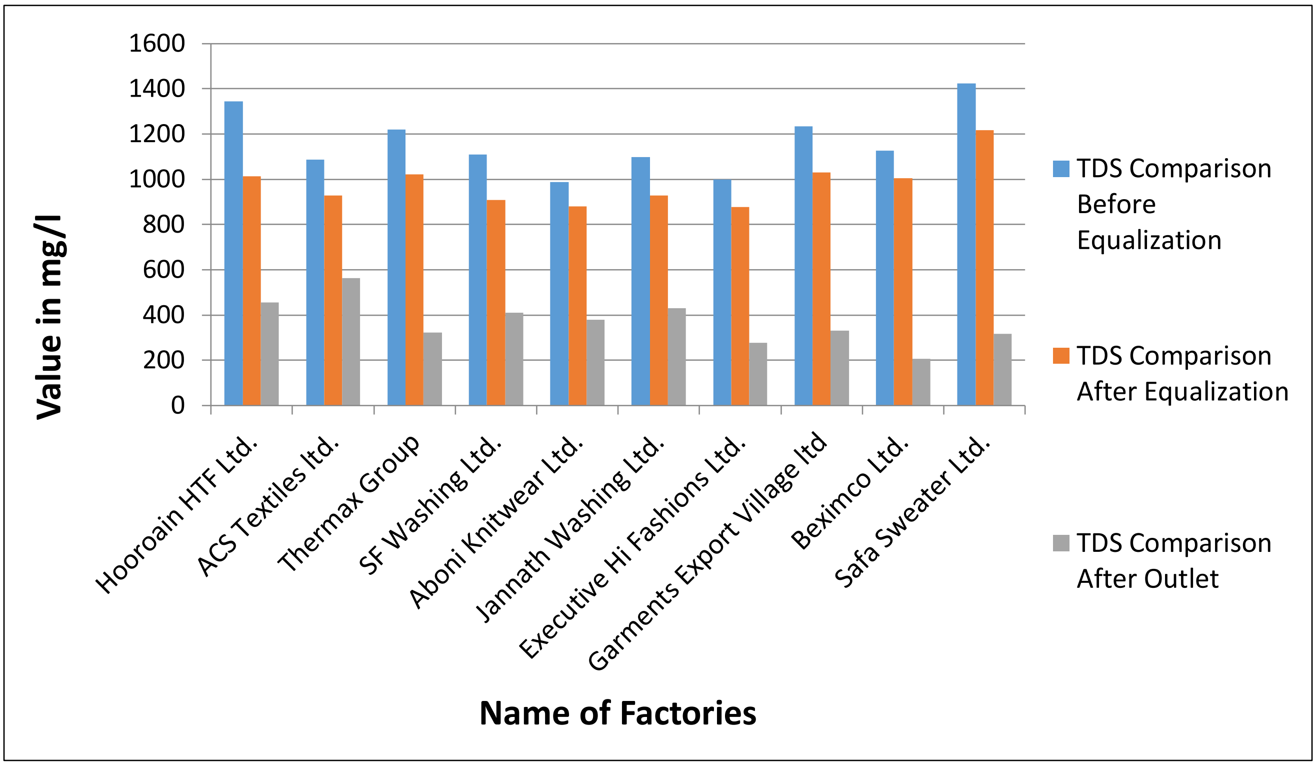
Name Of Factory	COD Comparison		
	Before Equalization (mg/l)	After Equalization (mg/l)	After Outlet (mg/l)
Hooroain HTF Ltd.	1200	1040	175
ACS Textiles ltd.	1320	1250	184
Thermax Group	1280	1150	165
SF Washing Ltd.	1056	976	185
Aboni Knitwear Ltd.	1498	1248	164
Jannath Washing Ltd.	2002	1802	199
Executive Hi Fashions Ltd.	1378	1248	134
Garments Export Village ltd	1567	1147	147
Beximco Ltd.	1788	1688	153
Safa Sweater Ltd.	1980	1750	163



Graph 5.5. COD level Comparison of ten factories

Table 5.10: TDS level Comparison of ten factories is presented in the below table

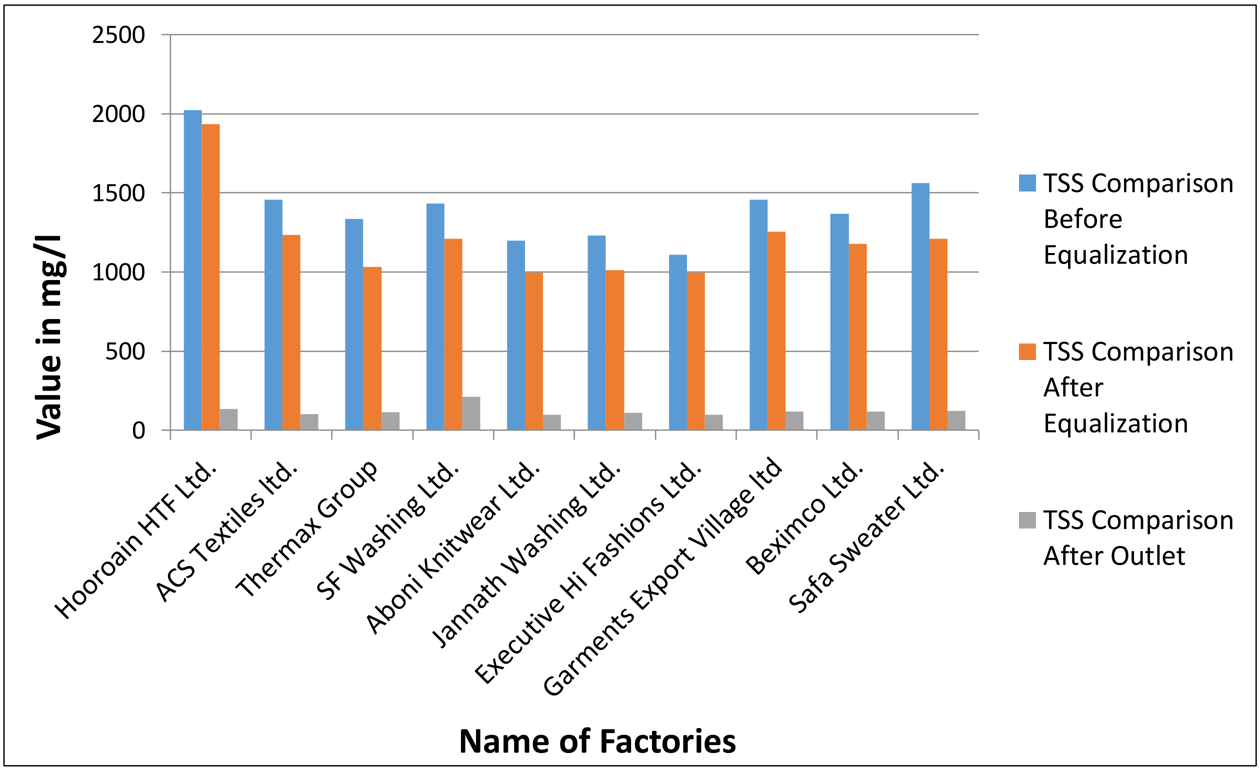
Name Of Factory	TDS Comparison		
	Before Equalization (mg/l)	After Equalization (mg/l)	After Outlet (mg/l)
Hooroain HTF Ltd.	1344	1014	456
ACS Textiles ltd.	1088	928	563
Thermax Group	1221	1021	321
SF Washing Ltd.	1109	909	409
Aboni Knitwear Ltd.	989	879	379
Jannath Washing Ltd.	1099	929	429
Executive Hi Fashions Ltd.	998	878	278
Garments Export Village ltd	1235	1031	331
Beximco Ltd.	1126	1006	206
Safa Sweater Ltd.	1423	1216	316



Graph 5.6. TDS level Comparison of ten factories

Table 5.11: TSS level Comparison of ten factories is presented in the below table

Name Of Factory	TSS Comparison		
	Before Equalization (mg/l)	After Equalization (mg/l)	After Outlet (mg/l)
Hooroain HTF Ltd.	2022	1933	133
ACS Textiles ltd.	1456	1234	104
Thermax Group	1334	1034	114
SF Washing Ltd.	1435	1211	211
Aboni Knitwear Ltd.	1200	998	98
Jannath Washing Ltd.	1231	1011	111
Executive Hi Fashions Ltd.	1109	998	99
Garments Export Village ltd	1456	1256	120
Beximco Ltd.	1367	1178	117
Safa Sweater Ltd.	1564	1212	122



Graph 5.7. TSS level Comparison of ten factories

5.3. CAPACITY DESIGN FROM FLOW FLUCTUATION:

Factory wise capacity has been calculated form flow considerations are given below,

5.3.1 Factory - Thermax Group Ltd:

Thermax Group Ltd. is a 100% export-oriented Garments manufacturing industry. It is situated at Karardi, Shibpur, Narsingdi. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 5600 Persons, monthly production capacity is 9000 Cubic meter, this factories earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Thermax Group
(Central Effluent Treatment Plant)
Karardi, Shibpur, Narsingdi

Wastewater Flow Variation with Time

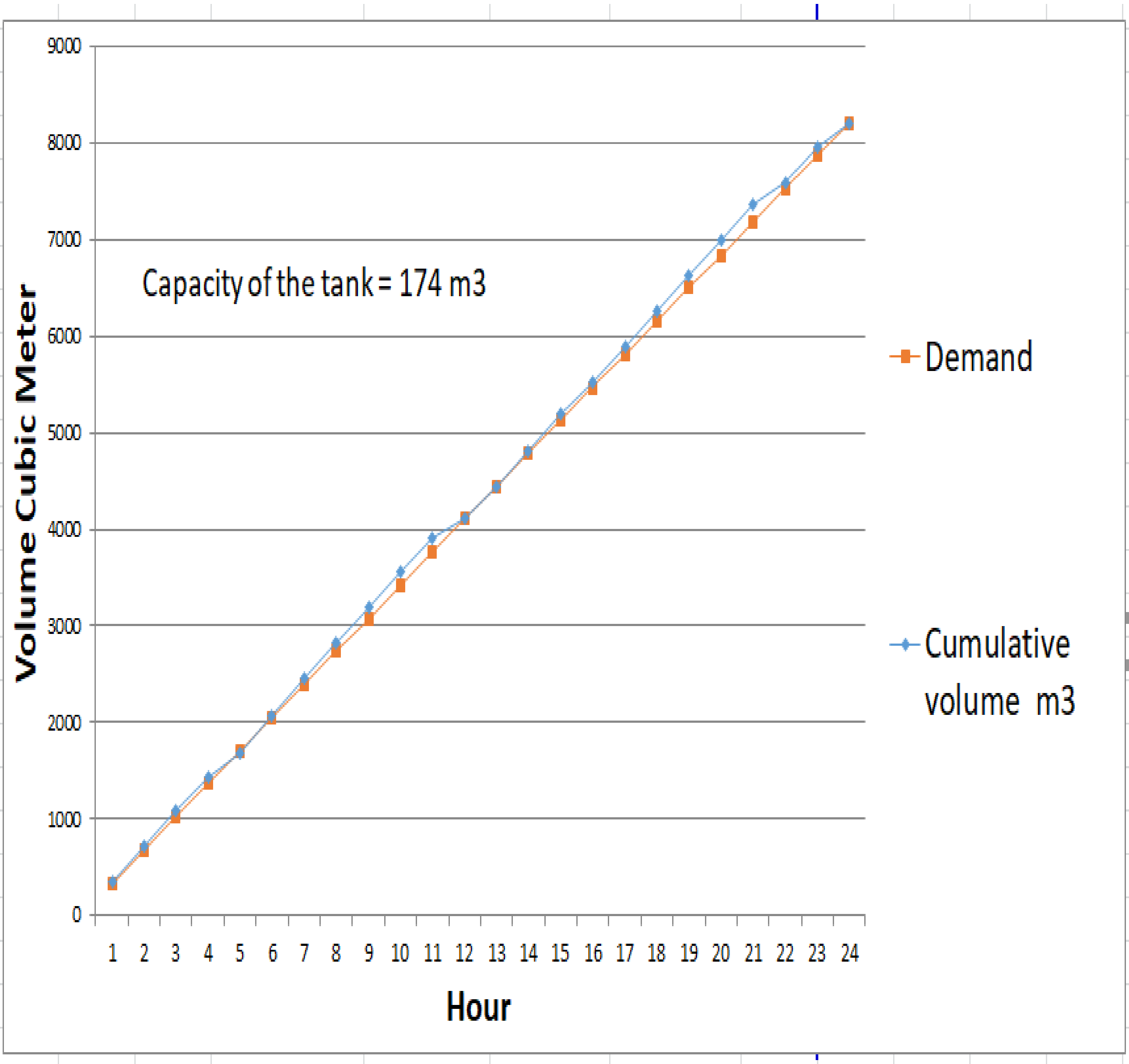
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	Difference	Hr.
08.00 AM	347.33	347.33	242	105.33	1
09.00 AM	372.13	719.46	484	235.46	2
10.00 AM	373.67	1093.13	726	367.13	3
11.00 AM	351.46	1444.58	968	476.58	4
12.00 PM	237.25	1681.83	1210	471.83	5
01.00 PM	391.75	2073.58	1452	621.58	6
02.00 PM	376.50	2450.08	1694	756.08	7
03.00 PM	382.38	2832.46	1936	896.46	8
04.00 PM	356.63	3189.08	2178	1011.08	9
05.00 PM	373.67	3562.75	2420	1142.75	10
06.00 PM	344.67	3907.42	2662	1245.42	11
07.00 Pm	208.92	4116.33	2904	1212.33	12
08.00 PM	325.79	4442.13	3146	1296.13	13
09.00 PM	375.46	4817.58	3388	1429.58	14
10.00 PM	372.88	5190.46	3630	1560.46	15
11.00 PM	323.88	5514.33	3872	1642.33	16
12.00 AM	370.38	5884.71	4114	1770.71	17
01.00 AP	370.83	6255.54	4356	1899.54	18
02.00 AM	370.04	6625.58	4598	2027.58	19
03.00 AM	358.58	6984.17	4840	2144.17	20
04.00 AM	368.33	7352.50	5082	2270.50	21
05.00 AM	241.79	7594.29	5324	2270.29	22
06.00 AM	365.17	7959.46	5566	2393.46	23

sensitivity analysis (depending on retention time)

Hr.	Capacity
1	342
2	684
3	1026
4	1368
5	1710
6	2052
7	2394
8	2736
9	3078
10	3420
11	3762
12	4104
13	4446
14	4788
15	5130
16	5472
17	5814
18	6156
19	6498
20	6840
21	7182
22	7524
23	7866

*Capacity= 174 m^3

Data and Sensitivity analysis of Thermax Group Ltd.



Capacity of the tank = 174 m3
Volume Cubic Meter
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Demand
Cumulative volume m3

5.3.2 Factory - ACS Textiles Ltd.

ACS Textiles Ltd. is a 100% export-oriented Garments manufacturing industry. It is situated at Tetlabo, Rupgonj, Narayanganj, Dhaka. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 5000 Person, monthly production capacity is 9000 Cubic meter, this factories earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

ACS Textile (BD) Ltd.

(Effluent Treatment Plant)

Date 26.11.2019

Wastewater Flow Variation with Time

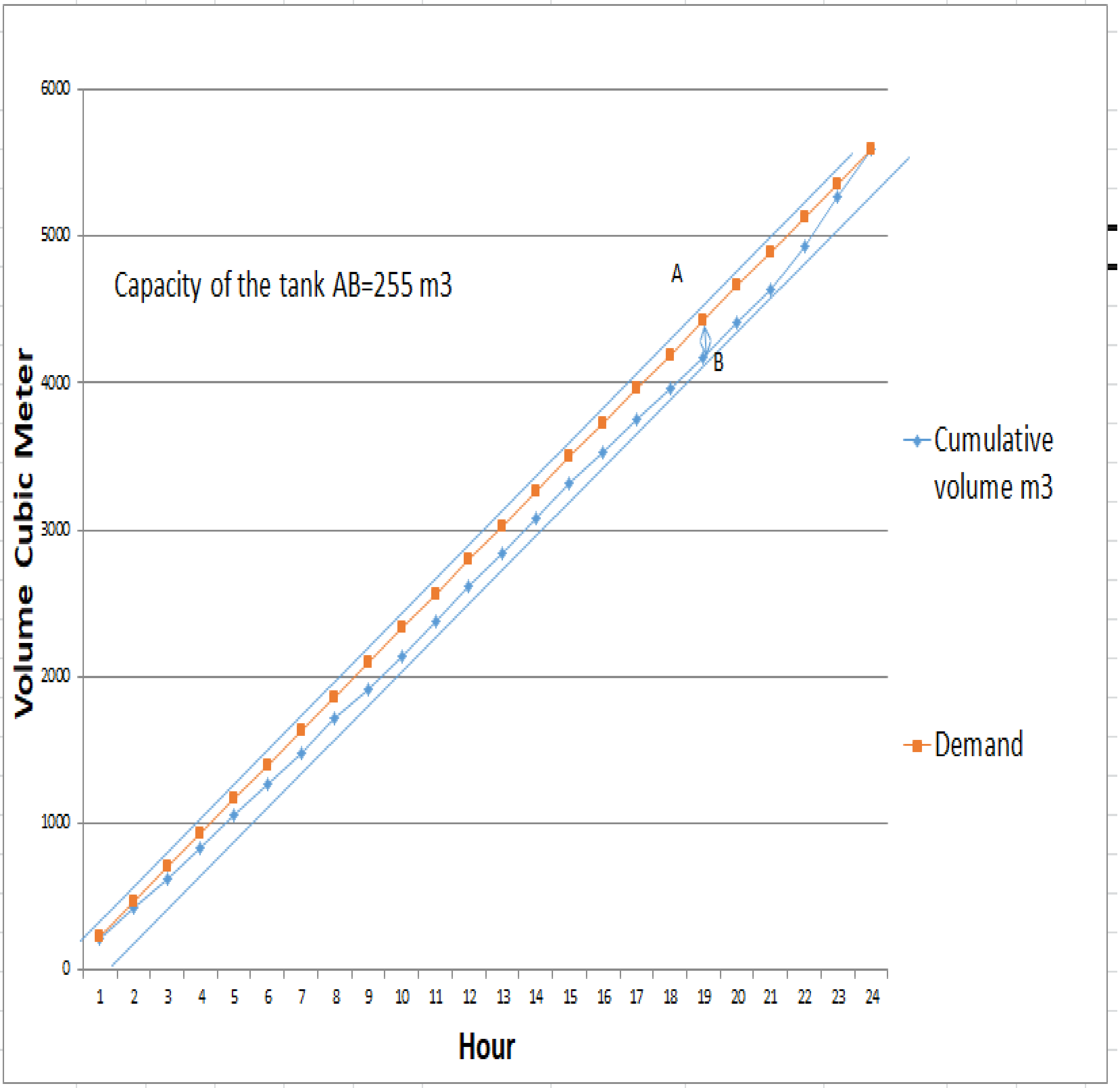
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	Difference	hr.
08.00 AM	215	215	233	18	1
09.00 AM	206	421	466	45	2
10.00 AM	204	625	699	74	3
11.00 AM	213	838	932	94	4
12.00 PM	213	1051	1165	114	5
01.00 PM	211	1262	1398	136	6
02.00 PM	218	1480	1631	151	7
03.00 PM	231	1711	1864	153	8
04.00 PM	207	1918	2097	179	9
05.00 PM	218	2136	2330	194	10
06.00 PM	240	2376	2563	187	11
07.00 Pm	234	2610	2796	186	12
08.00 PM	237	2847	3029	182	13
09.00 PM	230	3077	3262	185	14
10.00 PM	240	3317	3495	178	15
11.00 PM	207	3524	3728	204	16
12.00 AM	223	3747	3961	214	17
01.00 AP	215	3962	4194	232	18
02.00 AM	210	4172	4427	255	19
03.00 AM	237	4409	4660	251	20
04.00 AM	231	4640	4893	253	21
05.00 AM	297	4937	5126	189	22
06.00 AM	330	5267	5359	92	23
07.00 AM	321	5588	5592	4	24

Sensitivity analysis (depending on retention time)

Hr.	Capacity
1	233
2	466
3	699
4	932
5	1165
6	1398
7	1631
8	1864
9	2097
10	2330
11	2563
12	2796
13	3029
14	3262
15	3495
16	3728
17	3961
18	4194

*Capacity = 255 m^3

Data and Sensitivity analysis of ACS Textiles Ltd.



Graphical presentation of Data (ACS Textiles Ltd.)

5.3.3 Factory - Hoorain HTF Ltd.

Hoorain HTF Ltd. is a 100% export-oriented Garments manufacturing industry. It is situated at Bejura, Madhobpur, Habigonj.. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 4000 Person, monthly production capacity is 10000000 yards/Month, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Hooraoin HTF Ltd.

Wastewater Flow Variation with Time

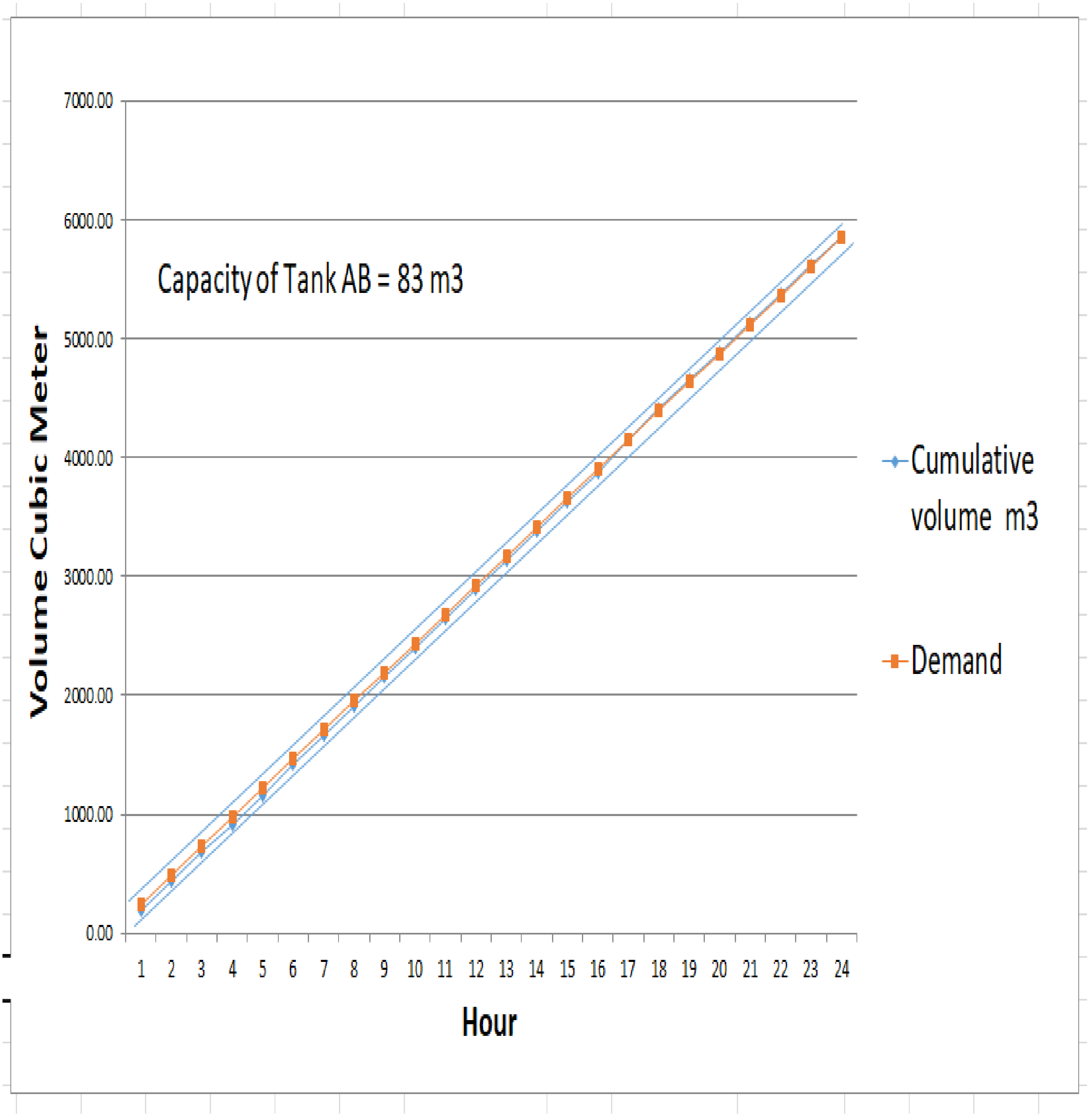
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	Difference	Hr.
08.00 AM	190.00	190.00	244	54.00	1
09.00 AM	245.00	435.00	488	53.00	2
10.00 AM	240.00	675.00	732	57.00	3
11.00 AM	241.00	916.00	976	60.00	4
12.00 PM	245.00	1161.00	1220	59.00	5
01.00 PM	256.00	1417.00	1464	47.00	6
02.00 PM	254.00	1671.00	1708	37.00	7
03.00 PM	241.00	1912.00	1952	40.00	8
04.00 PM	243.00	2155.00	2196	41.00	9
05.00 PM	243.00	2398.00	2440	42.00	10
06.00 PM	243.00	2641.00	2684	43.00	11
07.00 Pm	248.00	2889.00	2928	39.00	12
08.00 PM	241.00	3130.00	3172	42.00	13
09.00 PM	246.00	3376.00	3416	40.00	14
10.00 PM	254.00	3630.00	3660	30.00	15
11.00 PM	250.00	3880.00	3904	24.00	16
12.00 AM	265.00	4145.00	4148	3.00	17
01.00 AM	270.00	4415.00	4392	-23.00	18
02.00 AM	238.00	4653.00	4636	-17.00	19
03.00 AM	240.00	4893.00	4880	-13.00	20
04.00 AM	238.00	5131.00	5124	-7.00	21
05.00 AM	246.00	5377.00	5368	-9.00	22
06.00 AM	243.00	5620.00	5612	-8.00	23
07.00 AM	240.00	5860.00	5856	-4.00	24

sensitivity analysis (depending on retention time)

Hr.	Capacity
1	244
2	488
3	732
4	976
5	1220
6	1464
7	1708
8	1952
9	2196
10	2440
11	2684
12	2928
13	3172
14	3416
15	3660
16	3904
17	4148
18	4392

*Capacity= 60+23= 83 m^3

Data and Sensitivity analysis of Hoorain HTF Ltd.



Graphical presentation of Data (Hoorain HTF Ltd.)

5.3.4 Factory- SF Washing:

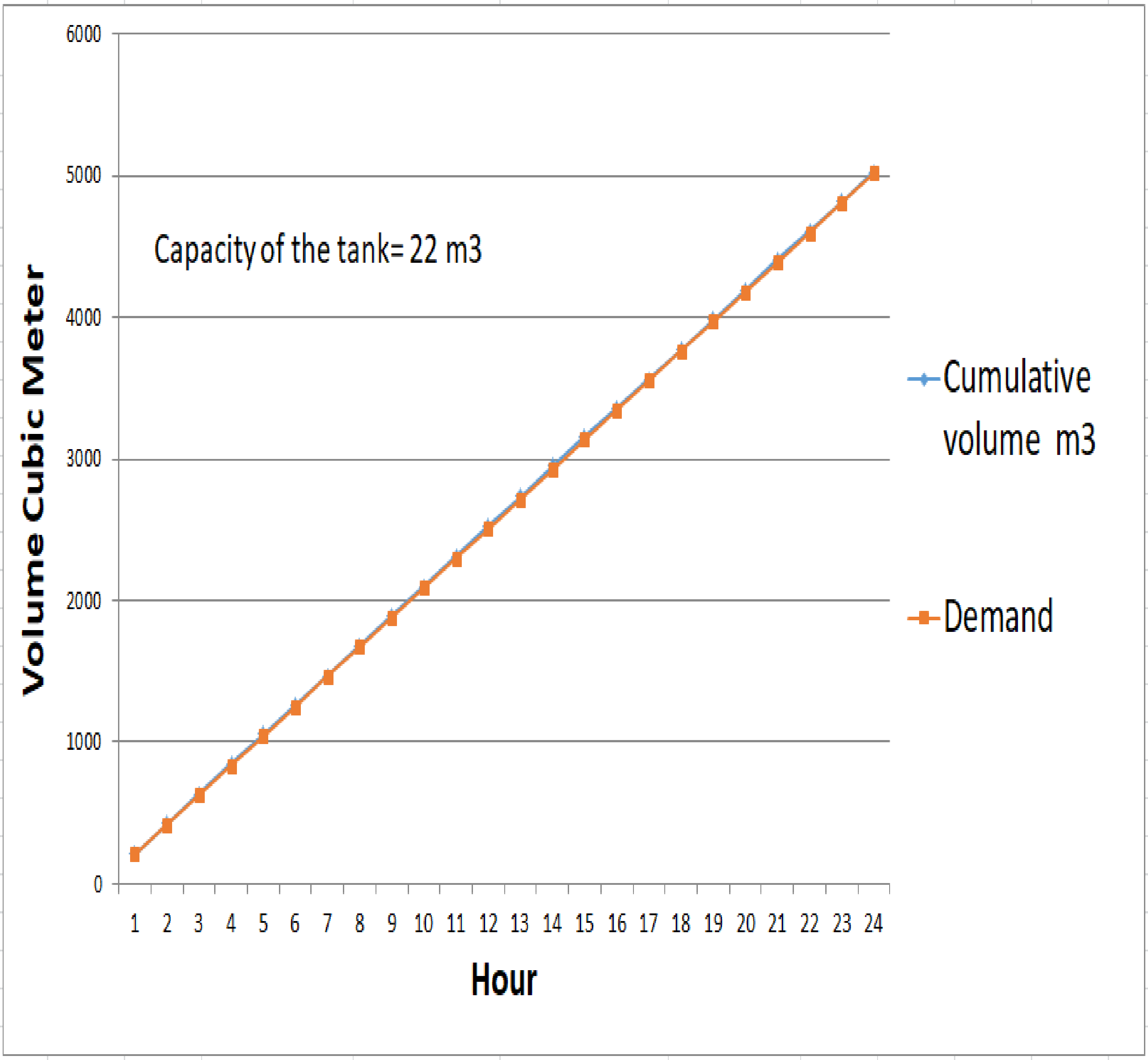
SF Washing is a 100% export-oriented Garments manufacturing industry. It is situated at Kanchpur, Sonargaon, Narayanganj. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 2900 Person, monthly production capacity is 2000000 Pcs/Month, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

SF Washing Ltd.					
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	Difference	Hr.
08.00 AM	212	212	209	3	1
09.00 AM	211.4	423.4	418	5.4	2
10.00 AM	212.2	635.6	627	8.6	3
11.00 AM	211.6	847.2	836	11.2	4
12.00 PM	210.9	1058.1	1045	13.1	5
01.00 PM	209.1	1267.2	1254	13.2	6
02.00 PM	199.8	1467	1463	4	7
03.00 PM	213.5	1680.5	1672	8.5	8
04.00 PM	213.8	1894.3	1881	13.3	9
05.00 PM	205.6	2099.9	2090	9.9	10
06.00 PM	212.8	2312.7	2299	13.7	11
07.00 Pm	213	2525.7	2508	17.7	12
08.00 PM	211.5	2737.2	2717	20.2	13
09.00 PM	210.9	2948.1	2926	22.1	14
10.00 PM	208	3156.1	3135	21.1	15
11.00 PM	204.8	3360.9	3344	16.9	16
12.00 AM	202.9	3563.8	3553	10.8	17
01.00 AP	208	3771.8	3762	9.8	18
02.00 AM	209.5	3981.3	3971	10.3	19
03.00 AM	209.9	4191.2	4180	11.2	20
04.00 AM	214.3	4405.5	4389	16.5	21
05.00 AM	200.6	4606.1	4598	8.1	22
06.00 AM	211.2	4817.3	4807	10.3	23
07.00 AM	204.8	5022.1	5016	6.1	24

Sensitivity analysis	
Hr.	Capacity
1	209
2	418
3	627
4	836
5	1045
6	1254
7	1463
8	1672
9	1881
10	2090
11	2299
12	2508
13	2717
14	2926
15	3135

*Capacity= 22 m^3

Data and Sensitivity analysis of SF Washing.



Graphical presentation of Data (SF Washing)

5.3.5 Factory - Aboni knitwear:

Aboni Knitwear is a 100% export-oriented Garments manufacturing industry. It is situated at Tetuljhora, Hemeyetpur, Savar Dhaka. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 2657 Person, monthly production capacity is 5500 Cubic meters, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Aboni Knitwear Ltd.

Hemayetpur, Savar, Dhaka

Wastewater Flow Variation with Time

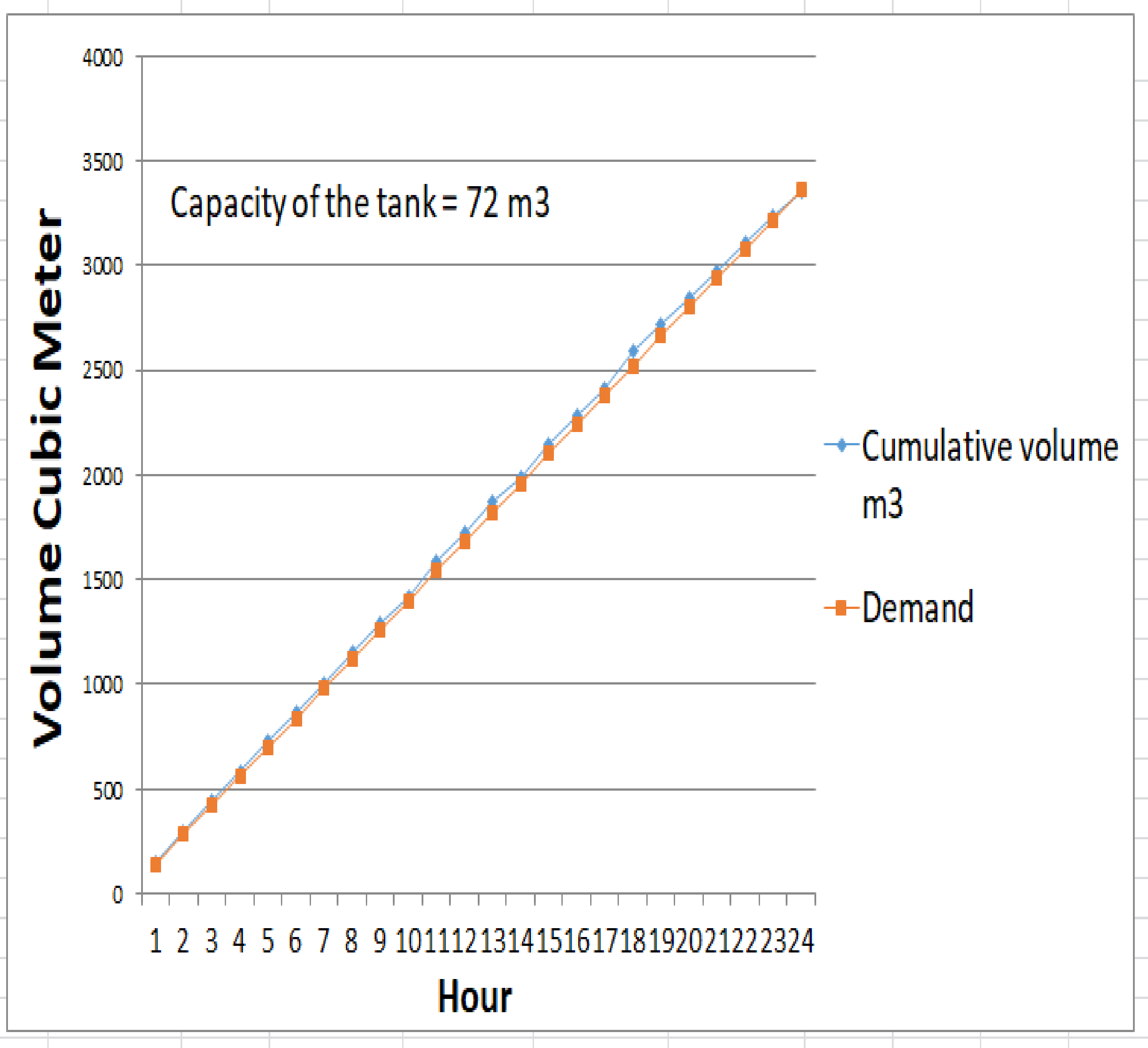
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	ifferenc	Hr.
08.00 AM	151	151	140	11	1
09.00 AM	140	291	280	11	2
10.00 AM	153	444	420	24	3
11.00 AM	137	581	560	21	4
12.00 PM	145	726	700	26	5
01.00 PM	140	866	840	26	6
02.00 PM	139	1005	980	25	7
03.00 PM	151	1156	1120	36	8
04.00 PM	133	1289	1260	29	9
05.00 PM	124	1413	1400	13	10
06.00 PM	168	1581	1540	41	11
07.00 Pm	141	1722	1680	42	12
08.00 PM	148	1870	1820	50	13
09.00 PM	121	1991	1960	31	14
10.00 PM	155	2146	2100	46	15
11.00 PM	141	2287	2240	47	16
12.00 AM	122	2409	2380	29	17
01.00 AP	180	2589	2520	69	18
02.00 AM	130	2719	2660	59	19
03.00 AM	127	2846	2800	46	20
04.00 AM	129	2975	2940	35	21
05.00 AM	138	3113	3080	33	22
06.00 AM	124	3237	3220	17	23
07.00 AM	120	3357	3360	-3	24

Sensitivity analysis

Hr.	Capacity
1	140
2	280
3	420
4	560
5	700
6	840
7	980
8	1120
9	1260
10	1400
11	1540
12	1680
13	1820
14	1960
15	2100
16	2240

*Capacity= 69+3= 72 m^3

Data and Sensitivity analysis of Abonti Knitwear ltd.



Graphical presentation of Data (Abonti Knitwear ltd.)

5.3.6 Factory - Executive Hi Fashion:

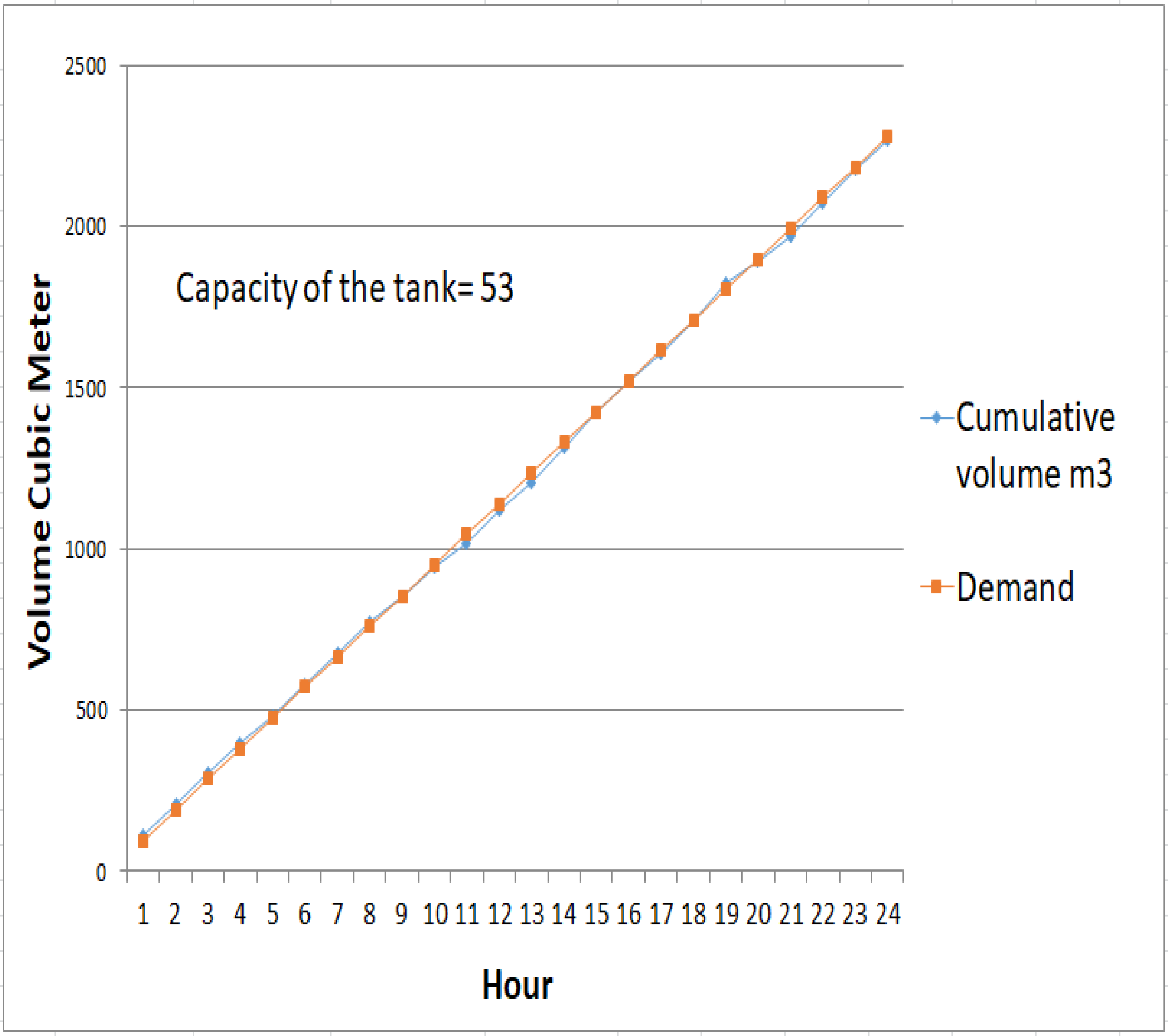
Executive Hi Fashion is a 100% export-oriented Garments manufacturing industry. It is situated at Shirirchala, Vabanipur, Gazipur. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 6215 Person, monthly production capacity is 500000 Pcs/Month, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Executive Hi Fashion Ltd. Wastewater Flow Variation with Time					
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	Difference	Hr.
08.00 AM	109	109	95	14	1
09.00 AM	100	209	190	19	2
10.00 AM	99	308	285	23	3
11.00 AM	89	397	380	17	4
12.00 PM	86	483	475	8	5
01.00 PM	98	581	570	11	6
02.00 PM	94	675	665	10	7
03.00 PM	101	776	760	16	8
04.00 PM	79	855	855	0	9
05.00 PM	87	942	950	-8	10
06.00 PM	76	1018	1045	-27	11
07.00 Pm	99	1117	1140	-23	12
08.00 PM	88	1205	1235	-30	13
09.00 PM	112	1317	1330	-13	14
10.00 PM	105	1422	1425	-3	15
11.00 PM	96	1518	1520	-2	16
12.00 AM	87	1605	1615	-10	17
01.00 AP	102	1707	1710	-3	18
02.00 AM	120	1827	1805	22	19
03.00 AM	67	1894	1900	-6	20
04.00 AM	75	1969	1995	-26	21
05.00 AM	106	2075	2090	-15	22
06.00 AM	100	2175	2185	-10	23
07.00 AM	94	2269	2280	-11	24

Sensitivity analysis	
Hr.	Capacity
1	95
2	190
3	285
4	380
5	475
6	570
7	665
8	760
9	855
10	950
11	1045
12	1140
13	1235
14	1330
15	1425

*Capacity= 30+23= 53 m^3

Data and Sensitivity analysis of Executive Hi Fashion



Graphical presentation of Data (Executive Hi Fashion)

5.3.7 Factory - Garments Export Village:

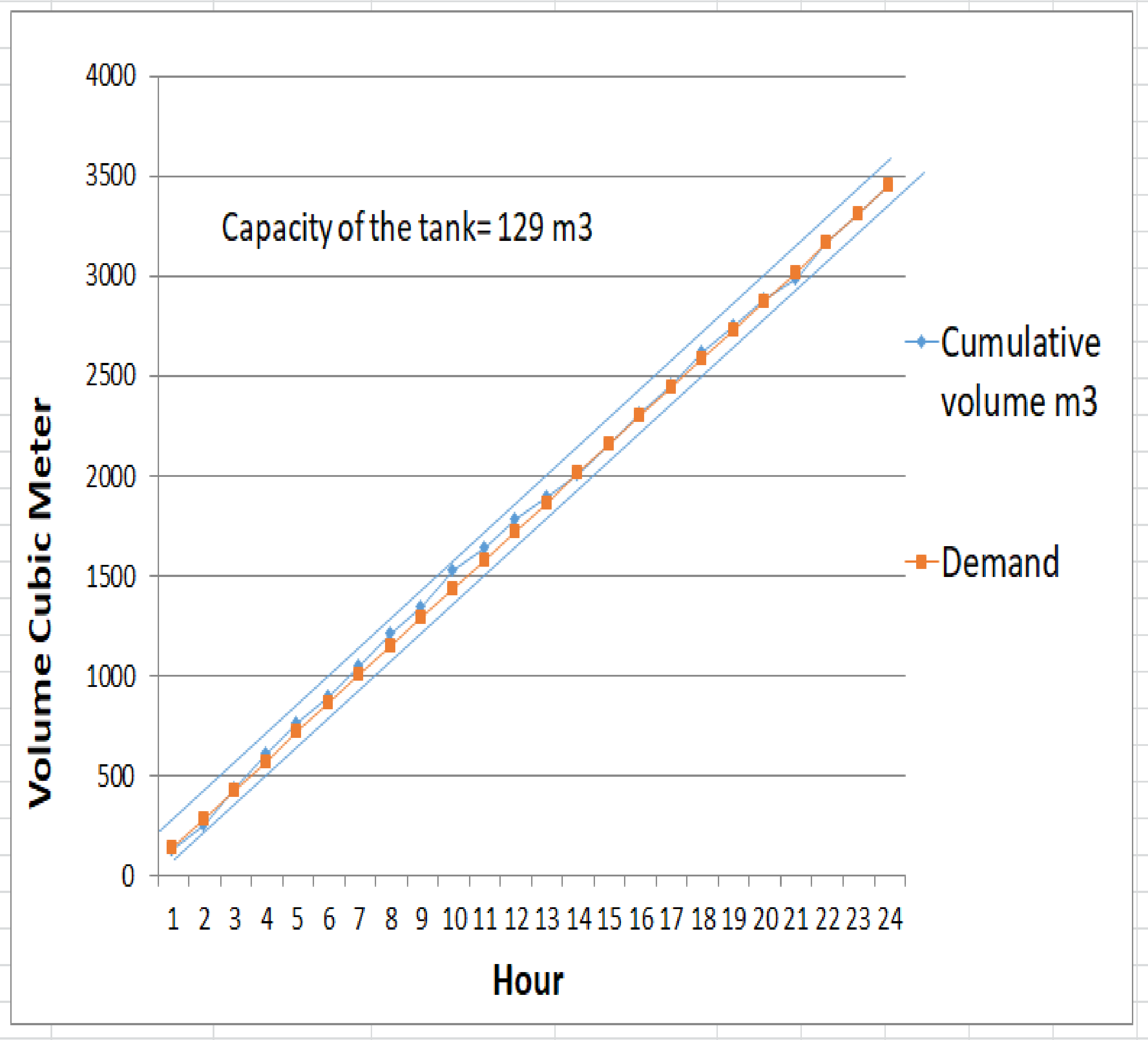
Garments Export Village is a 100% export-oriented Garments manufacturing industry. It is situated at Ma Tower, Tongi, Gazipur. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 1100 Person, monthly production capacity is 200000 Pcs/Month, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Garments Exports Village					
Gazipur, Dhaka					
Wastewater Flow Variation with Time					
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	differenc	Hr.
08.00 AM	134	134	144	10	1
09.00 AM	122	256	288	32	2
10.00 AM	188	444	432	-12	3
11.00 AM	165	609	576	-33	4
12.00 PM	156	765	720	-45	5
01.00 PM	129	894	864	-30	6
02.00 PM	160	1054	1008	-46	7
03.00 PM	165	1219	1152	-67	8
04.00 PM	129	1348	1296	-52	9
05.00 PM	187	1535	1440	-95	10
06.00 PM	106	1641	1584	-57	11
07.00 Pm	143	1784	1728	-56	12
08.00 PM	109	1893	1872	-21	13
09.00 PM	112	2005	2016	11	14
10.00 PM	156	2161	2160	-1	15
11.00 PM	156	2317	2304	-13	16
12.00 AM	145	2462	2448	-14	17
01.00 AP	164	2626	2592	-34	18
02.00 AM	132	2758	2736	-22	19
03.00 AM	124	2882	2880	-2	20
04.00 AM	108	2990	3024	34	21
05.00 AM	178	3168	3168	0	22
06.00 AM	144	3312	3312	0	23
07.00 AM	145	3457	3456	-1	24

Sensitivity analysis	
Hr.	Capacity
1	144
2	288
3	432
4	576
5	720
6	864
7	1008
8	1152
9	1296
10	1440
11	1584
12	1728

*Capacity= 95+34=129 m^3

Data and Sensitivity analysis of Garments Export Village



Graphical presentation of Data (Garments Export Village)

5.3.8 Factory - Beximco Ltd.

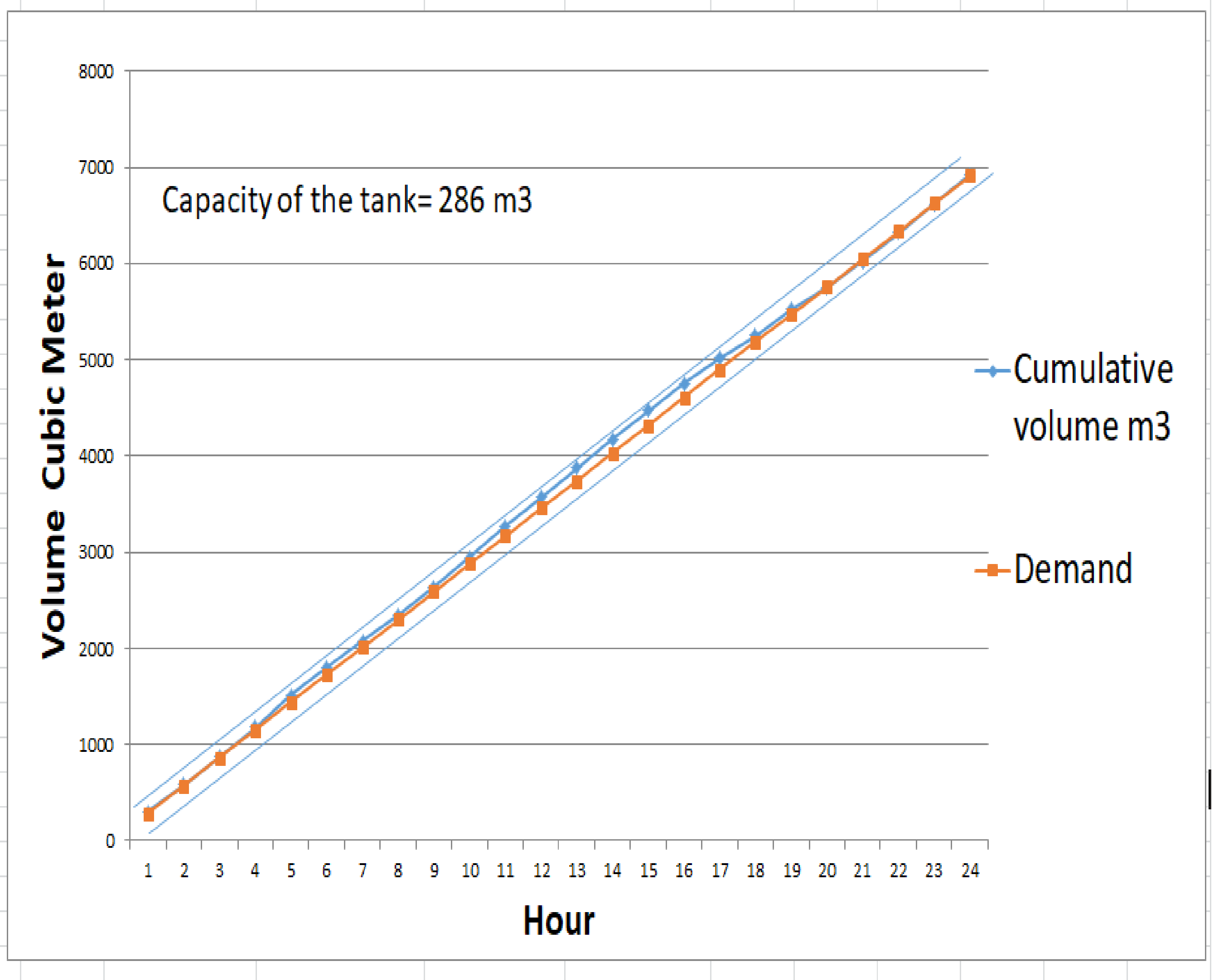
Beximco Ltd. is a 100% export-oriented Garments manufacturing industry. It is situated at Kashimpur, Sharabo, Gazipur. The industry is adding to the present readymade Garments production of the country as well as providing employment to a substantial number of personnel/the total manpower of the factories 11515 Person, monthly production capacity is 2200000 yards/Month, this factory earning a considerable amount of foreign currency and thus contributing to national economy and social uplifts. According to the environmental conservation rules 1997, the factory is considered under the red category of (schedule 1 item 60).

Beximco Ltd.					
Gazipur, Dhaka					
Wastewater Flow Variation with Time					
Time	Flow rate (m3/hr)	Cumulative volume m3	Demand	differenc	Hr.
08.00 AM	302	302	288	14	1
09.00 AM	277	579	576	3	2
10.00 AM	290	869	864	5	3
11.00 AM	311	1180	1152	28	4
12.00 PM	333	1513	1440	73	5
01.00 PM	289	1802	1728	74	6
02.00 PM	276	2078	2016	62	7
03.00 PM	265	2343	2304	39	8
04.00 PM	290	2633	2592	41	9
05.00 PM	311	2944	2880	64	10
06.00 PM	321	3265	3168	97	11
07.00 Pm	300	3565	3456	109	12
08.00 PM	309	3874	3744	130	13
09.00 PM	300	4174	4032	142	14
10.00 PM	301	4475	4320	155	15
11.00 PM	278	4753	4608	145	16
12.00 AM	265	5018	4896	122	17
01.00 AP	234	5252	5184	68	18
02.00 AM	272	5524	5472	52	19
03.00 AM	228	5752	5760	-8	20
04.00 AM	265	6017	6048	-31	21
05.00 AM	298	6315	6336	-21	22
06.00 AM	301	6616	6624	-8	23
07.00 AM	304	6920	6912	8	24

Sensitivity analysis	
Hr.	Capacity
1	288
2	576
3	864
4	1152
5	1440
6	1728
7	2016
8	2304
9	2592
10	2880
11	3168
12	3456
13	3744
14	4032
15	4320
16	4608
17	4896
18	5184
19	5472
20	5760

*Capacity= 255+31=286 m^3

Data and Sensitivity analysis of Beximco Ltd.



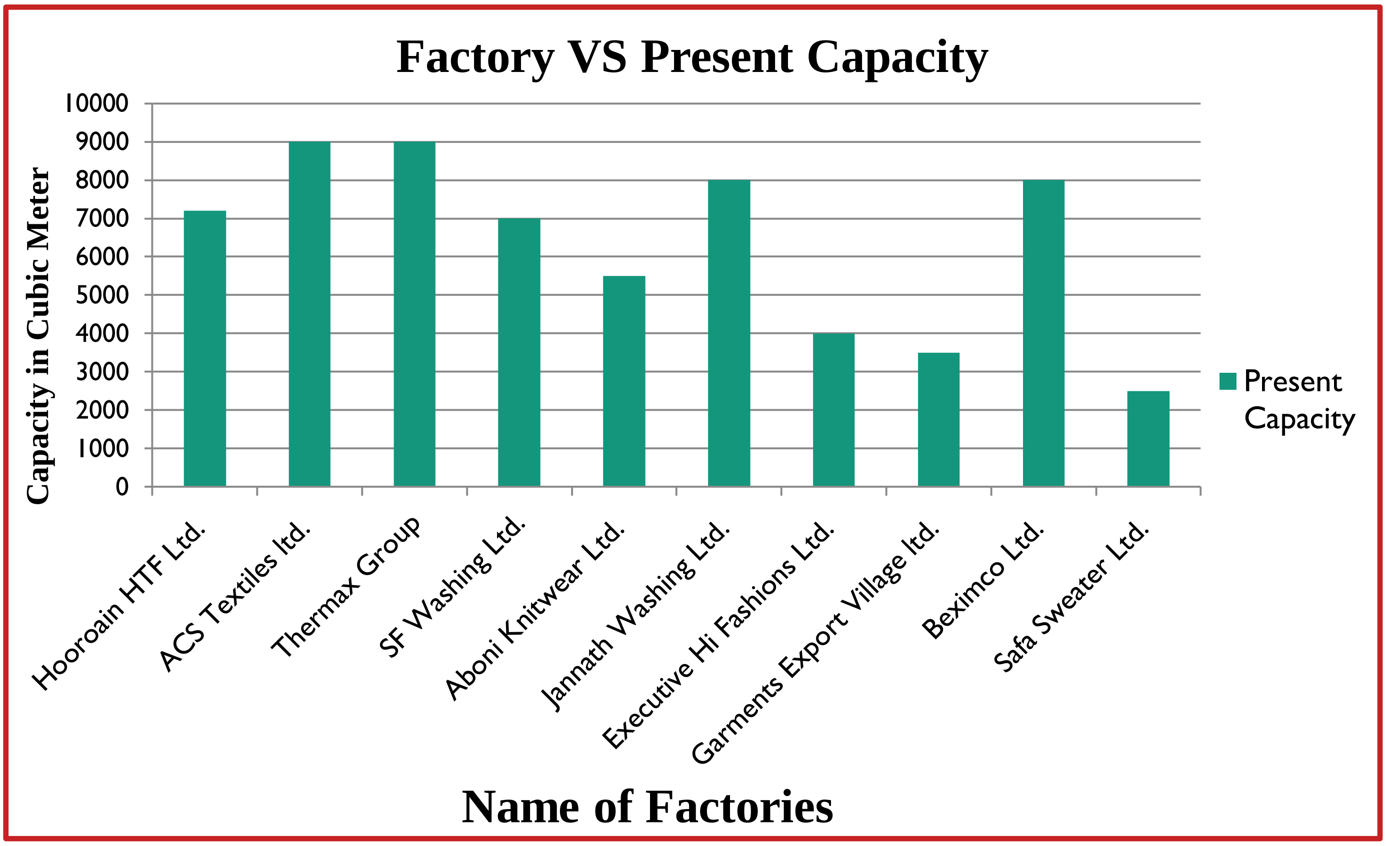
Graphical presentation of Data (Beximco Ltd.)

5.4. Retention time variations are given in below table.

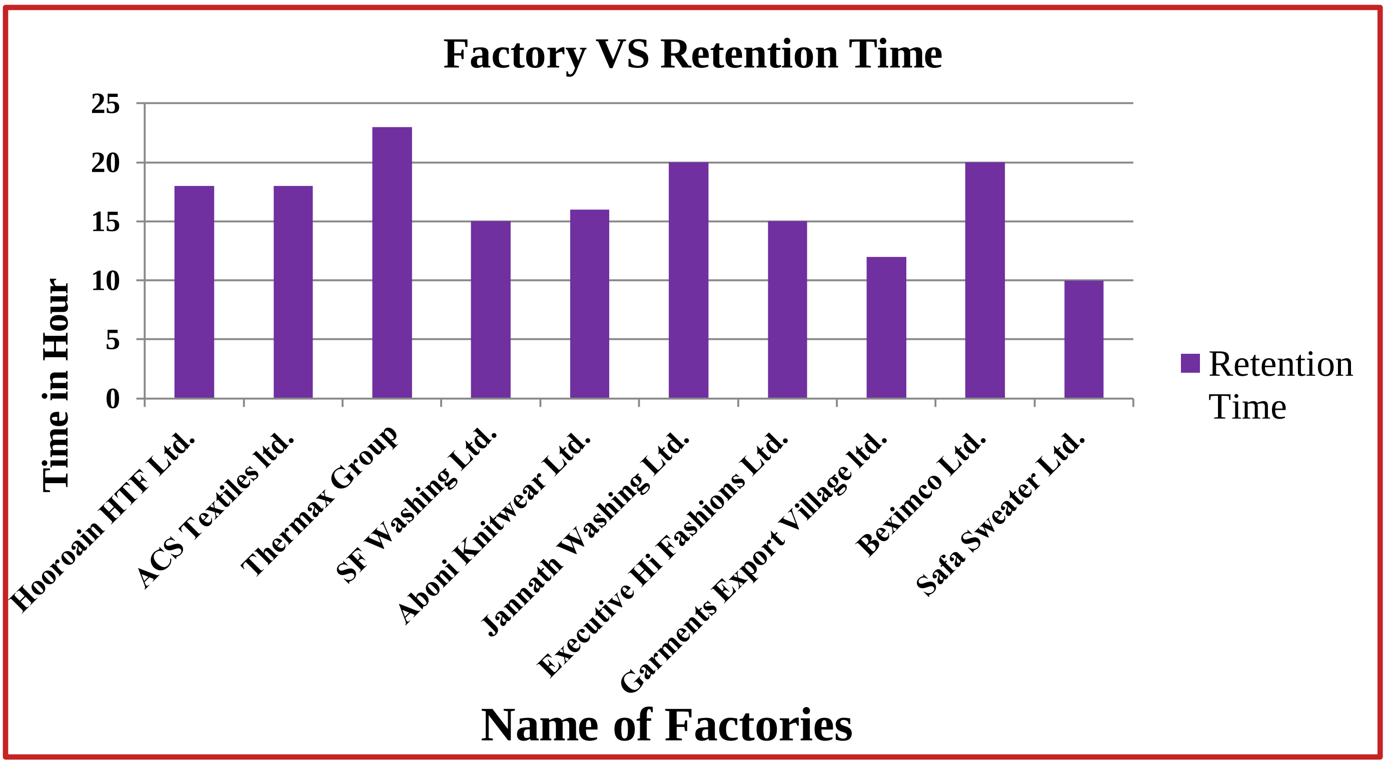
Capacity, Retention time, Flow rate & Safety Factor has Comprised among the ten Factories

Name of Factory	Present Capacity (m^3)	Retention Time (hr.)	Average Flow Rate (m^3/hr.)	Safety Factor
Hooroain HTF Ltd.	7200	18	244	1.6
ACS Textiles ltd.	9000	18	233	2.1
Thermax Group	9000	23	342	1.1
SF Washing Ltd.	7000	15	209	2.2
Aboni Knitwear Ltd.	5500	16	140	2.5
Jannath Washing Ltd.	8000	20	296	1.4
Executive Hi Fashions Ltd.	4000	15	95	2.8
Garments Export Village ltd.	3500	12	144	2.0
Beximco Ltd.	8000	20	288	1.4

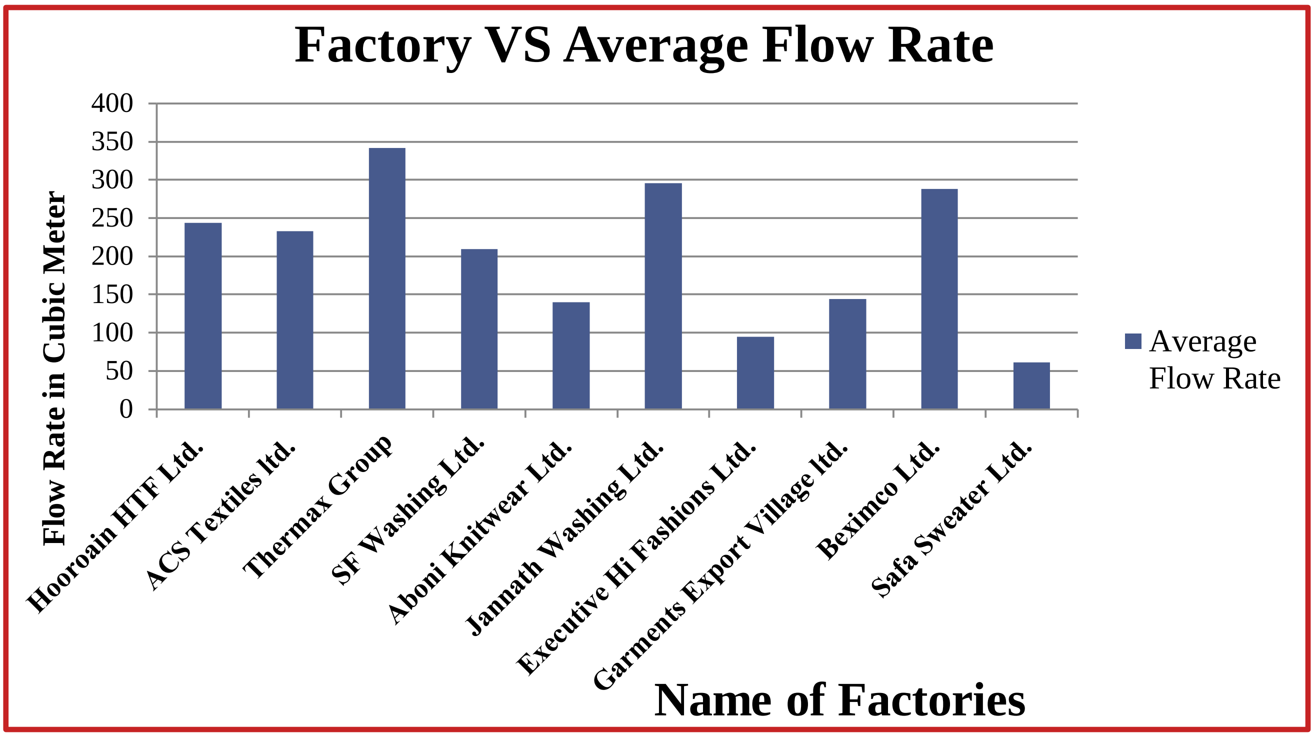
5.4.1. Comparison of parameters of different industries: The comparison is presented graphically as below.



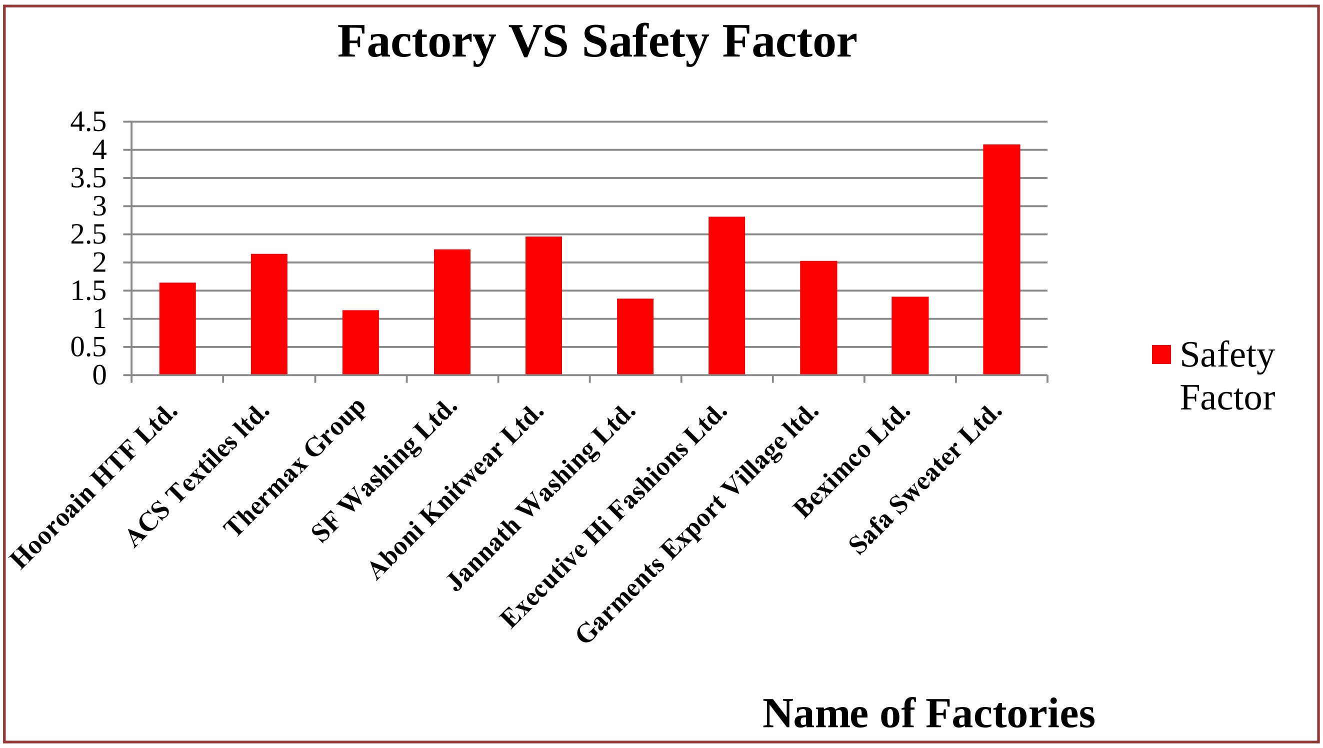
Retention time:



Average Flow Rate:



<u>Safety Factor:</u>



Equalization tank Capacity Comparison Based on Retention Time			
Name of Factory	Factory Design Capacity (M^3/day)	Based on Existing Retention Time (hr.)	Considering 8* hour Retention Time
Hooroain HTF Ltd.	7200	4992	1952
ACS Textiles ltd.	9000	6120	1864
Thermax Group	9000	4176	2736
SF Washing Ltd.	7000	5020	1672
Aboni Knitwear Ltd.	5500	1728	1120
Jannath Washing Ltd.	8000	3024	2368
Executive Hi Fashions Ltd.	4000	1272	760
Garments Export Village ltd.	3500	3096	1152
Beximco Ltd.	8000	6860	2304
Safa Sweater Ltd.	3600	3552	488

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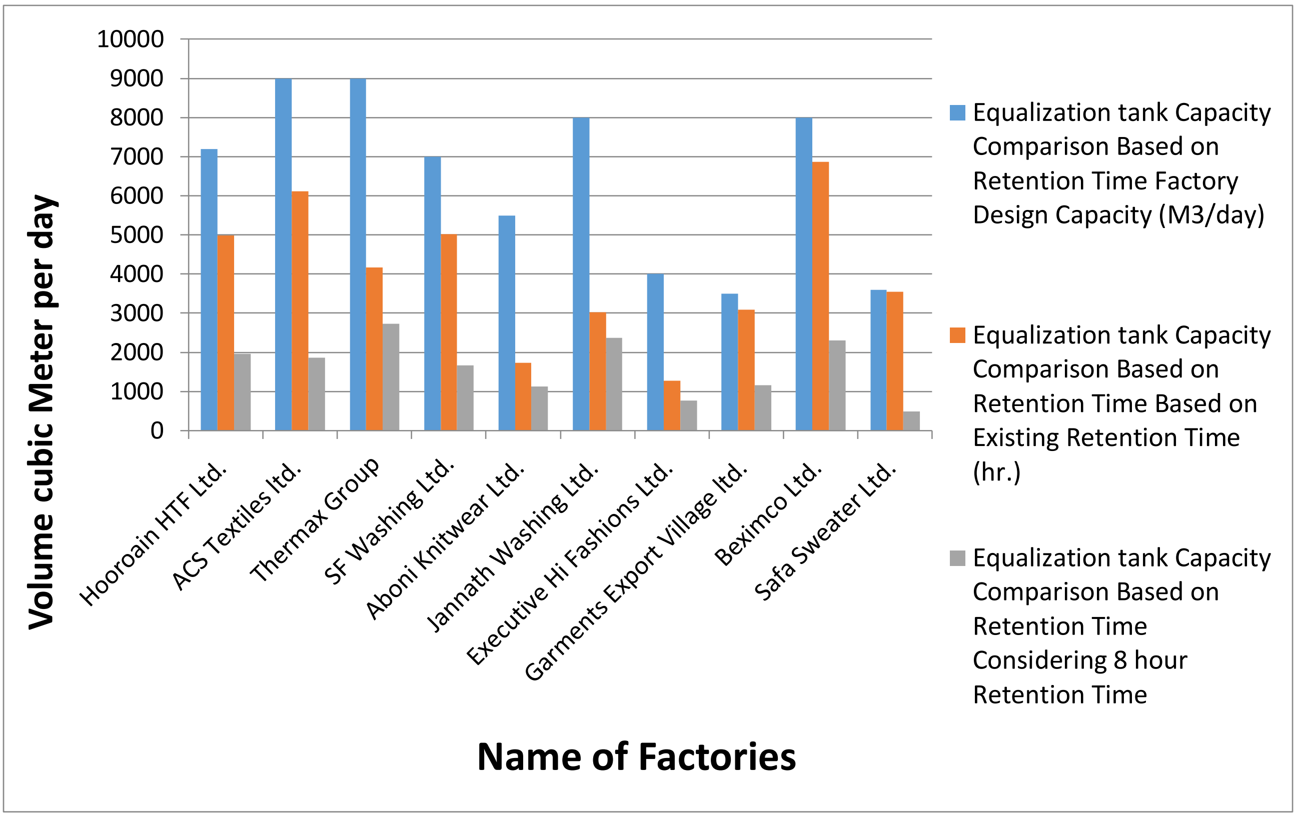

Summary table

Comparison of capacity of Equalization Tanks,

Name of the factory	Capacity from flow fluctuation (m^3)	Capacity from Retention Time (m^3)	Actual capacity (m^3)	Factor of safety
Hooroain HTF Ltd.	83	4992	7200	1.44
ACS Textiles ltd.	255	6120	9000	1.5
Thermax Group	174	4176	9000	2.2
SF Washing Ltd.	22	5020	7000	1.4
Aboni Knitwear Ltd.	72	1728	5500	3.2
Jannath Washing Ltd.	126	3024	8000	2.6
Executive Hi Fashions Ltd.	53	1272	4000	3.1
Garments Export Village ltd.	129	3096	3500	1.1
Beximco Ltd.	286	6860	8000	1.2
Safa Sweater Ltd.	148	3552	3600	1.0

5.5. Discussion:

We have conducted this thesis to meet the above mentioned parameters in line of the mentioned objectives among the factories. From the comparison of different water parameters among the before and after equalization tank, it has been observed that the values of pH, Temperature, Total Dissolved Oxygen (TDS), Total Suspended Solid (TSS), Total Solid (TS), Biochemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD) has decreased the values, as well as the value of Dissolve Oxygen (DO) has increased from that condition which has been found before the equalization tank.

From the above work it has been also found that the flow fluctuation of effluent was not too much high among the factories which will become the reason for over capacity of the tank. However those tanks have been designed for over capacity which is responsible to increasing the investment. As well as the retention time of the equalization tank for some factories has been found more than the standard limit which is must responsible for over capacity.

Finally we can say that from the above result and discussion, the equalization tank is one of the most important thing for Effluent Treatment plant (ETP). That's why we should remember that when an equalization tank will be design, must should be consider the above mentioned things, it will help to standard design and cost minimization.

Chapter- 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The existing pollution level of the water bodies from the textile waste water will be significantly reduced if this simple technology Effluent Treatment Plant (ETP) is adopted. As equalization tank is the main and major/or beginning part of ETP, so the role of this tank is borderless in this treatment process. Through this tank the temperature level is decreased by homogenization as well as shock elimination, pH stabilization, constant flow maintaining etc. As the tank has a vital role to play the treatment, so the tank capacity needs to design considering the retention time as the capacity depend on it. Retention time as much less the tank capacity will be decrease. So the retention time must need to consider during the period of tank volume design.

6.2 RECOMMENDATIONS

- Since the best time period of retention time is 6 to 8 hr. that we got from the study so it is recommended to consider this time period during the tank design. This research work has been done by data analyzing of ten factories, so there has scope to further research on this topic by considering more than 20 factories.
- When the equalization tank is design should consider the matter that effluent will come from how many sources into the tank. Because there is a wide variation in flow composition over time, so that reason treatment efficiency of the equalization process may degrade severely.
- Have scope to research for on this topic about next treatment process after equalization.
- From our analysis and study it has been observed that the design capacity of tank along with operational process is very nearest of safa sweater ltd. So we can follow the design and operational process of equalization tank of Safa Sweater Ltd.

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