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Evaluation of AL- Mussyeb Water Treatment Plant

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بسم الله الرحمن الرحيم

وَيَسْأَلُونَكَ عَنِ الرُّوحِ قُلِ الرُّوحُ مِنْ

أَمْرِ رَبِّي وَمَا أُوتِيتُم مِّنَ الْعِلْمِ إِلَّا قَلِيلًا

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

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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).

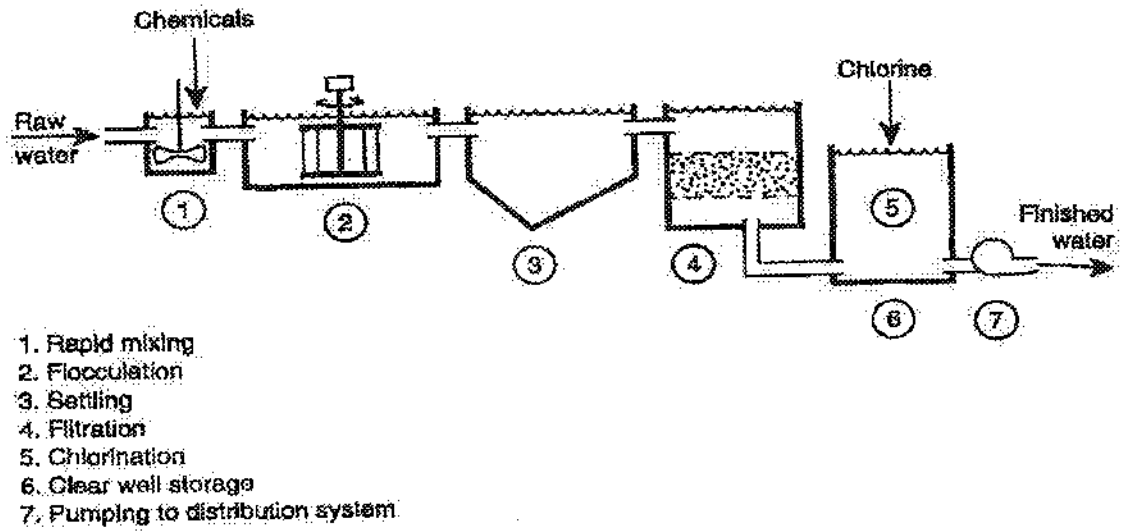

Figure (3-1)*:- typical Water Treatment Plant*

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:

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

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.

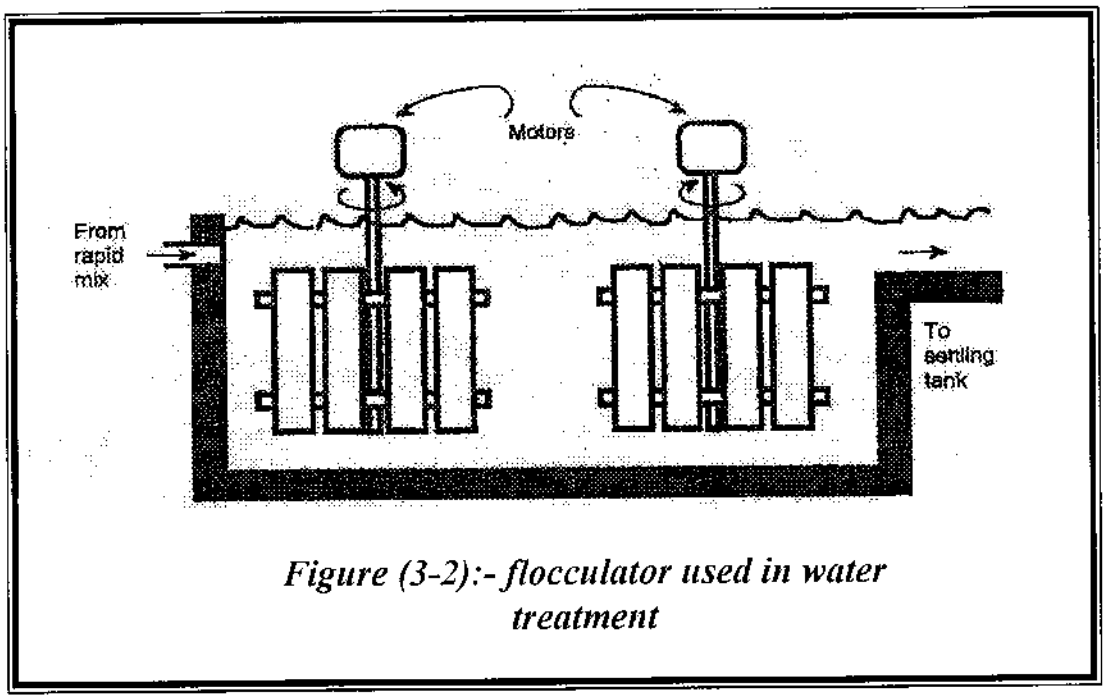

Figure (3-2):- flocculator used in water treatment

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.

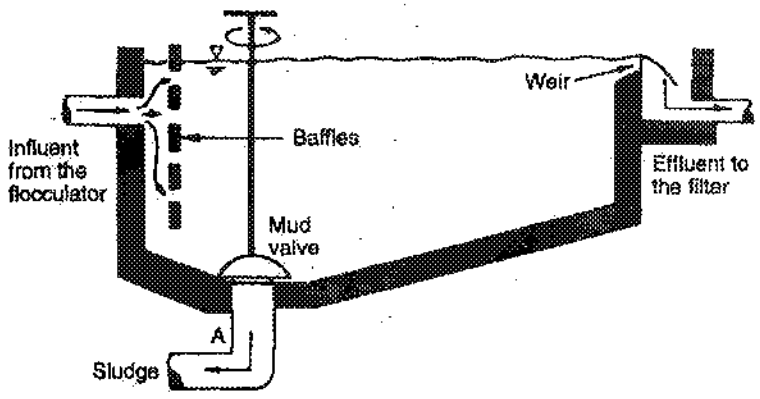

Figure* (3-3):- *Settling tank used in water treatment

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.

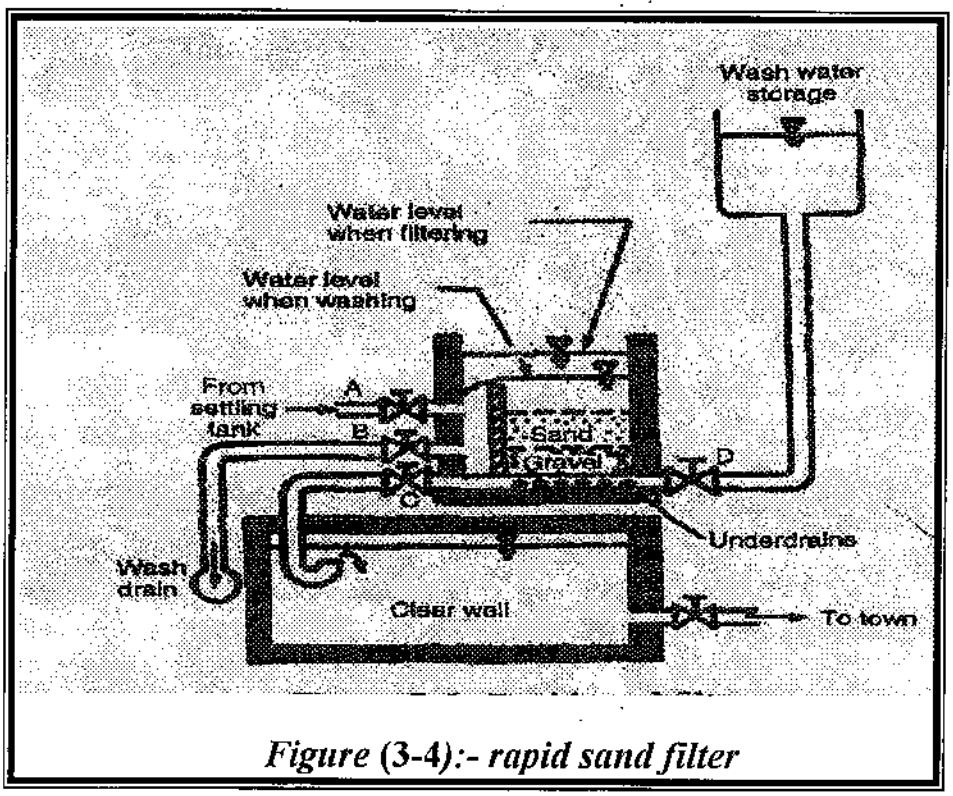

Figure (3-4):- rapid sand filter

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 1μm) particles. Unfortunately, many viruses, bacteria, and fine clay particles are about 1μm 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.

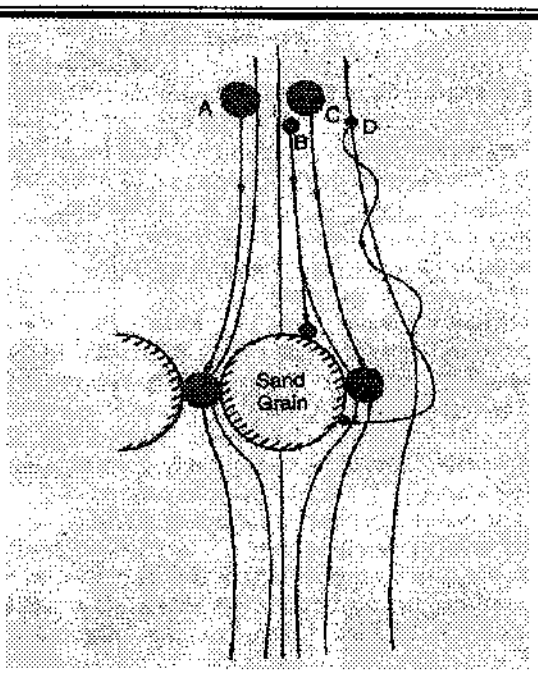

Figure (3-5):- Mechanisms of solids removal in a filter:

(A): Straining, (B): Sedimentation

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