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Evaluation of AL- Mussyeb Water Treatment Plant

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بسم الله الرحمن الرحيم

ويسئلونك عن الروح قل الروح من

أمر ربي وما أوتيتم من العلم الا قليلا

صدق الله العظيم

سورة الاسراء اية ٨٥

Dedication

To the plant in my heart love and teach me the life	my mother
To the immerse me in his generousness	my father
To the oars that help us row	my brother and sister
To wind that aid us to sail	our friends
To the maps that guide our path	our teachers

Special thanks

I have to thank (Dr. Ali Sadiq) for the knowledge and time he shared with me, as well as his worthy suggestions, which aided the conducting of this Study. I would like to thank (Dr. Mahmood Saleh) for all advices and helping. And would like to thank team of Al-mussyeb water treatment plant for their help and support.

CONTENT

CONTENT

LIST OF FIGURES

Chapter

One

INTRODUCTION

1-1 GENERAL

Water may require treatment for a number of reasons; most important is the necessity of removing the germs of disease. For palatability it must be free from unpleasant tastes and odors and also have an inviting appearance, necessitating the elimination of gases, murkiness and color. The processes required to render raw water potable depend on its physicochemical and biological quality. The treated water should be suitable for such domestic uses as cooking and washing and also usable for wide variety of industrial purposes as steam generation etc. A number of treatment methods have been developed to meet these necessities of a modern community.

The amount and the type of treatment vary with the source type of water and the quality. Many groundwater (or Sub-surface water which is fresh water located in the pore space of soil and rocks, It is also water that is flowing within aquifers below the water table) can satisfy all requirements without Appling any treatment while the surface water (which is the water in a river, lake or fresh water wet land) can be dangerously contaminated and more or less turbid, so it usually needs some form of pre-treatment to prepare it for disinfection or, in some cases, slows and filtration, or to add chlorine or additional treatment because it is exposed to direct wet weather runoff and to atmosphere, therefore it can be more easily contaminated.

Water suppliers use a variety of treatment processes to remove contaminants from drinking water. These individual processes may be arranges in a 'treatment train" which are a series of processes applied in sequence. The most commonly used processes include filtration, flocculation, sedimentation and disinfection as a final precaution for elimination of disease germs. Some treatment train also includes ion exchange and adsorption, So all the water treatment system shear

Chapter Two

REVIEW OF LITERATURES

2-1 GENERAL

The disinfection of raw water plays an important role in environmental engineering. In this chapter study over view several feed book controllers proposed by different authors to purify the water contain in water distribution systems. Several techniques to purify the water and sensors needed as a part of the whole system are presented to provide an over view of the components and processes encountered in water treatment plants.

2-2 REVIEW OF SOME RESEARCHES

Mc Graw (2003) studied the water treatment plant and fined in the first stage that the water plant removes course material and debris. Then after following the basic treatment process of clarification, the treatment would include coagulation flocculation and sedimentation prior to filtration (most by used chlorination) with a good quality source. He concluded that the treatment processes may modify by removing the sedimentation process and to just have coagulation and flocculation processes followed by filtration, this process scheme is called direct filtration [1].

The American water works association (AWWA) (1969–1981) prepared a series of reports with a compressive literature review on the nature and solution of water treatment plant. The first report reviewed plant operations for various type of water and regulatory of treatment. The second part (AWWA 1969) described various treatment processes employed and their efficiency and degree of success and presented cost analyses. The last part (AWWA1970) summarized research needs; Engineering needs plant operation and regulatory needs.

The AWWA of water treatment plant published an updated for its previous reports which is (AWWA 1972). This report dealt with processing and re-processing in sludge production and the selection and modification of treatment processes reclamation of lime and alum recovery of filter back wash water [2].

Watt & Wood (1979) discovered that the processes of treatment of water required rendering raw potable depend on its physicochemical and biological quality. Surface water is highly turbid and heavily contaminated and it usually needs some form of pre-treatment to prepare it for disinfection or in some case slow sand filtration. The pre-treatment processes described are storage and plain sedimentation, coagulation and flocculation and roughing flirtation [3].

Steel (1979) took in his consideration that the character and degree of treatment required depends upon the nature of the water and this is in turn will depend largely on its source. Number of treatment method have been developed to necessity of treated the water in the modern community. Storage and plane sedimentation are occasionally used although they have largely given way to more efficient method to treatment [3].

A recent risk analysis **(Morris2009)** has found a weak positive association between bladder and rectal cancer and consumption of chlorination drinking water, indication that there may be some risk of carcinogenesis. The authors suggest use of both chlorine and ammonia as disinfectants in order to reduce the chlorine concentration used. Disinfection by ozonation, bubbling ozone through the water also avoids the risk of side effects from chlorination.

Water treatment is often necessary if surface water and sometime ground water supplies are to be available for human use, because the vast majority of citied use one water distribution system for households, industries, and fire

control. Large quantities of water often must be available to satisfy the highest use of growing demand for water [4].

Ruth F. weiner &Robin Mathew (2003) suggested a serious consideration of dual water supplies; one high-quality for drinking water and one of lower quality (perhaps reclaimed from waste water) used for irrigation, fire fighting and similar applications.. The next major environmental engineering concern will be the availability and production of water to meet an ever increasing demand [1].

Alvaro E.Gil and Kevin M.Passin(2004) Considered the purification of drinking water is very important problem in environmental engineering. Chlorine is the most common disinfectant used in drinking water purification systems because it is expensive and destroys a large number of pathogens. The purification of drinking water involves several stages of treatment of raw water to remove of suspended solid, color and bacteria before entering the distribution network .Then they concluded the regulation of chlorination in drinking water systems is based on open loop manual control although chlorine concentration sensors have been used in large drinking water systems [6].

Steve muscroft (2009) Observed that the water treatment specification cover the design review plant and specification instillation inspection. Testing and acceptance of drinking (potable) water depended on the distribution system of water, main extensions and all appurtenants items which are to be constructed by private enter pries and are to be owned and maintained. The water technical specification may provide additional clarification regarding materials of construction. Although he recommended that all pipeline and appurtenance material in contact with potable water must be certified [4].

Lawrence K.wang yung .Tse Hung (2006) observed that The water aeration discuss have been long used in water treatment for removing of odor

and test causing compounds like iron, manganese as well as corrosion., however this process has been used to remove inorganic and chemicals from water .As a result water aeration may be the single most important water treatment process used in the twenty-one century. The type of aeration process may be accomplished in a variety of ways using different type of equipment including surface aeration, submerge aeration and fall water unit [4].

Joseph A. Salvato& David A. Cornwell (2003) found that the water treatment plants produce some type of waste stream, the quality and characteristics of these streams are related to main treatment process. These streams could impact the finished water quality or recycled. Whatever the treatment process produce was dealt with in technically appropriate manner with increasing costs associated with managing waste streams, it has become produce to consider the waste stream quality and characteristics as part of overall evaluation and design of main water treatment process. The waste streams must be viewed as a part of process to be optimized when determining the most economical method for meeting a specific set finished water quality goal [5].

Chapter Three

WATER TREATMENT PLANT SPECIFICATIONS

3-1 GENREAL

Many aquifers and isolated surface waters are high in water quality and pumped from the supply and transmission network directly to any number of end users, including Human consumption, irrigation, industrial processes, or fire control. However, clean water sources are the exception in many parts of the world, particularly regions where the population is dense or where there is heavy agricultural use. In these places, the water supply must receive varying degrees of treatment before distribution.

The method and degree of water treatment are important considerations for environmental engineers. Generally speaking, the characteristics of raw water determine the treatment method. Most public water systems are relied on for drinking water as well as for industrial consumption and fire fighting, so that human consumption, the highest use of the water, defines the degree of treatment. Thus, we focus on treatment techniques that produce potable water.

A typical water treatment plant is diagrammed in Fig. (3-1). It is designed to remove odors, color, and turbidity as well as bacteria and other contaminants. Raw water entering a treatment plant usually has significant turbidity caused by colloidal clay and silt particles. These particles carry an electrostatic charge that keeps them in continual motion and prevents them from colliding and sticking together. Chemicals like alum (Aluminum sulfate) are added to the water both to neutralize the particles electrically and to aid in making them “sticky” so that they can coalesce and form large particles called flocs. This process is called coagulation and flocculation and is represented in stages 1 and 2 in Fig. (3-1).

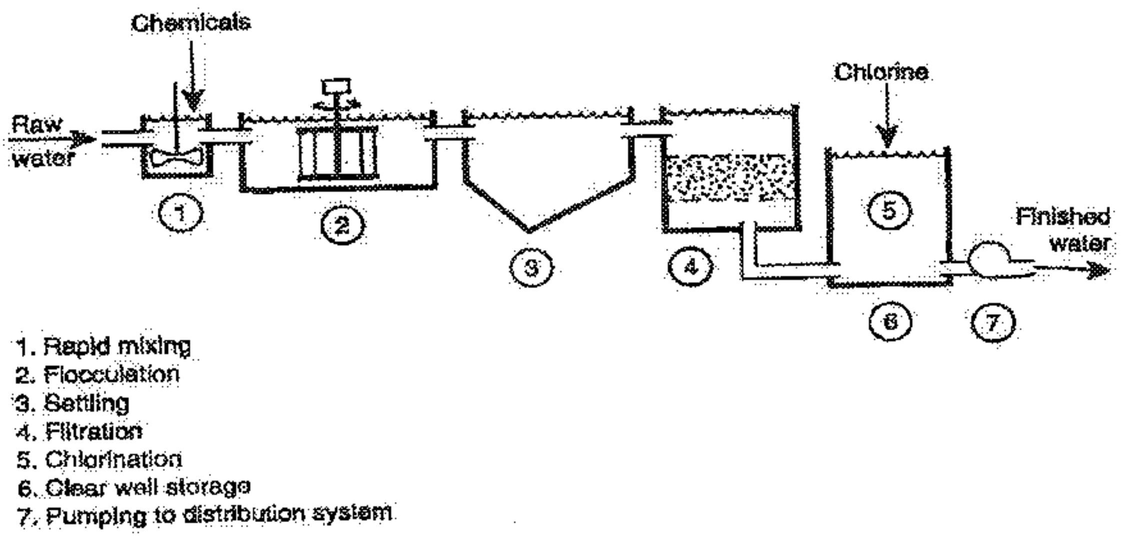

Figure (3-1):- typical Water Treatment Plant

3-2 COAGULATION AND FLOCCULATION

Naturally occurring silt particles suspended in water are difficult to remove because they are very small, often colloidal in size, and possess negative charges, and are thus prevented from coming together to form large particles that could more readily be settled out. The removal of these particles by settling requires first that their charges be neutralized and second that the particles be encouraged to collide with each other. The charge neutralization is called coagulation, and the building of larger flocs from smaller particles is called flocculation. Figure (3-2) shows the flocculator used in water treatment.

The solid particle is negatively charged, and attracts positively charged ions counterions from the surrounding fluid. Some of these negative ions are so strongly attracted that they are virtually attached to the particle and travel with it, thereby forming a slippage plane. Around this inner layer is an outer layer of ions consisting mostly of positive ions, but they are less strongly attracted, are

loosely attached, and can slip off. The charge on the particle as it moves through the fluid is the negative charge, diminished in part by the positive ions in the inner layer. The latter is called the zeta potential.

So the net negative charge is considered a repulsive charge, since the neighboring particles are also so charged, In addition to this repulsive charge, however, all particles carry an attractive electrostatic charge, van der Waals force that is a function of the molecular structure of the particle. The combination of these forces results in a net repulsive charge, an energy barrier that prevents the particles from coming together. The objective of coagulation is to reduce this energy barrier to 0 so that the particles no longer repel each other.

Adding trivalent cations to the water is one way to reduce the energy barrier. These ions are electro statically attracted to the negatively charged particle and; because they are more positively charged, they displace the monovalent cations. The net negative charge and thus the net repulsive force are thereby reduced under this condition. Alum (aluminum sulfate) is the usual source of trivalent cations in water treatment. Alum has an advantage in addition to its high positive charge some fraction of the aluminum ions may form aluminum oxide and hydroxide by the reaction,

$$Al^{+3} + 3OH^{-} \rightarrow Al(OH)_3 \downarrow$$

These complexes are sticky and heavy and will greatly assist in the clarification of the water in the settling tank if the unstable colloidal particles can be made to come in contact with the floc. This process is enhanced through an operation known as flocculation. The flocculation introduces velocity gradients into the water as a result of a power input in a given volume of water V as:

$$G = \left(\frac{P}{V\mu}\right)^{0.5} \quad \text{......} \quad (3\text{-}1)$$

Where: - G =velocity gradient (in s^{-1})

P= power (N/s or ft-lb/s)

μ= viscosity (in dyne-s/cm^2 or lb-s/ft^2), and

V =tank volume (in m^3 or ft^3).

Generally accepted design standards require G to be between (30 – 60) s^{-1}. Time is also an important variable in flocculation.

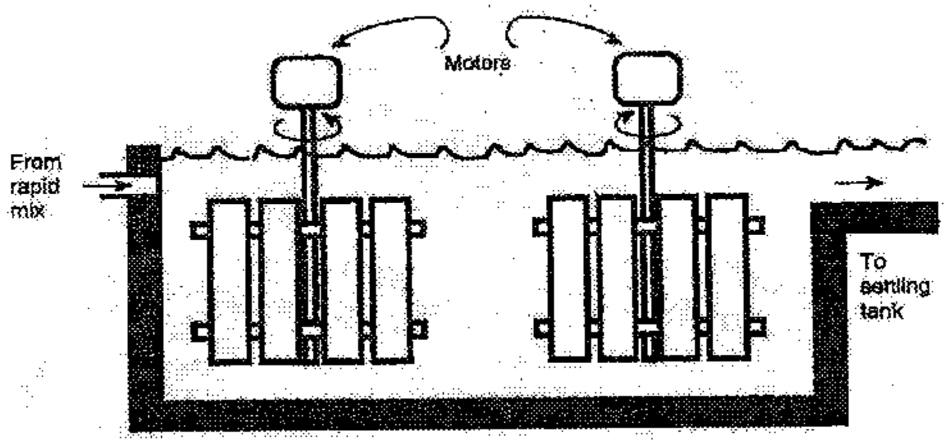

Figure (3-2):- flocculator used in water treatment

3-3 SETTLING

When the flocs have been formed they must be separated from the water. This is invariably done in gravity settling tanks that allow the heavier than water particles to settle to the bottom. Settling tanks are designed to approximate uniform flow and to minimize turbulence. Hence, the two critical elements of a settling tank are the entrance and exit configurations. Figure (3-3) shows one

type of entrance and exit configuration used for distributing the flow entering and leaving the water treatment settling tank.

Alum sludge is not very biodegradable and will not decompose at the bottom of the tank. After some time, usually several weeks, the accumulation of alum sludge at the bottom of the tank is such that it must be removed. Typically the sludge exits through a mud valve at the bottom and is wasted either into a sewer or to a sludge holding and drying pond. In contrast to water treatment sludges, sludges collected in waste water treatment plants can remain in the bottom of the settling tanks only a matter of hours before starting to produce odoriferous gases and floating some of the solids. The water leaving a settling tank is essentially clear. Polishing is performed with a rapid sand filter.

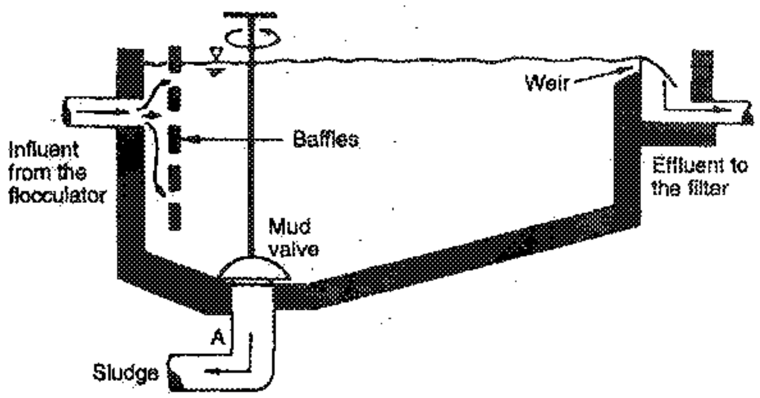

Figure (3-3):- Settling tank used in water treatment

3-4 FILTRATION

In this section discuss the movement of water into the ground and through soil particles and the cleaning action the particles have on contaminants in the water. Picture the extremely clear water that bubbles up from "under ground streams "as spring water. Soil particles help filter the ground water, and through the years environmental engineers have learned to apply this natural process in water treatment and supply systems, and have developed what we now know as the rapid sand filter. The actual process of separating impurities from carrying liquid by rapid sand filtration involves two processes: filtration and backwashing.

Figure (3-4) shows a cutaway of a slightly simplified version of a rapid sand filter. Water from the settling basins enters the filter and seeps through the sand and gravel bed, through a false floor, and out into a clear well that stores the finished water. Valves A and C are open during filtration.

The rapid sand filter eventually becomes clogged and must be cleaned. Cleaning is performed hydraulically. The operator first shuts off the flow of water to the filter, closing valves A and C, then opens valves D and B, which allow wash water (clean water stored in an elevated tank or pumped from the clear well) to enter below the filter bed. This rush of water forces the sand and gravel bed to expand and jolts individual sand particles into motion, rubbing against their neighbors. The light colloidal material trapped within the filter is released and escapes with the wash water. After a few minutes from (5 to 10), the wash water is shut off and filtration is resumed.

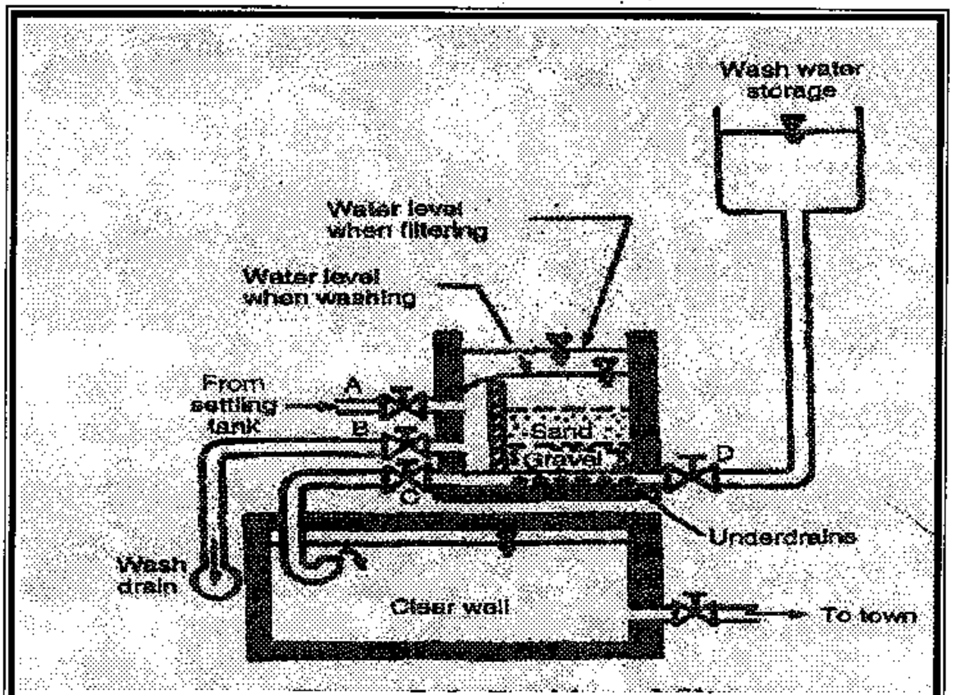

Figure (3-4):- rapid sand filter

3 -4 -1 SOLID IMPURITIES REMOVAL

The solid impurities in the water are removed by many processes, the most important of which are straining; sedimentation, interception, and diffusion (Fig. 3-5). Straining, possibly the most important mechanism, takes place exclusively in the first few centimeters of the filter medium. As the filtering process begins, straining removes only particles in the water large enough to get caught in the pores (A in Fig. 3-5). After a time, these trapped particles themselves begin to form a screen that has smaller openings than the original filter medium. Smaller particles suspended in the water are trapped by this mat and immediately begin acting as part of the screen. Thus, removal efficiency owing to screening tends to increase in some proportion to the time of the filtration phase.

In sedimentation, larger and heavier particles do not follow the fluid streamline around the sand grain, and settle on the grain (B in Fig. 3-5). Interception occurs with particles that do follow the streamline, but are too large

and are caught because they brush up against the sand grain (C in Fig. 3-5). Finally, very small particles are experiencing Brownian motion and may collide with the sand grain by chance. This process is called diffusion (D in Fig. 3-5).

The first three mechanisms are most effective for larger particles, while diffusion can occur only for colloidal particles. Efficiency removal is high for both large and small particles, and substantially reduced for mid sized (about 1 μm) particles. Unfortunately, many viruses, bacteria, and fine clay particles are about 1 μm in size, and thus the filter is less effective in the removal of these particles.

Filter beds are often classified as single medium, dual media, or tragedian. The latter two are often utilized in wastewater treatment because they permit solids to penetrate into the bed, have more storage capacity, and thus increase the required time between back washings. Also, multimedia filters tend to spread head loss buildup over time and further permit longer filter runs.

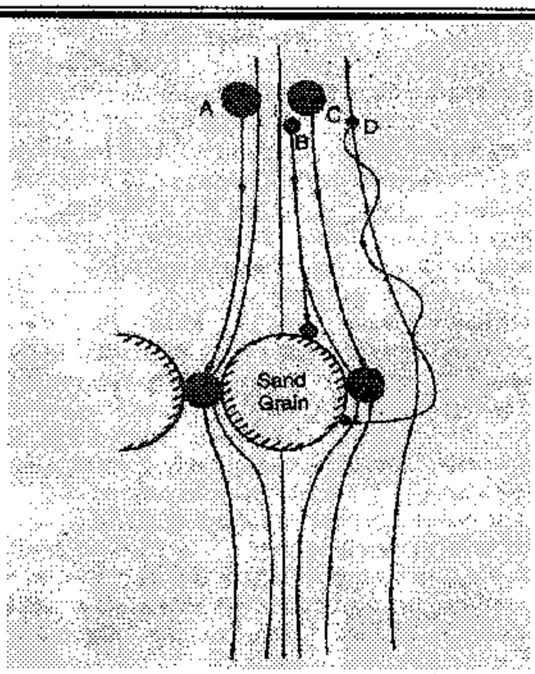

Figure (3-5):- Mechanisms of solids removal in a filter:

(A): Straining, (B): Sedimentation

(C): interception, (D): diffusion.

3-4-2 HEAD LOSSES

Head loss through the sand is a primary condition in filter design. As sand gets progressively dirtier the head loss increases. Figure (3-6) shows a simplified representation of head loss in a filter.

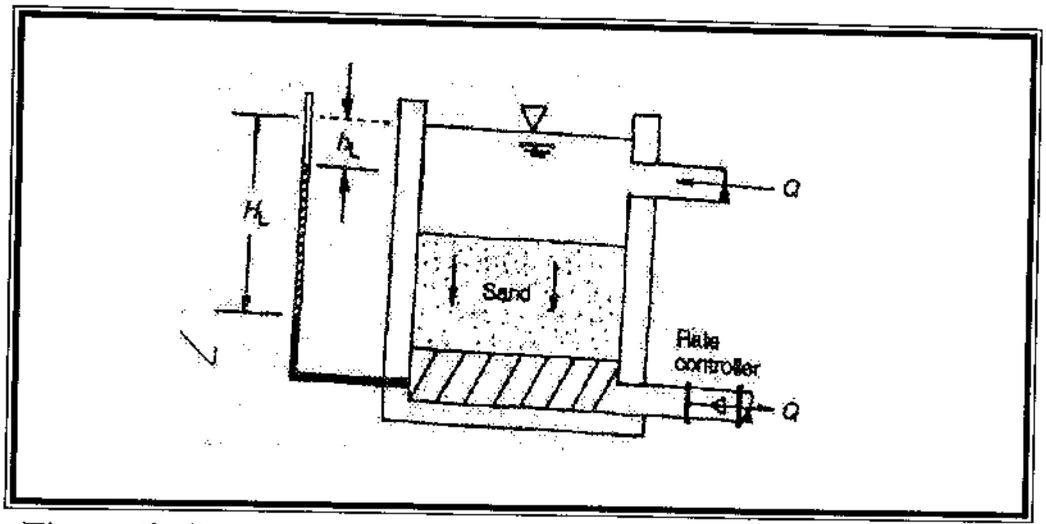

Figure (3-6):- Head loss in a filter as measured by a manometer.

Although the head losses experienced in a particular application cannot be predicted, the head loss in clean sand may be estimated by several different equations. One of the oldest and most widely used methods is the Cannan-Kozeny equation. Head loss in clean sand while filtering may be estimated by first considering the filter to be a mass of pipes, in which case the Darcy-Weisbach head loss equation applies, which is

$$h_l = f \frac{L}{D} \frac{v^2}{2g} \quad \text{.......} \quad (3\text{-}2)$$

Where:

L =depth of filter, f=friction factor. , D = pipe diameter, v = velocity in pipes

However, the pipes or channels through the sand arc not straight and D varies, so we can substitute D = 4R, where

$$R = \frac{area}{wetted\ perimeter} = \frac{\pi D^2/4}{\pi D} = \frac{D}{4} = \text{hydraulic ratio} \quad \text{.........} \quad (3\text{-}3)$$

We thus have:-

$$h_L = f\frac{L}{4R}\frac{v^2}{2g} \quad \text{.........................} \quad (3\text{-}4)$$

The velocity of the water approaching the sand is:

$$V_a = \frac{Q}{A'} \quad \text{..............................} \quad (3\text{-}5)$$

And the velocity through the bed is:-

$$V = \frac{V_a}{e} \quad \text{.....................................} \quad (3\text{-}6)$$

Where:

e = porosity, Q = flow rate and , A' surface area of the sand bed.

The total channel volume is the porosity of the bed multiplied by the total volume, or eV. The total solids volume is (1-e) times the total volume, which is also equal to the number of particles times the volume of the particles. Thus the total volume is:

$$NV_p/(1\text{-}e)$$

where N = number of particles and V_p =volume occupied by each particle. The total channel volume is

$$eNV_p/(1\text{-}e)$$

and since the total wetted surfaces NA_P, where A_p is the surface area of each particle, The hydraulic radius

$$R = \frac{area}{wetted\text{-}perimeter} = \frac{volume}{area} = \frac{e\frac{NV_p}{1-e}}{NA_p} = \left(\frac{e}{1-e}\right)\left(\frac{V_p}{A_p}\right).$$

For spherical particles, V_p/A_p = d/6, but for particles that are not true spheres,

$V_p/A_p = \varphi$ (d/6), where φ is a shape factor. For example, 4 =0.95 for Ottawa sand which is common filter sand. We thus have

$$R = \left(\frac{e}{1-e}\right)\varphi\,(d/6) \quad \text{.................................} \quad (3\text{-}7)$$

Substituting Equations. (3-3), (3-4), and (3-5) into Equation. (3-2),

$$h_L = f\left(\frac{L}{\varphi d}\right)\left(\frac{1-e}{e^3}\right)\left(\frac{v^2}{2g}\right) \quad \text{(3-8)}$$

The friction factor may be approximated as

$$f = 150\left(\frac{1-2}{R}\right) + 1.75 \quad \text{(3-9)}$$

Where R is the Reynolds number which is equal to $R = \varphi\left(\frac{\rho v_a d}{\mu}\right)$,

The preceding discussion is applicable to a filter bed made of only one size particle. The deposition of material during the filtering process increases the head loss through the filter. And also a filter run is the time a filter operates before it must be cleaned. The end of a filter run is indicated by excessive head loss or excessive turbidity of the filtered water. If either of these occurs, the filter must be washed.

The flow rate in most filters is controlled by a value that allows only a given volume of water to pass through, regardless of the pressure. Such rate controllers allow the filter to operate at a constant rate, as shown by curve A in Fig.(3-7). An alternative method of filter operation is to allow the water to flow through at a rate governed by the head loss, as shown by curve B in Fig. (3-7).The relative advantages of these two methods of filter operation are still being debated.

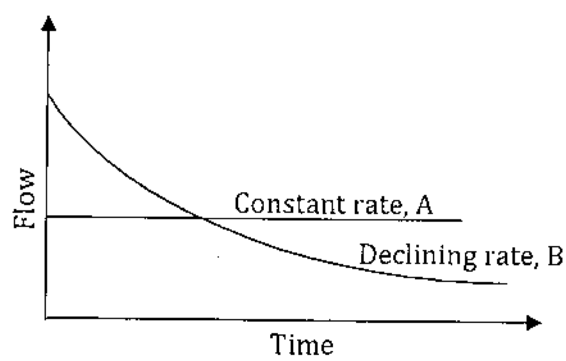

Figure (3-7):- Flow rate through a filter.

3-5 DISINFECTION

After filtration, the finished water is often disinfected with chlorine (Step 5 in Fig. 3-1). Disinfection kills the remaining microorganisms in the water, some of which may be pathogenic. Chlorine from bottles or drums is fed in correct proportions to the water to obtain a desired level of chlorine in the finished water. When chlorine comes in contact with organic matter, including microorganisms, it oxidizes this material and is in turn itself reduced. Chlorine gas is rapidly hydrolyzed in water to form hydrochloric acid and hypochlorous acid, which is ionizes further. At the temperatures usually found in water supply systems, the hydrolysis of chlorine is usually complete in a matter of seconds, while the ionization of hypochlorous is instantaneous.

Many water plant operators prefer to maintain a residual of chlorine in the water. Then if organic matter, like bacteria, enters the distribution system, there is sufficient chlorine present to eliminate this potential health hazard.

Chlorine may have adverse secondary effects. Chlorine is thought to combine with trace amounts of organic compounds in the water to produce chlorinated organic compounds that may be carcinogenic or have other adverse health effects.

A number of municipalities also add fluorine to drinking water, since fluorine has been shown to prevent tooth decay in children and young adults. The amount of fluorine added is so small that it does not participate in the disinfection process.

From the clear well (step 6 in Figure 3-1) the water is pumped into the distribution system. This is a closed network of pipes, all under pressure. In most cases, water is pumped to an elevated storage tank that not only serves to equalize pressures but provides storage for fires and other emergencies as well[1].

Chapter

Four

Al-Mussyeb *water treatment plant*

4-1 GENERAL

In this project, Al-Mussyeb Water treatment plant as a practical case study. This station was established in 1978 on the Euphrates River with design age 20 year to serve the Mussyeb city and some around villages. The total design capacity of the project is (2160 m^3/hr) with efficiency of (80%). The actual discharge is (1728 m^3/hr). This station consist of many hydraulic parts to treated the water and pump to distribution system which explained below.

4-2 PARTS OF STATION

4-2-1 INTAKE

This station include four intakes of water with cylinder form filter have circulatory perforate and valve to stop the water coming entry into the station when drawing pumps stopped and to guarantee that phenomenon of hammer not occur that smashing the intake. Water draws from intake by four pumps with discharge of (700 m^3/hr) each and the total energy of these four pumps equal to (2800 m^3/hr) with efficiency of (80%). this pump work to rise the water level to (11m) in Euphrates river.

4-2-2 FLASH MIX

The flash mix takes up the water by drawing pumps which rise to it. mixing is an important operation for coagulation process. In practice rapid mixing provides complete and uniform dispersion a chemical and water mixed with alum. The alum formed by adding it from four pump to three separated tanks, alum and water mixed together by three mixers and then this water in these separated take pumped to flash mix upside pipe. The alum which added to water made rapid sedimentation and particle in the soil coagulation. the flash mix takes have three gates to water to sedimentation takes in some time chorine adding to flash mix tank to initial purifying by pipe to kill any algae or mycological.

4-2-3 SEDIMENTATION TANK

In this station there are three sedimentation tanks with circular shape each and diameter of changeable depth (8m) outside of tank and (9m) at the center of tank. The water inter from top of sediment tank to lower level and then exist from round tank called locally (skirt) where primary sedimentation (flocculate) occur. Final sedimentation occurs in outer tank. In this tank the muds have rasping works (24hr) to clean tank from sedimentation mud which take mud to three holes in the bottom of sedimentation tank and then they collected in one channel. The water used in this tank and go to filter is faller water from sedimentation tank canals drive water to filters.

4-2-4 FILTRATION

After sedimentation occurred, water inter to the filter by canals with gravity active to ten filter with dimension of ($4\times 10m^2$) and with depth of ($5m$). The filter consist from upper to lower (sand, soft ballast, and big ballast (boulder)), to perforate ground which form in shape flagstone have (150 nozzles). These ingredients have thickness of (170cm) but after time of work, layer of sand has absence then the thickness lower to (160cm), the discharge from each filter is ($216m^3$/hr) with (80%) efficiency and designing age as (20 year).

Every filter tank has five valves. The advantages of these valves are:-

- Discharge filtered water to earth ground tank with ($200mm$) diameter of pipe.
- Washing the filter with ($300mm$) diameter.
- Using to pump air during washing the filter with (200mm) diameter.
- Safety
- Using to riddance mud after washing filters.

The washing process has been done when water level in the filter becomes low and one of sections is empty to sweep mud. In washing first we closed the valve that going to storage tank and separate the two air pumps to destroy layers of clay which causative closing the nozzle later pumped water from lower to top filter then we opened valve to draw mud and clean filter after that we closed air valve and washing mud and working keep going . The operation of washing in station has been done every day with rotated five filter in morning and five in evening. In case of turbidity of water the washing process need more than number of wash in the day, the filter has upper hole used in case of swelling (filling) as safety the outer water from these ten filter pumped by gravity to main channel drive water to storage tank.

4-2-5 STORAGE TANK

After the finishing of filtration process, the water pumps to storage tank and adding chlorine gas to it to sterilize water and kill bacteria (germs).

4-2-6 PUMP TO DISTRIBUTION SYSTEM

The quantity of treated water at the Mussyeb treatment plant depends on consumption of cities that the station served which they are:

1. Abu Hamadan town (the required discharge is 240m^3/hr, H=43m).
2. Al-Mussyeb Alkaper town (the required discharge is 300m^3/hr, H=31m).
3. Alexandria and Alhasoa towns (the required discharge is 660m^3/hr, H=85m).
4. One pump to village near the plant.

The total design energy of the station is (2160m^3/hr) with efficiency of (80%) thus the actual value of discharge is (1728m^3/hr).

4-3 PROBLEMS AND SOLUTIONS

There are several problems in Al mussyeb water treatment plant, some of these are:-

1- The hydraulic designing of plant depended on discharging the mud directly to river without locks by three mud treated pumps but after building the plant the designers found that the level of river is high from project therefore the mud flooded the plant and the three pump are not enough to discharge mud, for this reason they put immersed pump to increase draining mud.

2-The pump of drawing water from the river is lower than the pumps ton distribution system, the solution of this problem is raising the drawing pumps to elevation of the pumps which discharge to distribution system.

3-The plant needs to bacteriological laboratories because the nearest install central labs checking water is about (1km) far from the station.

4-The electric board mannequin to moisture and nearby the pumps, thus it needs a specially isolated room.

5-In sedimentation tank outer (tire) of rasping sometime way out of edge of tank therefore the (tire) destroyed because the sweeping heaviness and gear box troubles. In case the water containing (algae or duckweeds) and mosses water treat with initial chlorine in flash mix stage to treat this livening because it made layer on filter and clogged it.

6-Use the open cannels to convey water from sedimentation tank to filter and filter not cover from the top then they must be use close conduit pipe instead of cannels.

7-The plant work one emergency line of electrical and when power cut from this line use electrical generators.

8- The filters is washed per day in two shaft five filters in the morning and five filters in the evening without know the filter clogged or not, then the gage must be added in inlet filter and outlet in the filter which measure the head loss in the filter. The gage is regulating the time of washing.

Chapter

Five

METHODS OF REMOVING ALGAE FROM WATER

5-1 GENERAL

For number of years the water treatment plant had been dealing with water contaminated with compounds caused by blue- green algae (cyan bacteria) that at times exceeded a million cell/mL. Although the processes used includes the *application* of algaecides, desertification and dosing with powdered active carbon (PAC) were generally successful they were time consuming and expensive. Occasionally when algae cant reached an exceptional high level or for operational reasons treatment was less than optional. Taste and odors were not totally controlled and customer complaints were received [4].

5-2 METHODS OF REMOVING ALGAE FROM WATER

5-2-1 CHLORINE: - chlorine (as a solid –liquid or gas) has been the primary disinfectant used in (USA) because it is effective and inexpensive and can provide a disinfectant residual in the distribution system. Ozone and ultraviolet radiation can also be used as primary disinfection, but chlorine or an appropriate substitute must also be used as a secondary disinfectant after the main treatment processes to prevent re-growth of microorganisms in the distribution system. A small amount of chlorine is added to keep the water from developing bacteria as it travels throughout the distribution pipes the amount of chlorine (usually no more than three parts per million) is carefully measured to be the lowest possible amount needed to keep the water free from germs. Residual chlorine at the tap should be near 0.5 parts per million. After the process of filtration the finished water is often disinfected with chlorine which kills the remaining microorganisms in the water some of which may be pathogenic. Chlorine from

bottles or drums is fed in correct proportional to the water to obtain desired level or chlorine in finished water when chlorine comes in contact with organic matter

Including microorganisms it oxidizes this material and is turn itself reduced chlorine gas is rapidly hydrolyzed in water to from hydrochloric acid and hybochlorous by the reaction

$$Cl_2 - H_2O \rightarrow HOCl + H^+ + Cl^-$$

The hypochlorous acid itself ionizes further

$$HOCl \rightarrow OCl^- + H^+$$

The hydrolysis of chlorine usually complete in a mater of seconds while the ionization of $HOCl$ is stantanous. Both $HOCl$ and OCl^- are effective disinfectants and are called free available chlorine in water. Free available chlorine kills pathogenic bacteria and thus disinfects the water [2].

***5-2-2 OZONE*:** The processes used which included the application of algaecides, desertification and dosing with powdered activated carbon (PAC), were generally successful they were time consuming and expensive. Occasionally, when the algal reached an exceptionally high level or for operational reasons treatment was less than optional, taste and odors were not totally controlled and customer complaints were received

The main methods used to remove taste and odor compounds from raw water are dosing with PAC, chemical dosing (for example potassium permanganate or chlorine) and ozonation. As noted the first method was already in use in and the second was considered impractical for a number of reasons. However the combination of ozonation and biological activated carbon (BAC) filtration is a relatively common process used in Europe and North America for the removal of natural organic material. Although the use of this process for

removal of taste and odor and algal toxins is a relatively new application for this technology, there was evidence that geosmin and 2-methyllisoborneol (MIB), both major components of taste and odor problems, could be successfully removed.

5-2-3 OZONE BAC PROCESS: Ozone BAC is a two stage process that consists of (injecting ozone into water and allowing it to stay in contact for a predetermined time) followed by filtration through a bed of biological activated carbon. If the process is retrofitted into an existing plant a pumping stage is required either before or after ozonation.

The primary reactions involved in the ozonation stage include the break down of complex organic carbon matter present in the water into simpler molecules that are readily biodegradable. This biodegradable matter supports the growth of micro-organisms in the granulated activated carbon (GAC) filters. The biological system established on the media converts the GAC filter media into a BAC filter that combines adsorption, filtration and biological action to remove contaminants. The ozone BAC process configuration is show in figure (5-1).

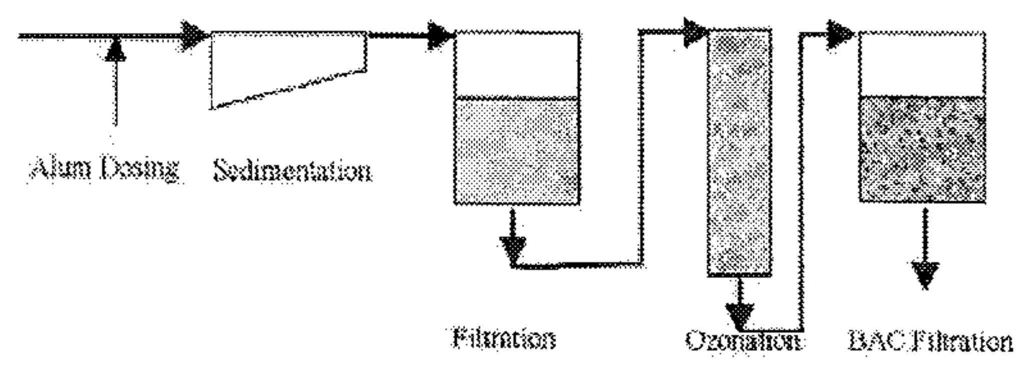

Figure (5-1) Ozone BAC Process Configuration

The ozone dose for BAC process is (1.7mg/L) which resulted in an ozone residual of (o.11mg/L) at the contactor outlet, indicating complete oxidation of organic material. The disinfection residual-time product, CT is (0.45mg.min/L).

The incoming settled water turbidity ranged between 0.5 and 2.6 NTU with ozone BAC filtration resulting in a final turbidity ranging from 0.13 to 0.27 NTU. The color of the settled water ranged between 2 and 35 HU. The ozone BAC process proved to be very effective in reducing color, consistently reducing the levels down to between 1.1 and 1.5 HU.

The ozone BAC process gives very effective removal of aluminum and manganese. Incoming total aluminum levels of between (152µg/L) and (85µg/L) were reduced to (61µg/L) by ozonation at a Ct value of (0.45mg.min/L) by a signification amount (49%). BAC filtration resulted in a further 59% reduction to (25µg/L). Similarly manganese in a concentration of (39µg/L) is reduced to (18µg/L) and then to below (10µg/L) by ozonation and BAC filtration. The efficiency of the ozone BAC process in MIB and Geosmin removal is as shown in figure (5-2)

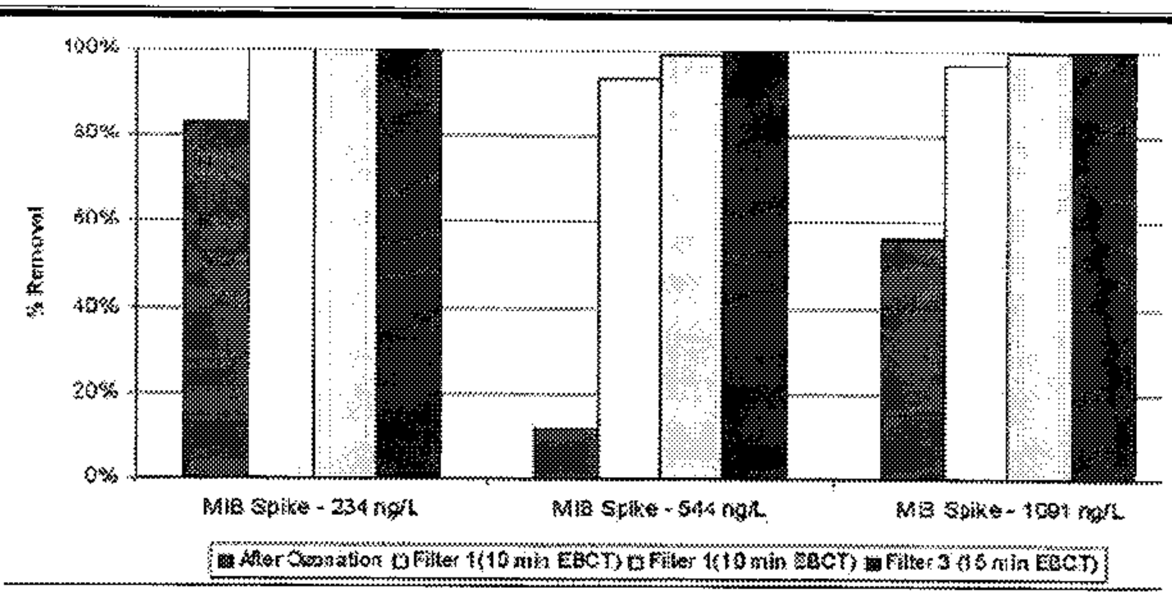

Figure (5-2) Percentage MIB removal by Ozone BAC Process

As can be seen ozone treatment by itself had little impact on MIB at the higher concentrations [4].

5-2- 4 SAX TOXINE REMOVAL: Sax toxin is an intracellular neurotoxin found is several species of cyan bacteria that has been identified as having potentially adverse effects on human health. The destruction of sax toxin by ozone was investigated by using a small scale bubble contactor and ozonator. This provided 94% destruction at higher levels of sax toxin. A further test was carried out to determine the reduction in sax toxin by BAC filtration alone. This was even more effective than ozone treatment achieving 100% reduction at all levels tested.

5-2-5 CRYPTOSPORIDIUM: this is a parasitic protozoan that can cause serious public health events when an outbreak occurs in municipal water supplies. It is resistant to many methods of disinfection commonly used in water treatment. Using a CT value of (4mg.min/L) ozonation was found to achieve of (5000 oocysts/L) of cryptosporidium.

5-2-6 CHLORINE DEMAND AND BY-PRODUCTS: The investigation showed that as well as the reduction or elimination of the main adverse parameters effecting the water treatment process there were other beneficial side effects. Chlorine jar tests were undertaken on filtered water and treated water from each of the BAC filters. These indicate that ozone BAC treatment significantly reduced the normal system chlorine demand between 20% and 50%. In addition by products from disinfection, trihalomethanes were reduced by 72% as compared to filtered water from the WTP [2].

There are considerable benefits in adopting ozone BAC and that if implemented it would place as leaders in the provision of high quality water and in dealing with the water quality risks facing the community.

5-2-7 TERBUTRYN: This is a granular product containing (1%) of terbutryn as the active ingredient this product will kill most submerged vegetation although water lilies are not usually effected. The granules should be spread evenly over the water surface. Susceptible algae should be treated at an application rate of 5kg product per 1000 cubic meters water. Moderately resistant algae should be treated at rate of 10kg per 1000 cubic meters of waters. The product should be applied early in spring as soon. Growth ceases almost immediately but signs of death only usually occur after 24 weeks. Re-growth will not usually occur for at least 34 months after treatment. If dense weed growth is present only use the product on 400m long stretches of water course separated by at least 400m of untreated section and on not more than one quarter of total area of a lake or pond. Leave 14 days before re-treating each remaining section.

5-2-8 CLAROSAN: Act by inhibiting photosynthesis (production of oxygen) but does not inhibit respiration (consumption of oxygen) levels of dissolved oxygen in treated areas will dramatically after treatment and may cause harm to fish and other animal in the area. It is very important not to the entire water course at one time to allow fish and invertebrates to find unaffected areas by clarosan. It is however important that the whole system is treated within a 6-8 week period otherwise control may be reduced. Clarsan is only effective in static water when the flow is less than 1meter in 3 minutes effectively static.

5-2-9 DICHLOBENIL: Dichlobenil products are granular formations and can be used in all types of water body. The only species of algae controlled are char species. All other filamentous algae are treated these products are claimed to control most submerged rooted plants.

5-2-10 ALGAE REMOVALBY ELECTRO-COAGULATION PROCESS:-

Electro-coagulation process use for the continues flow electro-coagulation reactor used in the experiment three aluminum were utilized this type metal was selected because it could introduce the flocculation agent in to the effluent There by algae could be removed by both mechanisms of electro-flotation and electro-coagulation treatment in this method were remarkably good and the efficiencies of total suspended solids (TSS) and chlorophyll a removal reached as 99.5% and about 100% by applying power input of about (550W). This level of power input was needed for complete of algae in a low retention time of 15 minutes.

Chapter six

CONCLUSION AND RECOMMENDATIONS

6-1 CONCLUSION

From the investigation of Al-Mussyeb water treatment plant, discovered some main problems and concludes the final solution for water treatment plant:-

1. In this study, evaluate the amount of demandable water for drinking, practices and industrial use.
2. The plant have only four pumps with draw water from river ,therefore we suggest a stand by pumps of at less two are to be ready for emergency state.
3. The bacteriological laboratories are missed therefore installing central lab in station is very necessary to check the water before and after treatment.
4. The plant flooded by muds so immersed pump must be added to discharge muds and avoiding flooding occurrence.
5. To avoid impurities and pollution to be entered into filters using close conduits pipes instead of open channels to convey the water to the filters.
6. Some parts of electronic board of plant noted are randomly locations not founded in main electronic control; therefore they must be changing the location of controlling electronic boards and put in isolated cabin to prevent water and moisture.
7. Sometimes water entered the plant with some Algae and Mosses, for this reason water treated with initial chlorine and other chemical materials in flash mix to prevent filters clogged and this solution is described in chapter (Five).

6-2 RECOMMENDATIONS

A future study for the following cases are requires:

1- Study the hydraulic design by butting immersed pump to discharge the muds from station to river.
2- The old channel needs to be change to close conduit pipes to convey water from sedimentation tank to filter.
3- Estimate the change in the level of drawing pump to put them in same level of pumps that discharge to distribution system

References:-

1-Environmental Engineering , fourth edition by Ruth. F. Weiner& Robin A. Mathews(2003).

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3-Water treatment , by E.W. steel of t.j. MCGHEE (1979).

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5- Environmental Engineering fifth edition by Joseph A.Salvato,P.E,DEE 2003.

6-Drinking water purification by AlvaroE.Gil and Kevin M.Passin(2004).

Appendix

The following pictures are taken to Al-mussiyab water treatment plant during a visiting to this plant as a practical work for this project.

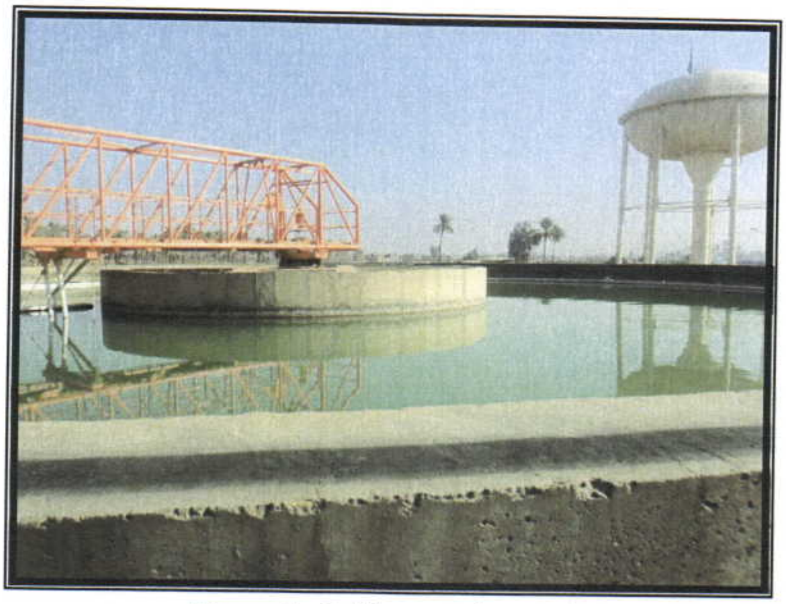

Figure 1:-Sedimentation tank

Figure 2:-input pipes for alum and choler for flash mix

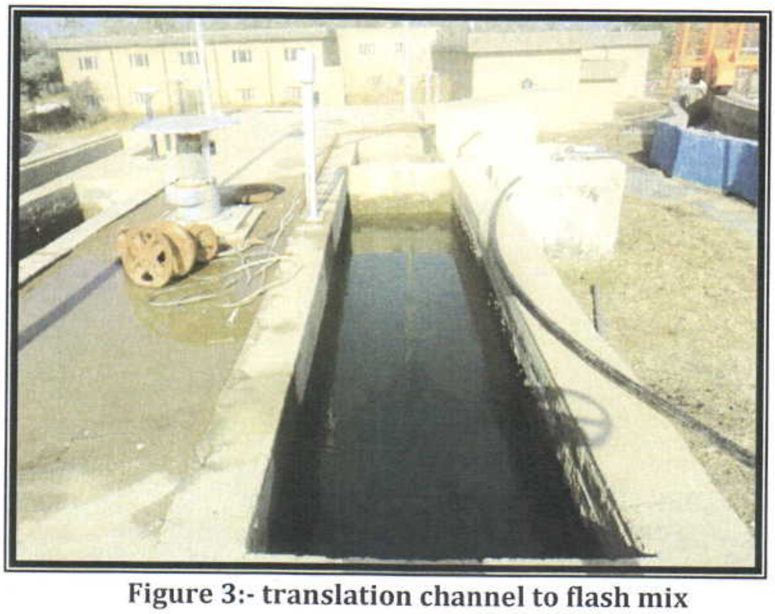

Figure 3:- translation channel to flash mix

Figure 4:- intake filters and valves

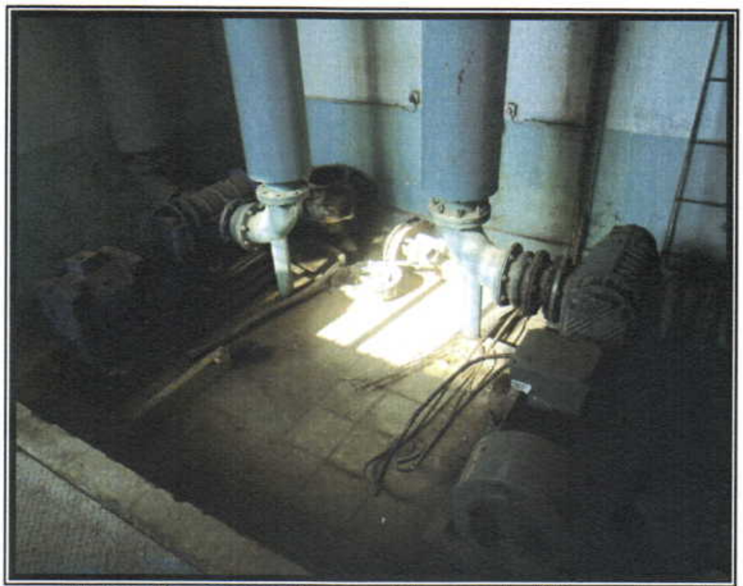

Figure 5:- pumps for pushing air to filters at pack wash

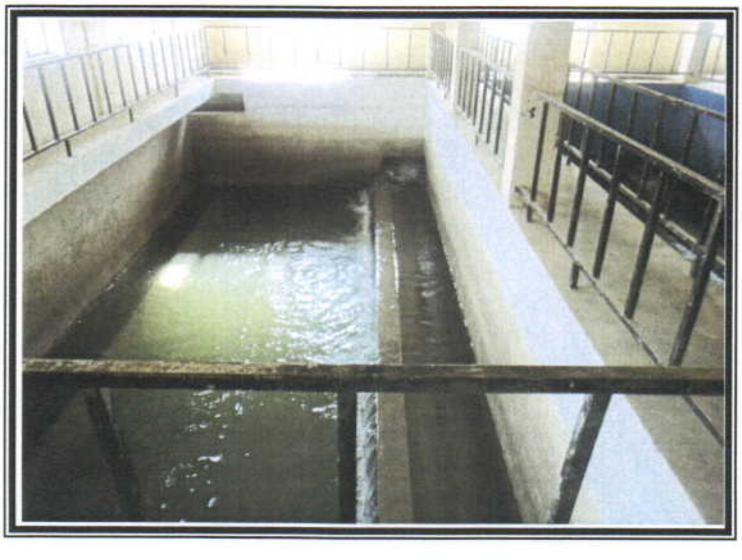

Figure 6:- filters

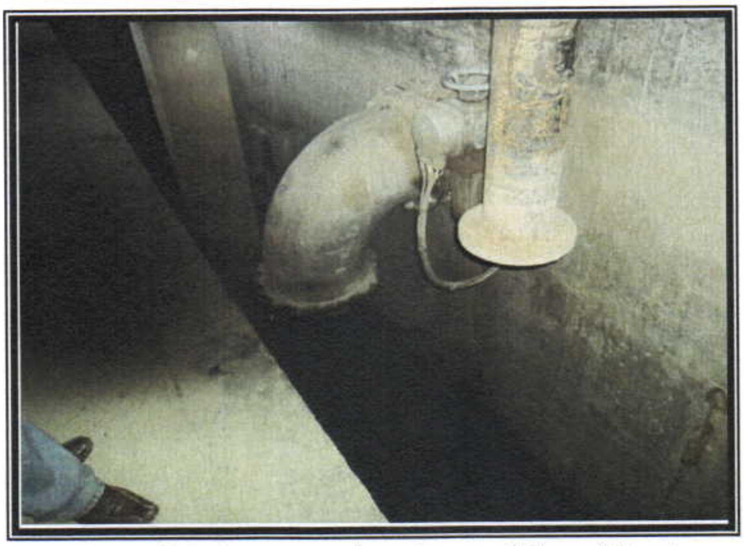

Figure 7:- pipes translate the mud from filter to the convey channel to the river

Figure 8:- immersed pumps to discharge mud