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IMPORTANCES OF WATER AND IT'S PURIFICATIONS TECHNIQUES

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ABSTRACT

Water is mostly used as a raw material, formulation, and manufacture of pharmaceutical products, it include a water treatment system along its method the review and evaluation of high purity water systems that are used for the manufacture of drug products and drug substances. The main objective of this review was people should aware the water, misuse of water and its treatment. It includes various contaminants that may represent hazards in themselves or that may be able to react with intended product substances, which are hazards to health.

Keywords: Grades of water, Purification of water, Trickling filter, Sewage treatment, Pharmaceutical waters.

INTRODUCTION

Water is the most commonly used material in pharmaceutical formulation. Water is directly or indirectly used in the formulation inject able products and in cleaning of manufacturing equipment [1]. It is the mostly used by the pharmaceutical industry, in the excipient, or used for during synthesis, during production of finished product, reconstitution of products, or as a cleaning agent for rinsing vessels, equipment and primary packing materials etc. It has unique chemical properties due to its polarity and hydrogen bonds. This means it is able to dissolve, absorb, adsorb or suspend many different compounds [2]. There are many different grades of water used for pharmaceutical purposes. Several are described in USP monographs that specify uses, acceptable methods of preparation, and quality attributes.

Why purification of water is needed

- Although tap water is reasonably pure [3], it is always variable due to seasonal variations, regional variation in quality and some time it contain fibres, traces and volatile substances
- One must remove impurities and control microbes to avoid contamination of products.
- Pretreatment is depends on quality of feed water.

Grades of water

When a specific process requires a special non-pharmacopoeia grade of water, it should be specified and should at least satisfy the pharmacopoeia requirements.

Drinking-water

Drinking-water is unmodified except for limited treatment of the water derived from a natural or stored source [4] like wells, rivers, lakes and the sea. Treatment like softening, particle reduction, specific ions, and antimicrobial treatment [5]. It is the common impurities can be seen in the drinking-water [6]. Quality of drinking-water is covered by the WHO, ISO, guidelines. Testing should be carried out periodically by the water user's site to confirm that the quality meets the standards required for potable water [7].

Purified water

Purified water (PW) should be prepared from a potable water source as a minimum-quality feed-water, should meet the pharmacopoeias specifications for chemical and microbiological purity, microbial proliferation and recontamination [8].

Highly purified water

Highly purified water (HPW) should be prepared from potable water [9]. This grade of water must meet the same quality standard as water for injections (WFI) including the limit for endotoxins, but the water-treatment methods are not considered to be as reliable as distillation. HPW may be prepared by combinations of methods such as reverse osmosis, ultra filtration and deionization [10].

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Water for Hemodialysis

It is used for hemodialysis applications, foe dilution of hemodialysis concentrate solutions [11]. It may be packaged and stored in unreactive containers that preclude bacterial entry.

Water for injections

(WFI) Water for injections prepared from potable water as a minimum-quality feed-water. WFI is not sterile water and is not a final dosage form [12]. It is the highest quality of pharmacopoeias limits.

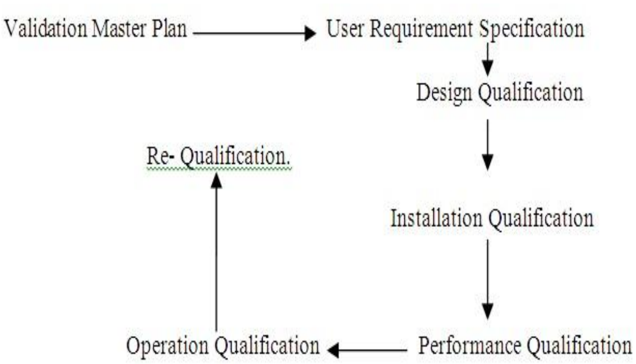
Sterile Water for Inhalation

Sterile Water for Inhalation is Water for Injection that is packaged and rendered sterile and is intended for use in inhalators and in the preparation of inhalation solutions [13]. It carries a less stringent specification for bacterial endotoxins than Sterile Water for Injection, and therefore, is not suitable for parenteral applications [14].

DIFFERENT TECHNIQUES USED FOR WATER TREATMENT [15]

- De-chlorination (Sodium Bisulphate, Carbon Filter)
- Filtration
- Ultra Filtration
- Softening
- Demineralization
- Reverse Osmosis
- UV Treatment
- Deionization
- Ionization

VALIDATION FLOW CHART OF WATER PLAN.



WASTE WATER TREATMENT SYSTEM

The purpose of treatment of sewage is to prevent the pollution of the receiving waters.

It is sub divided into three stages: physical, primary treatment and secondary is shown in Figure wastewater should receive (physical removal/settling) primary and (biological) secondary treatment, which can be followed by disinfection before discharge [16]. There are many basic types of sewage treatment plants employing both primary and secondary treatment stages that are in use today for treating large quantities of sewage [17].

TRICKLING FILTER SYSTEM

A common type of treatment system used extensive water collection systems handle large quantities of sewage is the trickling filter system [18].

Bar screens

Bar screens consist a grating of steel bars having a space about 2-4 cm on centers is placed at an angle to the flow of sewage through an open channel [19]. The raw influent first goes through a self-cleaning screen and then into one end of a shallow and rather fast moving basin so that sand and gravel can settle out skimmers rotate around the surface of the basin to remove oils that may have been flushed into the system [20].

Grit chamber

The settled material is buried or used for fill [21]. A chamber in which the velocity of waste flow is reduced to a point where the denser sand and other grit will settle out, but the organic solids will remain in suspension.

Primary settling tanks

These are usually large tanks in which solids settle out of water by gravity (figure 5) where the settle-able solids are pumped away (as sludge), while oils float to the top and are skimmed off. The detention time is 11/2–21/2 hours. Removal of suspended solids ranges from 50–65 per cent, and a 30–40 per cent reduction of the five-day (BOD) biochemical oxygen demand [22].

Sludge digestors

The sludge which settles in the sedimentation basin is pumped to the sludge digesters. This is the optimum temperature for the anaerobic bacteria [23]. Where a temperature of 30–35ºC is maintained. The usual length of digestion is 20–30 days but can be much longer during winter months.

Drying beds

In this system the liquid may evaporate or drain into the soil [24]. The dried sludge is a porous humus-like cake which can be used as a fertilizer base.

PREPARATION OF PHARMACEUTICAL WATERS

According to United States Pharmacopeia (USP) there are of several types of water like Water for Injection, Sterile Purified Water, Purified Water, Sterile Water for Injection, Sterile Bacteriostatic, Sterile Water for Inhalation, and Sterile Water for Irrigation [25].

Chlorine is most certainly present in the water and will have to be removed at some point in the purification process. The analytical standards for USP water have been significantly streamlined [26]. In the current USP 24, analyses for conductivity, total organic carbon, and bacteria are all that is required.

Dechlorination

Use chlorine to disinfect the water supply was discovered by John Snow. Soho that had helped spread the cholera outbreak [27]. The most common method is filtration through activated carbon media. There are also other dechlorination Medias including dissimilar metals. Injection of a reducing agent, most commonly sodium metabisulfite, is also a common dechlorination method[27]. Permanent water chlorination began in 1905, when a faulty slow sand filter and a contaminated water supply led to a serious typhoid fever epidemic in Lincoln, England. Dr. Alexander Cruickshank Houston used chlorination of the water to stem the epidemic. His installation fed a concentrated solution of chloride of lime to the water being treated [28]. The chlorination of the water supply helped stop the epidemic and as a precaution.

Carbon Filtration

Carbon is effective on chloramines as well as free chlorine although significant increased contact time is required [29]. For chloramines removal, Carbon filters are also effective for TOC reduction. The biggest problem with carbon filters is their propensity to become colonized by bacteria [30]. The quality of the carbon used in carbon filters is also important. When carbon is used for removal of specific organic compounds the exact characteristics of the carbon are extremely important [31]. In pharmaceutical dechlorination applications the primary concern is cleanliness of the carbon.

Uses

- Remove man-made organic chemicals
- Remove miscellaneous tastes and odor from water – assuming no bacterial problems
- Remove radon gas from water

Maintenance Carbon must be replaced routinely

UV Light

UV light is widely used in water purification systems for disinfection. It is new process for dechlorination. It destruct of many compounds is proliferating [32]. It has been demonstrated that UV light at a 254 nm wavelength at many times disinfection dosage will destroy free chlorine it. Ultraviolet light (UV) is very effective at inactivating cysts, in low turbidity water [33]. UV light's disinfection effectiveness decreases as turbidity increases, a result of the absorption, scattering, and shadowing caused by the suspended solids [34]. Damages the genetic structure of viruses, bacteria, and other pathogens, in this no chemicals are used water taste it is advantages more natural Disadvantages: high maintenance of the UV-lamp

Membrane Processes

Membranes range dramatically in pore size, molecular weight cut off, and ion rejection. Membrane filters are widely used for filtering both drinking water and sewage [35]. For drinking water, membrane filters can remove virtually all particles larger than 0.2 um. Membrane filters are an effective form of tertiary treatment when it is desired to reuse the water for industry, for limited domestic purposes, or before discharging the water into a river that is used by towns further downstream. They are widely used in industry, particularly for beverage preparation (including bottled water). Ion removal membranes are at the "tight" end of the spectrum and include reverse osmosis (RO) membranes, and nanofiltration membranes. Membranes accomplish a great deal in water purification systems, including: ion removal, removal of organic compounds, particulate removal, and organism removal [36]. It is work due to the osmotic pressure. Proper application of membrane technology requires adherence to proper design criteria and incorporation of proper pretreatment, monitoring, control, and flushing capability.

Ion Exchange

Ion exchange processes will remove carbon dioxide that can cause two pass RO water to fail on line conductivity requirements [37]. A strong case can be made for ion exchange following reverse osmosis in pharmaceutical systems. The ion exchange system will provide an additional ion reduction process, generally rendering the water much lower in conductivity than required and providing a back up to the membrane process. Electrodeionization (EDI) technology provides continuous deionization and continuous regeneration without acid and caustic.

Distillation

Distillation equipment is expensive to operate due to the energy cost of vaporizing water. Any contaminant that vaporizes at a lower temperature than water will not be removed in the distillation process, everything else will be removed in a very high percentage (typically >99%). Use of distillation in pharmaceutical water purification systems is primarily for the preparation of Water for Injection [38].

Chemical Sanitization

The most important concern with chemical sanitizing agents is the ability to remove them from the system. A variety of chemical compounds can be used to sanitize various devices in the water purification system [39]. Because heat sanitizable membrane systems are very expensive, often sanitizing chemicals are periodically circulated through the membrane system.

Removal of Specific Impurities

Since all water sources supplying USP water purification systems must comply with drinking water standards, the specific problem contaminants are never impurities covered by the primary standards[34]. Iron, manganese, hydrogen sulfide, hardness ions, particulate matter, high conductivity, and high TOC are all contaminants that occur regularly.

Iron, Manganese, and Hydrogen Sulfide

They will precipitate out of solution when oxidized and the standard method of treating these contaminants is by oxidation and filtration. Membranes will reject iron and manganese in solution and therefore it is sometimes beneficial to maintain the water in a reduced state and utilize membrane separation for their removal.

Hardness

Hardness of water can be removing by Ion exchange systems (softeners) consist of action resin in the sodium form, regenerated by sodium chloride. Membranes will remove hardness ions, but these ions also tend to precipitate on the surface of the membrane, forming scale. A strong case can be made for both ion exchange softening and membrane removal of hardness ions in pharmaceutical systems [40].

Particulate Matter

Well water will typically have much lower particle counts than surface water sources. Municipal water sources will generally be very low in particulate matter at the point of distribution; however, it is not unusual for particulate matter to enter the water stream in distribution piping. All pharmaceutical systems require particulate removal. If the particulate load is primarily smaller than this size, the MMF is useless. Granular carbon filters and ion exchange resins also provide filtration similar to a multimedia filter [41].

High Conductivity

There is not a primary standard for conductivity in drinking water. Therefore it is possible to have very high levels. High inlet conductivity will affect the choice of ion reduction processes in the system. The high inlet conductivity may negate the possibility of complying with USP conductivity limits in a two pass RO or may require a two pass RO in front of EDI, etc.

High TOC

It may be necessary to specifically address high TOC levels in the influent water. A carbon bed may adequately reduce TOC level. Another alternative is an anion exchange bed specifically targeted to organic removal. This would most likely be regenerated with sodium chloride [42].

Figure 1. Water Treatment

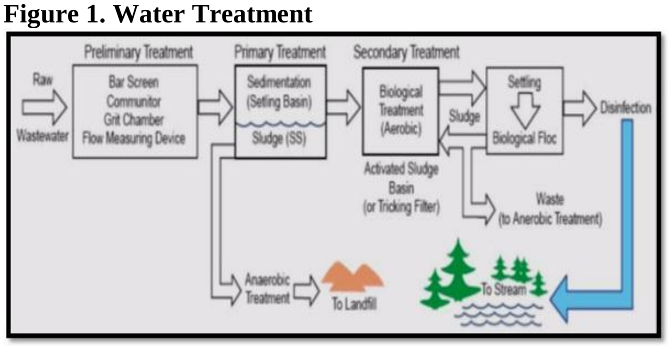


Figure 2.Trickling filter system for wastewater treatment

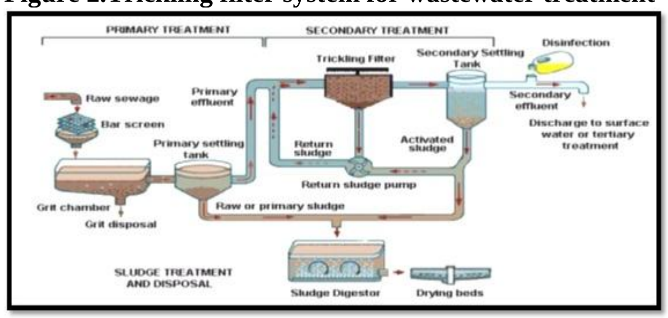


Figure 3. Bar screen

Figure 4: Grit chamber

Figure 5. Water settling tank. Sludge digestors

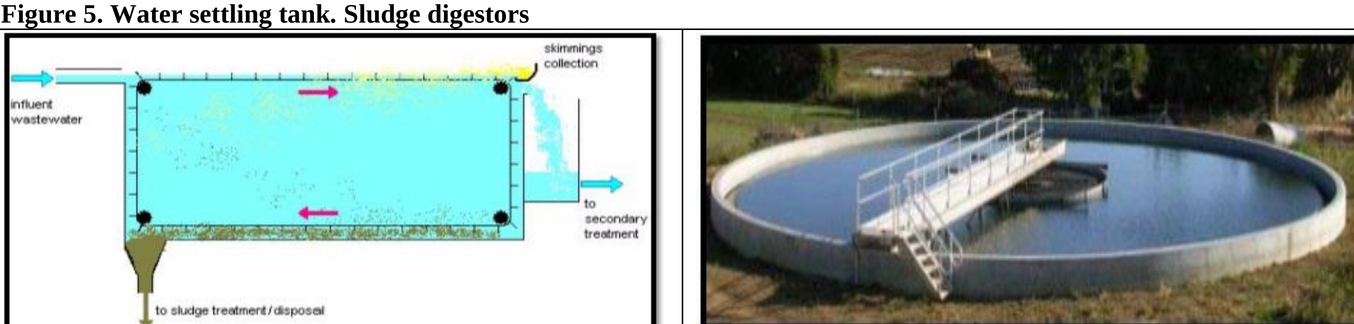


Figure 6. Sludge digesters

Figure 7. Drying beds

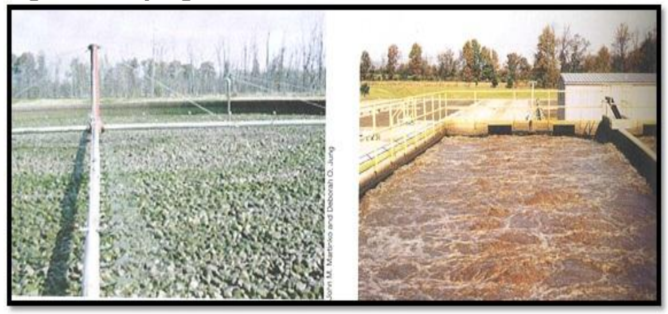


Figure 8. Water for pharmaceutical purposes [43,44]

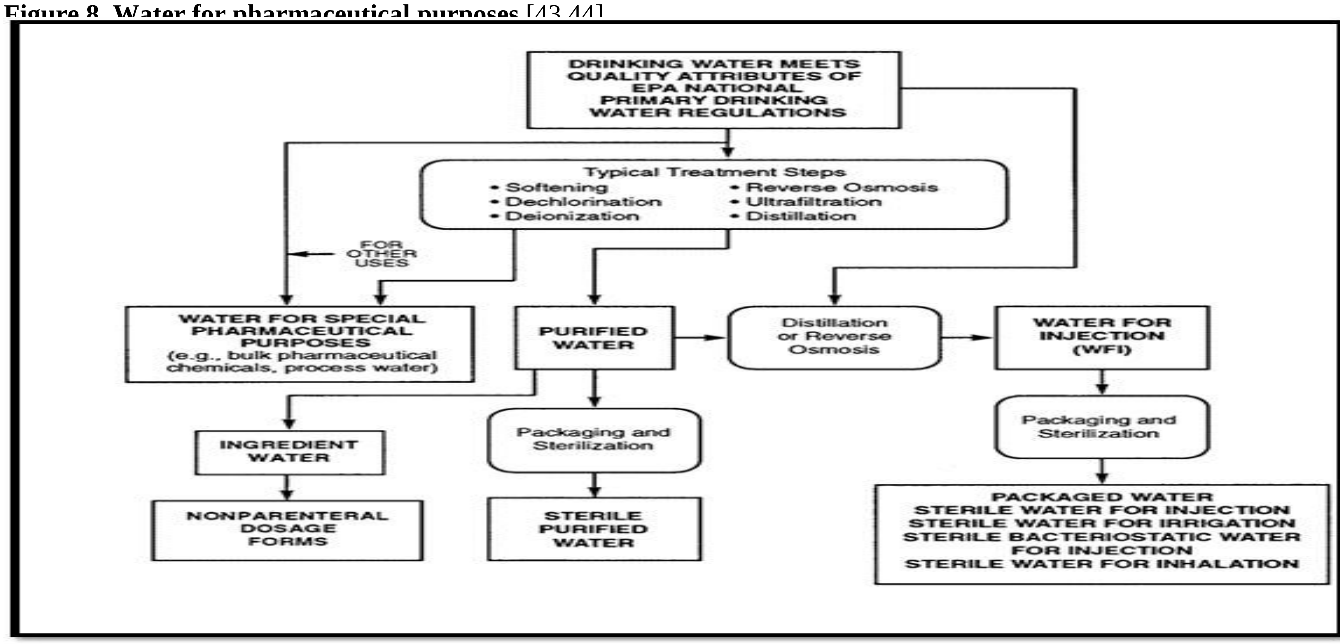
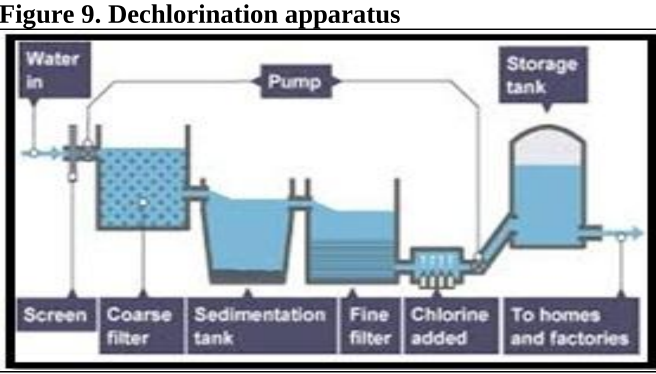


Figure 9. Dechlorination apparatus



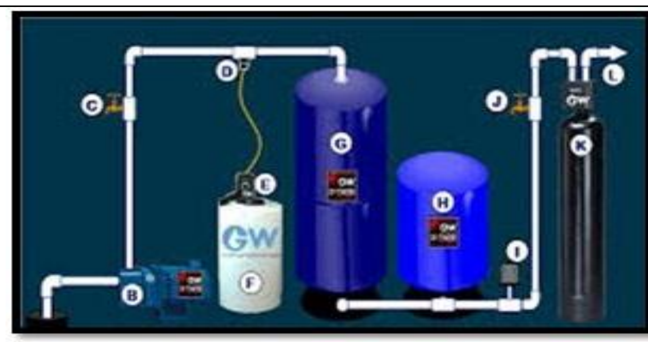
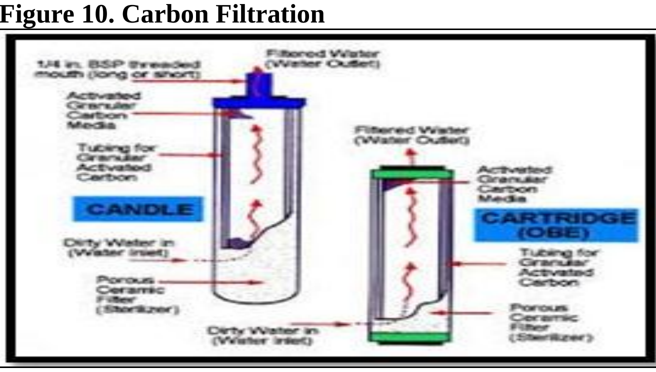
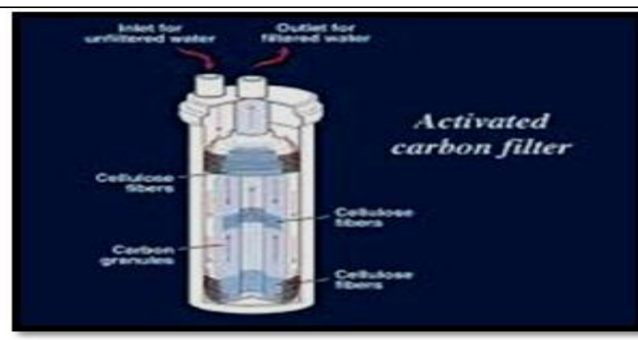


Figure 10. Carbon Filtration





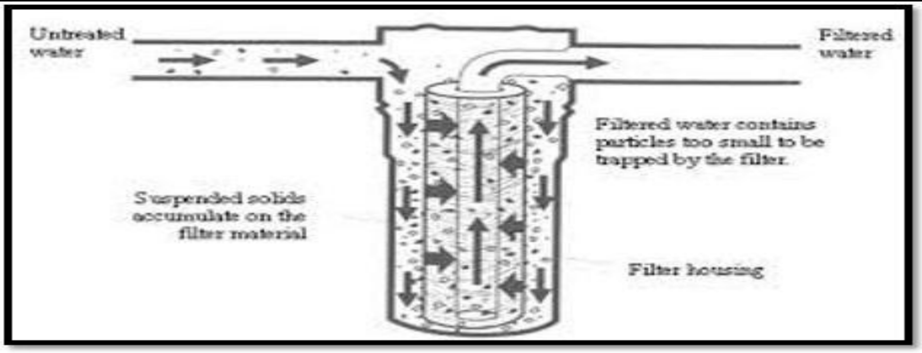


Figure 11. UV rays used for treating the waste water.

A) UV tubes

B) Treating effect

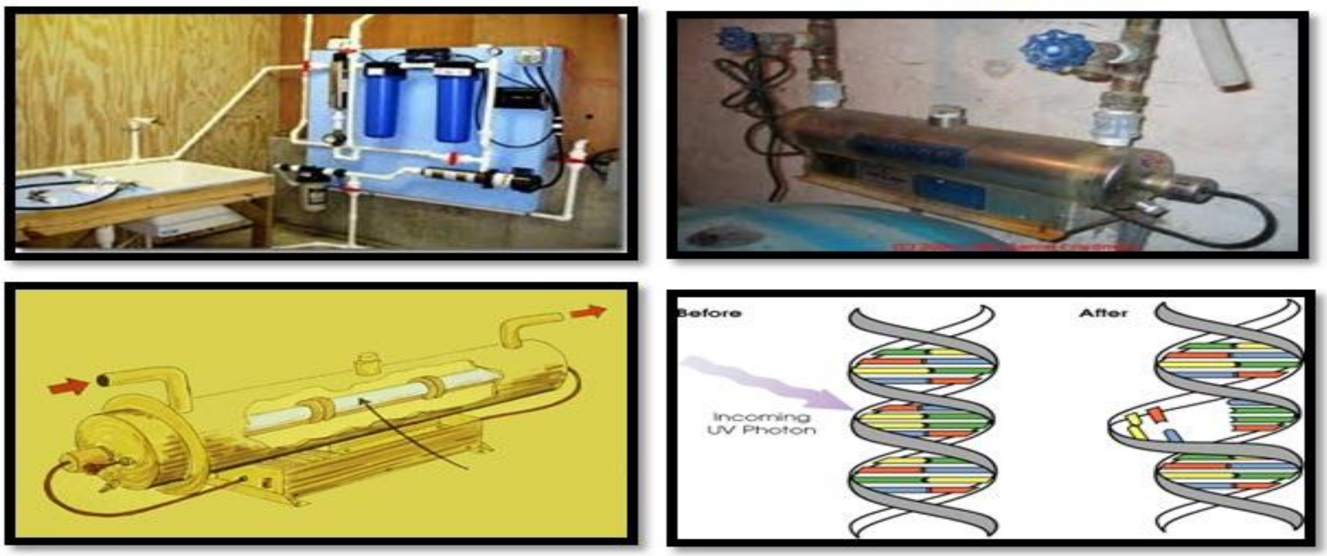


Figure 11. Membrane filters process

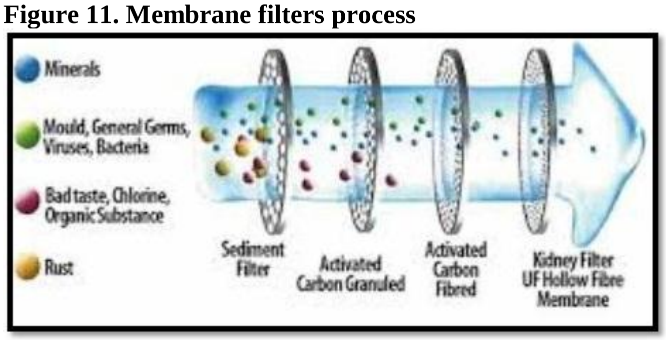


Figure 12. Ion Exchange

Figure 13. Distillation Apparatus

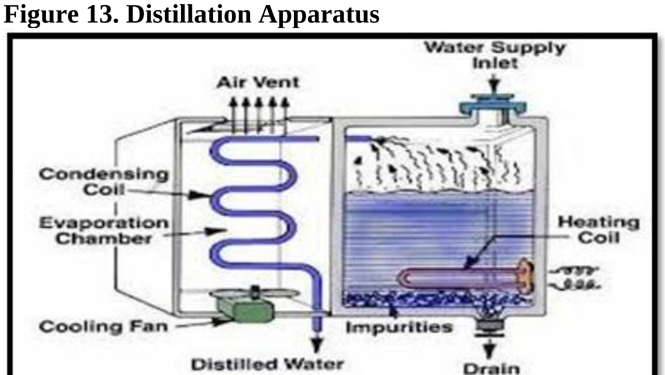


Figure 14. Chemical use for filtrations.

Figure 15. High Conductivity Appratus

Figure 16. Total organic carbon

CONCLUSION

A safe water supply is an essential part of camp hygiene for this purpose this is an attempt to examine the waste substances in the water and its treatment techniques. Water is the most commonly used material in pharmaceutical formulation and it is directly or indirectly used in the formulation.

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