ANALYSIS OF PURIFIED WATER IN DISTILLED WATER UNIT

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Abstract

Distilled water is created through the process of distillation. Basically,in the process of distillation ,the pure H2O is boiled out of contaminants .so, as the water (with it is contaminants) is boiled,the pure water turns into steam and is capture and cooled and thus becomes distilled water is the water that has been boiled into vapor and condenser back into liquid in a separated contain.

Key word: *Analysis, water unit , distilled water*

Introduction;

Water is probably the most commonly used laboratory reagent and is often taken for granted. In fact, water is often not even regarded as a "reagent" in the same way as other commonly used chemicals. While water companies are required to supply tap water fit for human consumption complying with specific drinking water regulations, for the scientist it is a grossly contaminated soup containing a wide variety of different, often unknown material which varies from location to location. Modern analytical techniques are often sensitive in the parts per billion range (?g/l) and many other biotechnology and HPLC procedures are affected by trace elements and so a reliable source of very pure water is often required in the modern laboratry. Even at a less critical level, the scientist needs to be sure that standard solutions are consistent and that washed glassware does not have a film of dried-on contamination. There are a variety of techniques available to purify water for the various different uses for which it is required and these notes are intended to highlight the good and bad points of each.

Water is one of the best solvents known to science and
has an almost unique ability to dissolve,

Impurities in water – what are they, how are they measured and what problems do they cause?

greater or lesser extent, almost every chemical compound. Even the most "insoluble" materials will, infact, dissolve to a level of a few micrograms per litre, sufficient to interfere with many laboratory procedures.

Common contaminants in tap water fall into seven major categories:

- Suspended solid particles
- Colloids
- Dissolved inorganic salts
- Dissolved organic compounds
- Micro-organisms
- Pyrogens.

These contaminants come from a variety of sources, each causes its own particular problems in the laboratory and each has its own method of detection and unit of measure. The levels of the various contaminants not only vary from one geographical area to another but also over periods of time. For example, water supplies from igneous rock upland areas such as the English Lake District are usually low in dissolved salts (soft water) but high in organic contamination, much of it colloidal, whereas water from underground sources is usually high in dissolved salts (hard water) but low in organic matter. Seasonal variations in levels of organic contamination are often apparent in water supplies derived from surface waters. During autumn dead leaves and decaying plants release large amounts of organic matter into streams, rivers and reservoirs and some of this finds its way into the water supply. Levels of organic contamination reach a peak in late winter and are much lower in late summer. The type of contamination encountered can have a marked effect on which method of purification is most suitable.

Dissolved inorganic salts

These are the most prevalent contamination in raw water and give rise to “kettle fur” in the domestic situation. There is a wide range of different salts commonly found in water which come from a variety of sources, some natural and some the result of human
Activity. Some are even added on purpose by
Water companies producing potable water.

Salt Some common sources;

Iprocal, the resistivity (MG-cm). Alternatively the salt concentration may be expressed as total dissolved solids (TDS) which can be calculated from the conductivity using a conversion factor. TDS is measured in ppm. Pure water has a theoretical resistivity of 18.24 MG-cm at 25°C, i.e. A very low but not zero conductivity of 0.055?S/cm. Water of this purity is virtually impossible to achieve in practice.

Dissolved organic matter

Many different organic solids are found in water, principally from animal and vegetable decay and human activity such as animal husbandry, domestic waste, industrial waste etc. They can include proteins, chloramines, alcohols, aldehydes, ketones and the organic residues from detergents, pesticides and herbicides. Also plasticisers and styrenes leached from plastic pipework. Organics hinder
electrophoresis and tissue culture and seriously interfere with organic analyses such as HPLC and gas chromatography. They foul ion exchange resins and block reverse osmosis membranes. Generally organic contaminants are non-ionic and as such are not detected by standard conductivity measurements. The concentration of all organic matter present in the water is measured either by a qualitative potassium permanganate colour retention test or, for greater sensitivity, by Total Organic Carbon (TOC) analysis which measures the CO2 liberated from oxidation of the organic compounds. TOC values are usually expressed in ppm.

Micro-organisms and Pyrogens

Bacteria, viruses, fungi and algae are found in most surface waters and can also multiply in the pipes delivering water to its point of use. Pyrogens are fever-inducing bacterial endotoxins or other microbial products and are also commonly present. They interfere with most biotechnology and microbiological procedures contaminating the water with DNA and nucleases but are often less relevant to chemistry laboratories. Bacteria can be quantified by culturing a sample of the water and counting the number of colony forming units (CFU) per ml. Pyrogens are traditionally detected by injecting a sample into test rabbits and monitoring body temperature. A newer more sensitive test for endotoxins is also available called The limulus amoebocyte lysate (LAL) gel-clotting test.

Dissolved gases

Carbon dioxide readily dissolves in water to form weakly acidic carbonic acid, H2CO3. Carbonic acid ionises in water to form H+ and CO32- ions, the concentration of which is measured by resistivity or conductivity. Freshly prepared pure water will rapidly dissolve CO2 from the air and the resulting carbonic acid can lower the ph as far as 4.5. This can often worry the scientist, but this low ph does not mean that the water is grossly contaminated, as only a few ppm of dissolved CO2 will cause a ph of this value. This dissolved gas does not usually cause any problems as it is also present in other reagents being used, but if it must be removed it can only be done by passing through an anion exchange resin and the water must then be protected from contact with the air.6

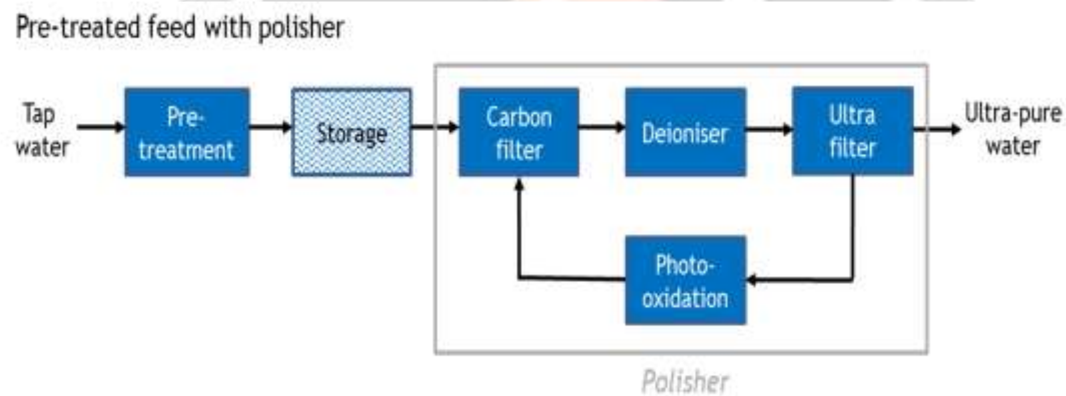
Pure water – How pure is it? What is it used ;

Several organisations have produced standards for the purity of water for use in different procedures. For clinical laboratory testing the most relevant standards are those of the Clinical and Laboratory Standards Institute (CLSI). For general chemical analysis and physical testing the requirements for reagent grade water are covered by the standards set out by the American Society for Testing and Materials (ASTM). Others include the international Pharmacopoeia standards (USP, EP and JP) which Specify water for use in medical work and the International Organization for Standardization specification for water for laboratory use (ISO 3696:1987). Most of the standards classify different levels of purity of water into different types or grades depending on the permitted levels of contaminat.

Distillation;

Distillation is a long established technique of water purification. It has the broadest capabilities and removes the widest spectrum of impurities. It is also unique in that the pure water is removed from the impurities rather than the impurities being removed from the water as is the case with other methods. Raw water is boiled to produce steam which is fed to a condenser where it returns to the liquid state, free of impurity. The impurities remain in the boiler and must be removed periodically, usually by dissolving them in an acid solution. The cooling water supply to the condenser is generally used to feed the boiler with warmed water to increase efficiency. For increased purity, a double still is used where the output from the first stage is then redistilled in the second. A double still can achieve the requirements of Type II water but careful

Collection and storage of the distillate is required to avoid contamination.ion. The ASTM standards are given below.



Storage of purified water;

Storage of purified water is a major concern since as soon as it reaches the point of delivery from the purification system it has the potential of becoming contaminated, either from the collection vessel or by contact with the air. Pure water is an excellent solvent and will dissolve almost anything it comes into contact with to a greater or lesser extent. It can also be quite corrosive which is one reason why ultra-pure water with a resistivity of >1MG-cm should not be used in a water bath as it can leach the iron from the stainless steel and lead to corrosion. In general Type I water is dispensed directly from the polishing unit avoiding storage concerns altogether. Type II water is however often stored in polyethylene reservoirs for ready availability in larger quantities. Other plastics such as polypropylene and fluorocarbon polymers are also used. Even
short term storage in plastics or transport of the water through plastic tubing to storage vessels can however cause leaching of plasticisers which interfere with techniques such as HPLC.
Glass is generally only recommended for general purpose water as some sodium can leach from borosilicate glass but for analysis of organic compounds glass bottles are preferred to plastic for storing water.

How a Stuart water still works

All Stuart® water stills consist of four basic components:

- Boiler
- Condenser
- Constant level device

- Heater

The raw feed water is fed through the coil of the condenser. When in operation, this forms a cold surface on which the steam condenses to produce the distilled water. As the water passes through the coil it becomes warmed in the process. This warmed water is then fed to the boiler via the constant

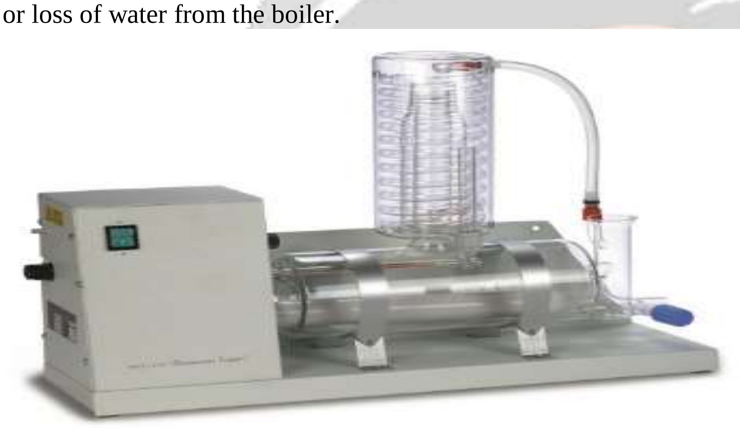
Level device which maintains the water in the boiler at the correct level and increases efficiency. Excess water is sent to drain. Water is heated in the boiler to produce pure steam. The steam rises into the condenser via a long vertical tube with baffles in order to prevent carry-over of raw water droplets. The vertical design of condenser is common to all Stuart water stills and ensures the maximum energy transfer between cooling water and condensate. The double pitch design ensures that condensation take place on the top 3-4 coils while the remainder ensure that the distillate is well cooled to a low

- Temperature, usually less than 30°C, ready for immediate use.

Distinction D4000

An economical Pyrex borosilicate glass water

Still with silica sheathed heating element. It produces 4 litres/h of high quality single distilled water and includes a reservoir level control which turns off the heating element and prevents overflow when the collecting reservoir is full. It has two-built-in thermal cut-outs for safety to protect against over-heating in the event of feed water failure or loss of water from the boiler.



Merit W4000

A simple glass water still with a chromium plated

Heating element with built-in twin safety thermostats. It produces 4 litres/h of good quality single distilled water.

Water text :

Regardless of which water treatment system is con- sidered, the water first should be tested to determine what substances are present. Public water systems routinely test for contaminants. Water utilities are required to publish Consumer Confidence Reports (ccrs), which inform con- sumers on the source of the water, contaminants present, potential health effects of those contaminants, and methods of treatment used by the utility. Depending on the population the utility serves, ccrs may be mailed, published in newspapers, or posted on the Internet, but copies can be obtained from the local water utility. Public supplies must conform to federal standards established by the Safe Drinking Water Act. If contaminants exceed the Maximum Contaminant Level (MCL), the water must be treated to correct the problem and/or another source of water suitable for drinking must be provided.

The cost to distill 1 gallon of water is determined by the wattage rating of the unit and the local electrical rate. The approximate cost of distilling 1 gallon of water can be determine as follows

Treatment Principles

Distillers use heat to boil contaminated water and pro- duce steam. Impurities such as inorganic compounds and large non-volatile organic compounds are not vaporized and are left behind in the boiling chamber of the unit. The heat inactivates bacteria, viruses, and protozoan cysts. The steam rises and enters a cooling section containing condensing coils. The steam cools, condenses back to a liquid, and the water flows into a storage container. This collected water can have up to 99.5 percent of impurities removed. The water remaining in the boiling chamber has a much higher concentration of impurities. This water is removed by a drain and discarded.

Since volatile organic compounds also can vaporize as the water is boiled and turned to steam, methods for remov- ing them can be incorporated into the system. Distillers that use a combination of removal methods for VOCs are more efficient than those with a single method. Gas vents (small holes in the passage of the distiller leading to the condensing coils) can allow VOCs to escape the distiller before entering the cooling section.

Since VOCs generally have boiling points close to or below that of water, they will vaporize early in the distillation process. If not removed, the VOCs then condense back to a liquid along with the water. For distillers without gas vents, fractional columns, or AC filters, VOCs may be removed to some degree by discarding the first pint (1/2 liter) of distilled water collected

Equipment :

Distillers are generally constructed of stainless steel, aluminum, and plastic material. These materials can be kept sanitary and do not tend to absorb contaminants from water. Also, distilled water should be stored under sanitary condi- tions to prevent recontamination. Storage containers should be glass or stainless steel.

There are two basic types of distillers. A batch distiller has water poured directly into the boiling chamber. When the unit is started, the water is heated to boiling by a heating element in the chamber. The unit shuts off when all water in the boiling chamber is evaporated. The distilled water is stored in a container for household use. The capacity of batch distillers generally ranges from 1 to 10 gallons. The smaller capacity distillers are similar in size to a coffee maker and sit on the countertop. Larger capacity distillers are floor units. Batch distillers typically produce 3 to 10 gallons of distilled water per day, which is generally sufficient for drinking and cooking.

A continuous flow distiller connects to the water sup- ply line. A float valve in the boiling chamber regulates and maintains the water level in the chamber. As distilled water is used from the storage container, the unit automatically starts producing more distilled water. The water and impurities remaining in the boiling chamber are periodically removed through a discharge line.

Summary :

Drinking water treatment using distillation is one option for treating water problems. Operated properly, distillation can remove up to 99.5 percent of impurities from water, including bacteria, metals, nitrate, and dissolved solids. Operation costs for distillation can be among the highest for home drinking water treatment systems. Selection of a distil- lation unit should be based on water analysis and assessment of the individual homeowner’s needs and situation. Regular maintenance of the unit is a critical factor in maintaining its effectiveness. NSF and the WQA test and certify products. This certification and validation can help guide selection.

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