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Overview of Filtration in Water Treatment Plant No.1 (Hesar Branch), Karaj City-Iran

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Abstract: **Water is essential for human health and well-being; there can be no life on Earth without water. Specifically in Iran country, freshwater availability is too scarce and it is necessary to provide clean drinking water to all citizens. In the Karaj city drinking water is one the main issues and challenges of the government. In Karaj Number 1 water treatment plant, water treatment process is chemical, physical and microbial during which turbidity and microbial load of raw water is reduced to the desired standard level and also modification and reduction of some chemical composition are done. Water treatment process at this treatment plant includes the following steps: Screening, Production and chemical injection of coagulant as lime and ferric chloride, Primary sedimentation, Flocculation, coagulation and sedimentation at clarifier unit of Pulsator type, Filtration with Rapid gravity sand filter, Final chlorination if needed, Storage and transferring water .This study talks about the overview of Filtration systems in water treatment plant No.1 (Hesar branch) Karaj city-Iran.**

Keywords: **drinking water, Filtration, Rapid sand filter, Karaj city-Iran.**

I. INTRODUCTION

Water is essential for human health and well-being; there can be no life on Earth without water. Specifically in Iran country, freshwater availability is too scarce and it is necessary to provide clean drinking water to all citizens. In Karaj Number 1 water treatment plant, water treatment process is chemical, physical and microbial during which turbidity and microbial load of raw water is reduced to the desired standard level and also modification and reduction of some chemical composition are done. Water treatment process at this treatment plant includes the following steps: Screening, Production and chemical injection of coagulant as lime and ferric chloride, Primary sedimentation, Flocculation, coagulation and sedimentation at clarifier unit of Pulsator type, Filtration with Rapid gravity sand filter, Final chlorination if needed, Storage and transferring water [1]. Filtration is used to separate non settleable solids from water and wastewater by passing it through a porous medium. Filtration was actually developed prior to the discovery of the germ theory by Louis Pasteur in France. In the 1700s the first water filters for domestic application were applied. These were made of wool, sponge and charcoal. In 1804 the first actual municipal water treatment plant designed by Robert Thom, was built in Paisley, Scotland. In 1854 it was discovered that a cholera epidemic spread through water, the outbreak seemed less severe in areas where sand filters were installed. British scientist John Snow found that the direct cause of the outbreak was water pump contamination by sewage water, He applied chlorine to purify the water, and this paved the way for water disinfection. The rapid sand filter commonly used in municipal drinking water, the first modern rapid sand filtration plant was designed and built by George Fuller in 1920 in Little Falls, New Jersey. And its success was responsible for the change to this technology in the U.S [2].

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II. MATERIALS AND METHODS

A. Description Of Filter Units (Filtration) In Water Treatment Plant No.1 (Hesar Branch) Karaj City-Iran:

Filtration is a physical method to remove suspended particles in any fluid such as water. These particles can be mud, colour, organic matter, plankton, bacteria, and particles of the softening process and so on. Filters can be divided into two categories:

A) Deep Filters: The act of separating particulate matter from fluid is done in depth such as gravity filters or pressure filters.

B) Surface Filters: separating action of suspended particles from the liquid is done in a very low depth which is surface of the filter, such as Filtering paper.

The final removal of suspended solids (colloidal) and micro Flocs of water that have not been deposited in the clarification stage is done in filters. After a few hours of filter operation, because of clogging the spaces between sand grains caused by particles, pressure drops which reduce the efficiency of the filter. To resolve this issue, filters are washed by air and water in reverse on alternate courses. Filters hall is with an area of 80 square meters and dimension of 40 x 2 m including the filters, washing control equipment and operation and the type of building structure is concrete. Water filtration process in this plant is carried out by eight sand filters of rapid gravity type and with dimensions of 2.5 x 6 m. Silica sand grain used in filters are between 0.7 to 1.4 mm and effective size of sand grains used in the filters are of 0.4 mm, and the total thickness of the layers of sand grains is about 100 cm and Uniformity Coefficient (UC) of grains of sand is 1.6.

Fig. 1. The view of filtration hall and sand filter bed.

B. Overview Of Filter Types Of Water Treatment Plant No.1 (Hesar Branch):

Deep filters are used in water purification. Water containing suspended particles passes through the bed of a material that can be sand or anthracite coal. As the water passes through the pores between the material, suspended solids are trapped and water almost free of suspended solids, is obtained. The accumulation of suspended particles in the pores of the filter is increasing the pressure loss (the difference between the water level on the filter surface and the water output of the filter). If this pressure loss exceeds a certain limit, the filter should be cleaned up. To start, the filters should slowly be filled up with water that flows from bottom to top, so that bed particles are immersed in water. This is necessary to remove any trapped air between the bed materials to prevent the obstruction of water by air. Sand filter types includes the following steps:

A. SLOW SAND FILTER (S.S.F):

In fact, use of Slow Sand Filter is one of the basic operations of water treatment in small communities that have been accepted as a standard for the purification of water. This type of filter is composed of concrete ponds. On floor channels with brick and cement or water outlet pipes are installed and then the holding layer (0.2 to 0.4 meters in height) and sand of the active layer (the height of 0.6 to 1.2 meters) are placed on top of them. The form of the bed is in such a way so that larger sands are at the bottom and finer sand is on highest part. Water on the filter bed with around 1 to 1.5 meters height passes through filter bed by the force of gravity and then gets out of bed and driven for disinfection process. Water passing through the bed containing suspended solids, colloids, various microorganisms and soluble salts that leaves them

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after passing through the depth of 40 to 60 cm bed, and after this depth water containing trace amounts of simple inorganic salts and relatively harmless. Bacteria activities are usually spreads to a depth of 60 cm of bed. In the slow sand filter not only most of harmful microorganisms are separated, but soluble nutrients that subsequently causes growth of bacteria in the sludge, are also eliminated.

B. RAPID SAND FILTER (R.S.F):

Structure of this type of sand filters is very similar to slow filters. So that pacifiers are installed on the floor of this type of filters, (about 50 to 70 of them per square meter). The sands are formed (preservatives and active layer) like slow sand filters. Retaining layer thickness of 0.3 - 0.6 meters and the thickness of the active layer is considered to be 1-1.2 m. Water on filter bed that has 1-1.5 meters height, by force of gravity from the depth filter bed passes through and gets out of it. Obviously, due to larger sand in the active layer (0.35-0.5 mm) and preservatives (2-25 mm) the amount of purified water per hour is more than the slow sand filter. In today modern filters, coarse sands are used instead of preservative layer and often pacifiers are used instead of drainage pipes. These pacifiers are screwed at the bottom of filter. Pacifier may be plastic or metal.

Pacifiers have grooves in which, the treated water flows below the filter. Due to the small groove (0.7 - 0.35 mm) sand grains cannot pass through them.

C. The Use Of Rapid Sand Filter And Filtering Mechanism In Rapid Sand Filtration:

Rapid Sand Filter could be used in the following conditions:

A. After aeration to separate the insoluble forms of iron and manganese, in this method water is usually sprayed from the proper height at top of the filter.

B. Water treatment of rivers with high turbidity after coagulation, flocculation and sedimentation units.

C. River Water treatment with high turbidity as pre-treatment before slow sand filter.

D. Low turbidity waters cleaning such as lakes and rivers. In this method disinfection is necessary after filtration.

In this filters also various mechanisms such as screening, electrostatic adsorption and biochemical processes are effective in separating impurities. In the first mechanism because the water flow rate is very high, so they are not effective in removing impurities, and in these filters the most effective separating mechanism is absorption.

Fig. 2. The view of Rapid Sand Filter bed.

III. CONCLUSION

The principal aim of every conventional drinking water treatment plant should be to provide accordingly sensitive standards of service, to gain customer satisfaction, delivering to consumer's water that is both aesthetically pleasing and to meet public health safety requirements [3].

Filtration is carried out for removal of fine solid particles suspended in the water that has passed from the processes of coagulation and Pulsator which those particles may stick between the sections through filters and cause filter plugging. If the obstruction becomes more then outflow decreases compared to inflow. Filters behave like a sieve with pores.

Filtration is based on Mechanical adsorption of Colloidal materials, algae and parasites. The sand filter is normally used for filtration of water containing suspended solids or to remove iron and manganese that can be deposited in ground water after aeration operation and Filtration of surface water with moderate turbidity. Rapid sand filters must be cleaned frequently, often several times a day, by backwashing, which involves reversing the direction of the water and adding compressed air. During backwashing, the bed is fluidized and care must be taken not to wash away the media [4], [5].

The quality of treated water in slow sand filter is better than rapid sand filter (no process alone cannot improve the quality of the physical, chemical and biological of water other than slow sand filter). If done well, slow sand filter is capable of reducing germs in about 99.9 to 99.99 percent.

1. Comparatively slow sand filter cost is much lesser, especially where land is cheaper and it is easier to build compare to Rapid sand filters.
2. The operation of the slow sand filters is easy and its operation cost is very low in comparison with rapid sand filters.
3. 2 to 3 percent of treated water is wasted in rapid sand filters due to continuous backwash.
4. sludge maintenance, dewatering and disposal in slow sand filter is much easier than rapid filter sand and the risk of environmental pollution caused by sludge in the slow sand filter does not exist and can be used as an Amending the soil.
5. Need for land in the slow sand filter is much higher compared to the rapid sand filters.
6. A sudden change in water quality does not cause serious problems in performance of slow sand filters.
7. Rapid sand filter's lifespan is more than slow sand filters.
8. Rapid sand filter occupy less space compared to slow sand filters.

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