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Cleaning of Water from Impurities by the Method of Filteration

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Abstract-*Water samples were taken from three industrial sites of barnala region such as Yarn factory, Gatta factory and Trident Company and were analyzed. This waste water from industries has been reaching ground water samples continuously.These have harmful effect on human health of barnala district. Hence, it is very necessary to take measures to mitigate water pollution.There are many methods of treatment of waste water and removal of pollutants.Many processes can be used for treatment of water ,such as clariflocculation ,filteration, Aeration, Chemical treatments, Adsorption, Ion Exchange by resins, membrane processes, waste Incineration etc.*

But in this research paper filteration method is discussed.

Keywords- Water pollution ,filteration, Types of filteration

1.INTRODUCTION- Filtration is the mechanical removal of turbidity particles by passing the water through a porous medium, which is either a granular bed or a membrane. Filtration's purpose is to remove all the turbidity particles carried over from the sedimentation phase, thus producing a sparkling clear water with almost zero turbidity.

Thus, filtration is a fundamental unit operation that, separates suspended particle matter from water. Although industrial applications of this operation vary significantly all filtration equipment operate by passing the solution or suspension through a porous membrane or medium, upon which the solid particles are retained on the medium's surface or within the pores of the medium, while the fluid, referred to as the filtrate, passes through.

In a very general sense, the operation is performed for one or both of the following reasons. It can be used for the recovery of valuable products (either the suspended solids or the fluid) or it may be applied to purify the liquid stream, thereby improving product quality or both. Examples of various processes that rely on filtration include adsorption, chromatography, operations involving the flow of suspensions through packed columns, ion exchange and various reactor engineering applications. In petroleum engineering, filtration principles are applied to the displacement of oil with gas (i.e. liquid-liquid separations), in the separation of water and miscible solvents (including solutions of surface-active agents) and in reservoir flow applications. In hydrology, interest is in the movement of trace pollutants in water systems, the purification of water for drinking and irrigation and to prevent saltwater encroachment into freshwater reservoirs. In soil physics, applications are in the movement of water, nutrients and pollutants into plants. In biophysics, the subject of flow through a porous media touches upon life processes such as the flow of fluids in the lungs and the kidney. Although there are numerous industry—specific applications of filtration, water treatment has historically and continues to be the largest general application of this unit operation.

The objective of this section is to provide an overview of filtration terminology and basic engineering principles, as well as calculation methods that describe the filtration process in a generalised way. The basis equations describing the generalised process of filtration have been around for nearly 100 years and with few refinements, continue to be applied to modern design practices.

2. FILTRATION DYNAMICS

When a suspension of solids passes through a porous media, the solid particles are collected on the feed side of the plate while the filtrate is forced through the media and carried away on the leeward side. A filter medium is, by nature, inhomogeneous, with pores non-uniform in size, irregular in geometry and unevenly distributed over the surface. Since flow through the medium takes place through the pores only, the micro-rate of liquid flow may result in large differences over the filter surface. This implies that the top layers of the generated filter cake are inhomogeneous and, furthermore, are established based on the structure and properties of the filter medium. Since the number of pore passages in the cake is large in comparison to the number in the filter medium, the cake's primary structure depends strongly on the structure of the initial layers. As a result, the cake and filter medium influence each other. Pores with passages extending all the way through the filter medium are capable of capturing solid particles that are smaller than the narrowest cross-section of the passage. This is generally attributed to the phenomenon of particle bridging or, in some cases, physical adsorption. Adsorption is the grouping together of molecules on the surface of a solid or liquid; such 'groupings' are the result of attractive forces between molecules.

Activated carbons are highly porous; they contain mazes of interconnecting channels. An imbalance of molecular forces in the walls attracts many substances; these are physically held (adsorbed) by the carbon surfaces. Afier much use, the carbon may be regenerated and used again. Depending on the particular filtration teclmique, different filter media can be employed. Examples of common media are sand, diatomite, coal, cotton or wool fabrics, metallic wire cloth, porous plates of quartz, chamotte, sintered glass, metal powder and powdered ebonite. The average pore size and configuration (including tortuosity and connectivity) are established from the size and form of individual elements from which the medium is manufactured. On the average, pore sizes are greater for larger medium elements. In addition, pore configuration tends to be more uniform with more uniform medium elements, the fabrication method of the filter medium also affects average pore size and form. For example, pore characteristics are altered when fibrous media are first pressed together.

Pore characteristics also depend on the properties of fibers in woven fabrics, as well as on the exact methods of sintering glass and metal powders. Some filter media, such as cloths (especially fibrous layers), undergo considerable compression when subjected to typical pressures employed in industrial filtration operations. Other filter media, such as ceramic, sintered plates of glass and metal powders, are stable under the same operating conditions. In addition, pore characteristics are greatly influenced by the separation process occurring within the pore passages, as this leads to a decrease in effective pore size and consequently an increase in flow resistance. This results from particle penetration into the pores of the filter medium. The separation of solid particles from a liquid via filtration is a complicated process. For practical reasons filter medium openings are designed to be larger than the average size of the particles to be filtered. The filter medium chosen should be capable of retaining solids by adsorption. Furthermore, interparticle cohesive forces should be large enough to induce particle flocculation around the pore openings.

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3.GRANULAR MEDIA FILTRATION

A granular media filter, generally, consists of a rectangular concrete structure with 4-feet-deep media formed of sand or a combination of sand, garnet, anthracite (crushed hard coal) and activated carbon. The media are supported by a layer of gravel. Under the gravel is a drain system for the drainage of filter effluent, called filtrate. Mostly, a small amount of cationic polymer is applied to the filter influent for micro flocculation.

Polymer and turbidity particles form a very fine floc that accumulates on the top of the filter media and forms a straining mat (also called a surface cake) that removes the turbidity. Turbidity is removed by two mechanisms, straining and adsorption. Adsorption is acquiring the turbidity particles on the surface of micro floc. Most of the turbidity is removed in the top few inches of media.

There is a slightly high turbidity during the first 10 to 15 minutes of the filtration because the mat is not effectively formed. This is known as the ripening period, after which filtration is adequate. When there is too much build-up of the surface mat and filter interstices are plugged up, the rate of filtration decreases and turbidity starts going up. At this point, the filter needs backwashing.

Backwashing is the removal of filtered-out turbidity by reversing the flow through the filter (i.e.,from the bottom upward). The time period from beginning filtration to the filter wash is called a filter run. The period from the start of filtration to the end of the backwashing is called a filter cycle. Turbidity of filter effluent and the resistance to flow, called head loss, are monitored continuously to determine the backwashing time and filter performance. Generally, a washed filter is taken out of service for at least 30 minutes for the proper settling of media before putting it back into operation.

A good filter operation removes more than 99 per cent of the feed water turbidity and produces a sparkling clear water with turbidity as low as 0.1 NTU or less.

Particle Size and Density

Particle size and density of a granular medium is expressed by three parameters: uniformity coefficient, effective size and specific gravity. The first two parameters are determined by sieving a sample of medium through a set of standard sieves with pore size as millimeters (mm). Two sieves are selected, one that allows 60 per cent of the media to pass through and retains 40 per cent and a second one that allows 10 per cent of the media to pass through and retains 90 per cent.

Uniformity coefficient is the ratio of the pore size of the first sieve to the second. Effective size is the pore size of the second sieve. If the pore size that allows 60 per cent of a medium to pass through is 0.75 mm and the pore size of the sieve that allows only 10 per cent to pass through is 0.45 m, then, uniformity coefficient of this medium is 0.75 mm/0.45 mm = 1.66 and the effective size is 0.45 mm.

Specific gravity is the ratio of the density of the medium to the density of water. It determines the vertical stratification of different media in the filter bed, with the lightest at the top and the heaviest at the bottom.

Types of Granular Filters Based on Media, Filtration Rate or Principle of Operation

The following list shows the types of filters:

1. Slow sand filters.
2. Rapid sand filters
3. High-rate sand filters.
4. Granular activated carbon multimedia filters
5. Pressure filters. .

Slow sand filters

These filters were first used in 1829 to treat the London, England, water supply. A slow sand filter is a covered underground concrete structure with a 3 to 5-foot-deep sand bed and 6 to 18 inches of graded gravel, which has the largest size at the bottom and the smallest at the top . Effective size of sand particles is 0.25 to 0.35 mm, with the uniformity coefficient 2.5 to 3.5. Media are supported by the under drain system. The filter cover is at least 6 feet above the media. The filter is operated with 3 to 5-feet-deep water above the medium. Water flows slowly through the medium and leaves most of the turbidity particles in the top layer. Loading rate is 0.03 to 0.06 gallon per minute per square foot (gpm/ft^2) of the filter surface.

Turbidity particles form a surface mat that becomes sticky due to microbial activity. This mat is called smutzdecke, which is very effective to remove particles by straining, adsorption and microbial metabolism. After the filter run, which could be several days or even weeks, the filter is taken out of service and cleaned. For cleaning, the top layer of sand is scraped, washed and stored for replacement.

The filter is cleaned several times by scraping the surface layer before replacing any sand. For an effective filtration, the minimum required depth of sand is 2 to 2.5 feet. There is no backwashing in these filters. These filters are effectively used for direct filtration of source water with very low (less than 1 NTU) turbidity such as pristine mountain streams or reservoirs.

Rapid sand filters

Unlike the slow sand filters, surface loading in these filters is 2 to 4 gpm/ft.2 and there is backwashing after the filter rim. Sand depth, in these filters, is 2 to 3 feet. The particles have an effective size of 0.35 to 0.55 mm and uniformity coefficient of 1.6. Medium is supported on 18 inches of gravel, which is graded from 4 inches to pea size. The under drain system has a Leopold or Wheeler-type false bottom for an effective drainage of the filter effluent. To facilitate the uniform flow of the water, the Leopold system has blocks with small holes and the Wheeler system has conical rectangular cavities with balls.

During filtration, there are about 30 inches of water above the medium. Free board, the distance between the surface of the medium and the lip of the backwash trough, is 24 to 27 inches to prevent any loss of medium during the backwashing. Filtration takes place in the top few inches of the medium. These filters are used to filter water with influent turbidity up to 5 NTU.

High-rate sarid filters

Rapid sand filters can be modified to create high-rate sand filters. A coarser and lighter layer of anthracite is applied above the sand to allow the turbidity particles to penetrate deeper into the media. Due to deeper penetration of particulate matter, these filters allow a higher rate of filtration, longer filter runs and an effective and economical filtration. These filters are operated at 5 to 10 gpm/ft$^{2.}$ loading. They have two or three media stratified according to their size, shape and specific gravity. The lightest and coarsest medium is at the top and the finest and heaviest medium is at the bottom. There are two types of high-rate filters: dual media and multimedia filters.

Dual media filters

Dual media filters have two media, which are anthracite and sand. Generally, the filter bed from top to bottom is formed of 18 to 30 inches of anthracite, 12 inches of sand and 12 inches of gravel. Anthracite, the crushed hard coal with angular particles and larger voids between particles, is lighter than sand. The effective size of anthracite is 0.6 to 0.7 mm, the uniformity coefficient is 1.6 and specific gravity is 1.55. Sand has rounded particles, which are more compacted with smaller voids. Effective size, uniformity coefficient and specific gravity of sand are 0.45 to 0.5 mm, 1.5 to 1.7 and 2.65, respectively. These specific gravities keep anthracite and sand well stratified after backwashing. Anthracite and sand trap the larger and smaller turbidity particles, respectively. These filters are quite common and popular among most of the water systems.

Triple media/mixed media fillers

Triple media/mixed media filters are a modification of dual media filters. A third layer of the heaviest medium is applied under the sand. Mostly, this layer is garnet, which is heavier and finer than sand. Garnet has effective size of 0.2 to 0.3 mm and specific gravity of 4.2. From top to bottom, a typical triple media filter has 36 inches of anthracite, 18 inches of sand, 8 inches of garnet and 8 inches of gravel. Garnet removes the smallest turbidity particles. There is some mixing of the media at the interface of adjacent layers, which makes them mixed media filters.

Granulated activated carbon (GAC) multimedia filters

GAC filters have a layer of activated carbon on top of anthracite or sand. Activated carbon adsorbs various contaminants, such as tastes and odour-causing organics, THMs and synthetic organics. GAC is lighter than sand or anthracite and has an effective size of 0.55 to 0.65 mm with a uniform coefficient of 2.4. These filters have the problem of losing some carbon during the backwashing; therefore, backwashing is properly controlled to prevent the excessive loss of GAC. Commonly, backwashing causes 1 to 6 per cent GAC loss per year.

All granular media filters discussed to this point are gravity flow filters.

Pressure filters

In these filters, media are enclosed in a cylindrical steel tank and the water is forced under pressure through the filter. Media are either sand or diatomaceous earth.

Rapid sand pressure filter

Rapid sand pressure filter has an 18 to 24 inches-thick sand layer with gravel underneath. The filter rate is 2-5 gpm/ft^2. Being small, their use is limited to some industries and recirculation of swimming pool water.

Diatomaceous earth pressure filters

Diatomaceous earth pressure filters have diatomaceous earth medium.Diatomaceous earth is a light medium formed of commercially available diatom fossils with particle size of 5 to 50 micrometers (μm).As compared to several inches of sand, thickness of this is only 0.06 to 0.12 inches. Turbidity particles are retained on the surface and there is hardly any penetration of them into the medium. Generally, the filtration rate is 1 gpm/fiz. These filters are used by the small water systems for low turbidity source water.

Filter Backwashing

There is no standard criterion for backwashing of a filter. Mostly, it is decided by the performance of the filter from effluent turbidly, head loss and filter run. For example, turbidity should not be more than 0.1 NTU, head loss should not be more than 6 feet (pressure as water height in feet) and filter run no longer than 24 hours. These are general guidelines, which vary from plant to plant.

Filter backwashing procedure

Following is a general step-by-step procedure for the manual filter wash:

1. Close the influent valve and let the water level drop to about 4 to 6 inches above the medium.
2. Close the effluent valve.
3. Gradually, start the surface wash system, which will loosen the surface mat of suspended material. Surface washing is done by revolving jets, by compressed air scrubbing or by mechanical rakes.
4. Open the backwash water valve gradually to prevent the media waste.
5. Open the waste-water drain valve. Wash until wash water is quite clean. Proper cleaning may take up to 10 minutes.

6. Stop the surface wash at least 2 minutes before closing the wash water valve.
7. Close the waste-water drain valve.
8. Let the media stratify properly.
9.To put the filter back in service, open the influent valve and then the effluent valve.

Modify this general procedure as required for a particular utility.

For uniformity of washing, a large number of plants have an automatic filter backwash system, which works fine; it needs to be monitored to make the necessary changes in its programming. Proper backwashing requires about 50 per cent expansion of the fluidised (suspended) sand. The percentage of sand expansion is calculated by using a stick with small panes at different heights. The stick is placed on top of the media while washing the filter. The highest pane that gets some sand is the point to which sand is expanded. The percentage of expansion is the per cent of sand particles rising. It is the rise of sand divided by the depth of the sand media and then multiplied by 100. For example, if the rise is 15 inches and the depth of media is 30 inches, the expansion is (15 inch/30 inch) X 100 = 50 per cent.

Backwash volume should not be more than 2.5 per cent of the total water filtered.

Factors affecting granular media filtration

l.Turbidity: The less the turbidity in the filter influent, longer the filter run and better is the performance.

2. Media form: The coarser the media the less is the head loss, the longer is the run and Vice versa.

3. Depth: The deeper the bed, the better is the filtration.

4. Backwashing: Proper backwashing is an important factor in the proper operation of a filter. Improper washing can cause the loss of media, mixing of media, formation of mud balls, cracks and craters. All these factors cause an inadequate filtration and a high-effluent turbidity.

5. Filtration rate: The higher the loading, the shorter the filter runs and less efficient is the filter.

6. Temperature: The higher the temperature, the better is the performance.

7. Water stability: In the lime softening plants, higher pH (above 9.3) and higher calcium carbonate content of water can cause deposition of calcium carbonate on the media particles. This build-up of calcium carbonate causes swelling of media and the formation of mud balls. Water needs to be stabilised by lowering the pH below 9.3. A controlled small amount of a polyphosphate, such as sodium hexametaphosphate, is applied as a sequestering agent to further correct this situation. Too much of a polyphosphate can cause excessive sloughing of calcium carbonate from the media particles, which causes higher turbidity and too little may not be enough for an adequate

sequestering.

8. Polymer dose: A small dose (0.5—0.75 mg/l) of a polymer is helpful in forming a micro-floc mat to aid the filtration. A higher dose causes cracks in the filter mat and a lower dose does not form an effective microfloc.

MEMBRANE FILTRATION

This process is the passing of pre-treated water under pressure through a membrane to remove specific sized particles. A membrane is a very thin paperlike structure. Membranes can achieve the degree of treatment comparable to a conventional treatment plant. Membrane treatment is one of the best treatment technologies to meet the present and expected safety for drinking water act (SDWA) challenges. It is capable of removing most of the regulated contaminants.

Conclusion- In the present time, it become very difficult to drink clean water.This is because of water pollution due to industries.In barnala region there are three industries which pollute water. Hence it is very necessary to treat water before use in order to prevent humans from harmful diseases.

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