STERILIZATION OF WATER USING BLEACHING POWDER

A CHEMISTRY INVESTIGATORY PROGECT

ANSHUL KUMAR PANDEY
XII B

[THIS PROJECT LOOKS AT THE TECHNIQUE CALLED STERILIZATION OF WATER USING BLEACHING POWDER WHICH IS USED TO PURIFY WATER AND MAKES IT FIT FOR DRINKING.]

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CERTIFICATE OF AUTHENTICITY

This is to certify that **Anshul Kumar Pandey**, a student of class XII has successfully completed the research project on the topic "**Sterilization of Water by using Bleaching Powder**" under the guidance of Mrs. Mohini Belani (Subject Teacher).

This project is absolutely genuine and does not indulge in plagiarism of any kind.

The references taken in making this project have been declared at the end of this report.

Signature (Subject Teacher) Signature (Examiner)

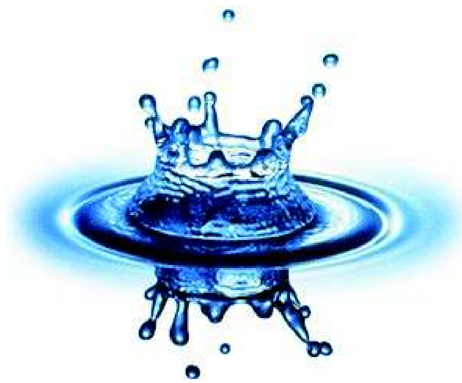
ACKNOWLEDGEMENT

I feel proud to present my Investigatory project in Chemistry on the topic "Sterilization of Water using Bleaching powder" which aims at using Bleaching powder as a disinfectant and purifier to make water fit for drinking.

This project wouldn't have been feasible without the proper and rigorous guidance of my Chemistry teacher Mrs. Mohini Belani who guided me throughout this project in every possible way. An investigatory project involves various difficult lab experiments which have to be carried out by the student to obtain the observations and conclude the report on a meaningful note. These experiments are very critical and in the case of failure, may result in disastrous consequences. Thereby, I would like to thank both Mrs.Belani and Lab Asst.Mr.Rajkumar for guiding me on a step by step basis and ensuring that I completed all my experiments with ease.

Rigorous hard work has been put in this project to ensure that it proves to be the best. I hope that this project will prove to be a breeding ground for the next generation of students and will guide them in every possible way.

INTRODUCTION



Need of water

Water is an important and essential ingredient in our quest for survival on this planet. It is very essential for carrying out various metabolic processes in our body and also to carry out Hemoglobin throughout the body.

A daily average of 1 gallon per man is sufficient for drinking and cooking purposes. A horse, bullock, or mule drinks about 11 gallons at a time. standing up, an average allowance of 5 gallons should be given for a man, and 10 gallons for a horse or a camel. An elephant drinks 25 gallons, each mule or ox drinks 6 to 8 gallons, each sheep or pig 6 to 8 pints. These are minimum quantities.

One cubic foot of water = 6 gallons (a gallon = 10 lbs.).

In order to fulfill such a huge demand of water, it needs to be purified and supplied in a orderly and systematic way.

But with the increasing world population, the demand for drinking water has also increased dramatically and therefore it is very essential to identify resources of water from which we can use water for drinking purposes. Many available resources of water do not have it in drinkable form. Either the water contains excess of Calcium or Magnesium salts or any other organic impurity or it simply contains foreign particles which make it unfit and unsafe for Drinking.

Purification of Water

There are many methods for the purification of water. Some of them are

1. Boiling
2. Filtration
3. Bleaching powder treatment
4. SODIS (Solar Water Disinfection)

And the list goes on....

Boiling is perhaps the most commonly used water purification technique in use today. While in normal households it is an efficient technique; it cannot be used for industrial and large scale purposes. It is because in normal households, the water to be purified is very small in quantity and hence the water loss due to evaporation is almost negligible. But in Industrial or large scale purification of water the water loss due to evaporation will be quite high and the amount of purified water obtained will be very less.

Filtration is also used for removing foreign particles from water. One major drawback of this purification process is that it cannot be used for removing foreign chemicals and impurities that are miscible with water.

SODIS or Solar Water Disinfection is recommended by the United Nations for disinfection of water using soft drink bottles, sunlight, and a black surface-- at least in hot nations with regularly intense sunlight.

Water-filled transparent bottles placed in a horizontal position atop a flat surface in strong sunlight for around five hours will kill microbes in the water. The process is made even more safe and effective if the bottom half of the bottle or the surface it's lying on is blackened, and/or the flat surface is made of plastic or metal. It's the combination of heat and ultraviolet light which kills the organisms.

The major drawback of this purification technique is that it cannot be used in countries with cold weather. Also, the time consumed for Purification process is more and it also needs a 'blackened' surface, much like solar cookers.

Need for a stable purification technique

Therefore we need a purification technique which can be used anytime and anywhere, does not require the use of any third party content and which is also economically feasible on both normal scale and large scale.

Hence we look at the method of purification of water using the technique of treatment by bleaching powder commonly known as "Chlorination".

THEORY

History of water purification in different parts of the world.

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. Since the water in the pump had tasted and smelled normal, the conclusion was finally drawn that good taste and smell alone do not guarantee safe drinking water. This discovery led to governments starting to install municipal water filters (sand filters and chlorination), and hence the first government regulation of public water.

In the 1890s America started building large sand filters to protect public health. These turned out to be a success. Instead of slow sand filtration, rapid sand filtration was now applied. Filter capacity was improved by cleaning it with powerful jet steam. Subsequently, Dr. Fuller found that rapid sand filtration worked much better when it was preceded by coagulation and sedimentation techniques. Meanwhile, such waterborne illnesses as cholera and typhoid became less and less common as water chlorination won terrain throughout the world.

But the victory obtained by the invention of chlorination did not last long. After some time the negative effects of this element were discovered. Chlorine vaporizes much faster than water, and it was linked to the aggravation and cause of respiratory disease. Water experts started looking for alternative water disinfectants. In 1902 calcium hypo chlorite and ferric chloride were mixed in a drinking water supply in Belgium, resulting in both coagulation and disinfection.

The treatment and distribution of water for safe use is one of the greatest achievements of the twentieth century. Before cities began routinely treating drinking water with chlorine (starting with Chicago and Jersey City in US in 1908), cholera, typhoid fever, dysentery and hepatitis A killed thousands of U.S. residents annually. Drinking water chlorination and filtration have helped to virtually eliminate these diseases in the U.S. and other developed countries. Meeting the goal of clean, safe drinking water requires a multi-barrier approach that includes: protecting source water from contamination, appropriately treating raw water, and ensuring safe distribution of treated water to consumers' taps. During the treatment process, chlorine is added to drinking water as elemental chlorine (chlorine gas),
sodium hypochlorite solution or dry calcium hypochlorite. When applied to water, each of these forms "free chlorine," which destroys pathogenic (disease-causing) organisms.
Almost all systems that disinfect their water use some type of chlorine-based process, either alone or in combination with other disinfectants. In addition to
controlling disease-causing organisms, chlorination offers a number of benefits including:

- Reduces many disagreeable tastes and odors;
- Eliminates slime bacteria, molds and algae that commonly grow in water supply reservoirs, on the walls of water mains and in storage tanks;
- Removes chemical compounds that have unpleasant tastes and hinder disinfection; and
- Helps remove iron and manganese from raw water.

As importantly, only chlorine-based chemicals provide "residual disinfectant" levels that prevent microbial re-growth and help protect treated water throughout the distribution system.

For more than a century, the safety of drinking water supplies has been greatly improved by the addition of bleaching powder. Disinfecting our drinking water ensures it is free of the microorganisms that can cause serious and life-threatening diseases, such as cholera and typhoid fever. To this day, bleaching powder remains the most commonly used drinking water disinfectant, and the disinfectant for which we have the most scientific information. Bleaching powder is added as part of the drinking water treatment process. However, bleaching powder also reacts with the organic matter, naturally present in water, such as decaying leaves. This chemical reaction forms a group of chemicals known as disinfection by-products. Current scientific data shows that the benefits of bleaching our drinking water (less disease) are much greater than any health risks from THMs and other by-products. Although other disinfectants are available, bleaching powder remains the choice of water treatment experts. When used with modern water filtration methods, chlorine is effective against virtually all microorganisms. Bleaching powder is easy to apply and small amounts of the chemical remain in the water as it travels in the distribution system from the treatment plant to the consumer's tap, this level of effectiveness ensures that microorganisms cannot recontaminate the water after it leaves the treatment.

But what is bleaching powder and how is it prepared?

Bleaching powder or Calcium hypochlorite is a chemical compound with formula $Ca(ClO)_2$. It is widely used for water treatment and as a bleaching agent bleaching powder). This chemical is considered to be relatively stable and has greater available chlorine than sodium hypochlorite (liquid bleach).

It is prepared by either calcium process or sodium process.

Calcium Process

$2\ Ca(OH)_2 + 2\ Cl_2 \rightarrow \mathbf{Ca(ClO)_2} + CaCl_2 + 2\ H_2O$

Sodium Process

$2\ Ca(OH)_2 + 3\ Cl_2 + 2\ NaOH \rightarrow \mathbf{Ca(ClO)_2} + CaCl_2 + 2\ H_2O + 2\ NaCl$

But how can this chemical be used to sterilize water?

This chemical can be used for sterilizing water by Using 5 drops of bleach per each half gallon of water to be purified, and allowing it to sit undisturbed for half an hour to make it safe for drinking. Letting it sit several hours more will help reduce the chlorine taste, as the chlorine will slowly evaporate out. A different reference advises when using household bleach for purification; add a single drop of bleach per quart of water which is visibly clear, or three drops per quart of water where the water is NOT visibly clear. Then allow the water to sit undisturbed for half an hour.

What are the actual processes involved in disinfecting and purifying water?

The combination of following processes is used for municipal drinking water treatment worldwide:

1. Pre-chlorination - for algae control and arresting any biological growth

2. Aeration - along with pre-chlorination for removal of dissolved iron and manganese

3. Coagulation - for flocculation

4. Coagulant aids also known as polyelectrolyte's - to improve coagulation and for thicker floc formation

5. Sedimentation - for solids separation, that is, removal of suspended solids trapped in the floc

6. Filtration - for removal of carried over floc

7. Disinfection - for killing bacteria

Out of these processes, the role of Bleaching powder is only in the last step i.e. for Disinfection of water.

EXPERIMENT

Aim: To Determine the dosage of bleaching powder required for sterilization or disinfection of different samples of water.

Requirements: Burette, titration flask, 100ml graduated cylinder, 250ml measuring flask, weight box, glazed tile, glass wool.

Bleaching Powder, Glass wool, 0.1 N $Na_2S_2O_3$ solution, 10% KI solution, different samples of water, starch solution.

Pre-Requisite Knowledge:

1. A known mass of the given sample of bleaching powder is dissolved in water to prepare a solution of known concentration. This solution contains dissolved chlorine, liberated by the action of bleaching powder with water.

$$CaOCl_2 + H_20 \Longrightarrow Ca(OH)_2 + Cl_2$$

2. The amount of Chlorine present in the above solution is determined by treating a known volume of the above solution with excess of 10% potassium iodide solution, when equivalent amount of Iodine is liberated. The Iodine, thus liberated is then estimated by titrating it against a standard solution of Sodium thiosulphate, using starch solution as indicator.

$$Cl_2 + 2KI \Longrightarrow 2KCl + I_2$$

$$I_2 + 2Na_2S_2O_3 \Longrightarrow Na_2S_4O_6 + 2NaI$$

3. A known Volume of one of the given samples of water is treated with a known volume of bleaching powder solution. The amount of residual chlorine is determined by adding excess potassium iodide solution and then titrating against standard sodium thiosulphate solution.
4. From the readings in 2 and 3, the amount of chlorine and hence bleaching powder required for the disinfection of a given volume of the given sample of water can be calculated.

Procedure:

1. Preparation of bleaching powder solution. Weigh accurately 2.5g of the given sample of bleaching powder and transfer it to a 250ml conical flask. Add about 100-150ml of distilled water. Stopper the flask and shake it vigorously. The suspension thus obtained is filtered through glass wool and the filtrate is diluted with water (in a measuring flask) to make the volume 250ml. The solution obtained is 1% bleaching powder solution.
2. Take 20ml of bleaching powder solution in a stoppered conical flask and add it to 20ml of 10% KI solution. Stopper the flask and shake it vigorously. Titrate this solution against 0.1N $Na_2S_2O_3$ solution taken in the burette. When the solution in the conical flask becomes light yellow in color, add about 2ml starch solution. The solution now becomes blue in color. Continue titrating till the blue color just disappears. Repeat the titration to get a set of three concordant readings.
3. Take 100ml of the water sample in a 250ml stoppered conical flask and add it to 10ml of bleching powder solution. Then add 20ml of KI solution and stopper the flask. Shake vigorously and titrate against 0.1N $Na_2S_2O_3$ solution using starch solution as indicator as described in step 2.
4. Repeat the step 3 with other samples of water and record the observations.

RESULT

Amount of the given sample of bleaching powder required to disinfect one litre of water

Sample I = ...g

Sample II= ....g

Sample III= ....g

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