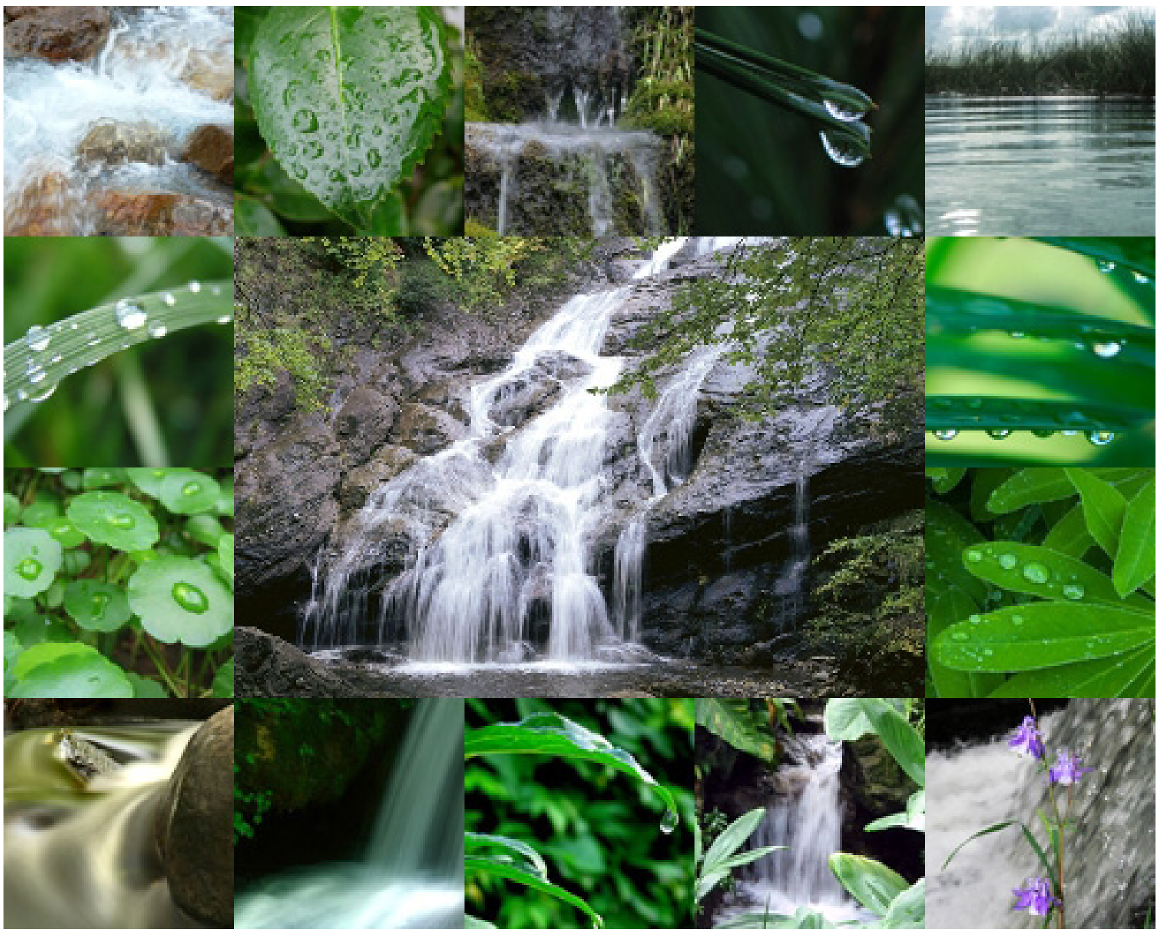
Danamark home



Understanding Water & WaterCare

DANAMARK watercare

GUIDING WATERCARE INNOVATION

Understanding Water & WaterCare

Water must have eye appeal and taste appeal before we will drink it with much relish. Instinctively we draw back from the idea of drinking dirty, smelly water. Actually far more important to our well-being is whether or not a water is safe to drink. If it holds disease bacteria, regardless of its clarity and sparkle, we should avoid it.

Let's consider these two highly important aspects of water: portability and palatability.

Regardless of any other factors, water piped into the home must be potable. To be potable, it should be completely free of disease organisms. Water is the breeding ground for an almost unbelievably large variety of organisms. Water does not produce these organisms. It merely is an ideal medium in which they can grow.

These organisms gain entry into water through a variety of sources. They enter from natural causes, surface drainage and sewage. Many of the organisms in water are harmless. In fact, they are extremely beneficial to man. Others have a wide nuisance value and still others are the source of disease.

In general, we are primarily concerned here with organisms which are potential disease-producers. These are of five types:

1. bacteria
2. protozoa
3. worms
4. viruses
5. fungi

The presence of certain organisms of these various types can lead to such infectious diseases as typhoid fever, dysentery, cholera, jaundice, hepatitis, undulant fever and tularemia. There are other diseases as well which spread through drinking unsafe water. Tremendous strides have been made in the control of these diseases within recent years. Much of the credit must go to sanitary engineers for their careful, consistent control of public water supplies.

Biologically, there are two major classifications for our purposes. We can classify water organisms either as members of the plant or animal kingdoms. The following ways are the natural ways in which water is purified.

1. Bacteria and algae consume organic waste
2. Micro-organisms devour bacteria and algae
3. Oxidation renders organic matter harmless
4. Ultra-violet rays of sun have germicidal effects.

FORMS OF LOWER LIFE IN WATER

Under the broad heading of plant forms, we can classify the following:

ALGAE

These organisms are found throughout the world. They constitute the chief group of aquatic plants both in sea and fresh water. Algae range in size from microscopic organisms to giant seaweeds several hundred feet in length. They contain chlorophyll and other pigments which give them a variety of colours.

They manufacture their food by photosynthesis. Algae thrive well in stagnant surface waters especially during the warm weather. Algae gives water fishy, grassy and other even more objectionable odours. While algae-laden waters are repulsive to man, animals will drink them and the presence of blue-green algae has been know to cause the death of cattle drinking this water.

DIATOMS

Diatoms belong to the algae family. Some exist as single cells; others are found as groups or colonies. More than 15,000 forms of diatoms are known to exist. Diatoms have silica-impregnated cell walls. At time they release essential oils which give water a fishy taste.

FUNGI

Fungi are another large group of plant forms. Like the algae, fungi have many varieties included among these are molds and bacteria. Fungi are not able to manufacture their own food. They exist by feeding on living things or on dead organic matter. Depending on their individual characteristics, they are usually colourless but may vary in this respect.

MOLDS

One important category of fungi is molds. This group of fungi feeds entirely on organic matter. They decompose carbohydrates such as sugars, starches and fats as well as proteins and other substances. They thrive ideally in water that has a temperature range of approximately 80 degrees to 100 degrees F. The presence of molds is generally a strong indicator of heavy pollution of water.

BACTERIA

Bacteria are another important class of fungi. Again numerous smaller groupings are possible. Among the higher organisms in this group are the iron, manganese and sulpher bacteria. These higher bacteria gain their energy from the oxidation of simple organic substances. Lower forms of bacteria can be grouped as those that are helpful and those that are harmful to man. Those harmful to man are mainly the disease-producing organisms. Helpful organisms hasten the process of decomposing organic matter and by feeding on waste material; they aid in the purifying of water.

All bacteria are sensitive to the temperature and pH of water. Some bacteria can tolerate acid water. But for the most part, they thrive best in waters that have a pH between 6.5 to 7.5, which is essentially neutral waters. As to temperature, most pathogenic or disease bacteria thrive best in water of body temperature. Beyond this no hard and fast statements can be made.

Some bacteria are more resistant to heat than are others. Some are more sensitive to cold. At low temperatures, for example. Some bacteria may become dormant for long periods of time but will still continue to exist. Interestingly enough, the waste products of their own growth can hamper bacteria and may even prove toxic to them.

LOWER ANIMAL LIFE

Animal forms like plant life thrive in water providing conditions are right. Among the higher forms of animal life found in water are fish, amphibians (turtles and frogs), mollusks (snails and shellfish) and anthropoids (lobsters, crabs, water insects, water mites and others). Our concern here is with those lower forms of animal life in water. Again, some are helpful to man as scavengers; others are injurious as possible sources of infection.

WORMS

There are three types of worms found in water. For the most part, they dwell in the bed of the material at the bottom of lakes and streams. There they do important work as scavengers. The rotifers are the only organisms in this category at or near the surface. They live primarily in stagnant fresh water. The eggs and larvae of various intestinal worms found in man and warm-blooded animals pollute the water at times. They do not generally cause widespread infection for several reasons. They are relatively few in number and are so large they can be filtered out of water with comparative ease.

PROTOZOA

Another basic classification in the animal kingdom is that group of microscopic animals known as protozoa. These one-celled organisms live mainly in water either at or near the surface or at great depths in the oceans. Many live as parasites in the bodies of man and animals.

Sometimes, drinking water becomes infested with certain protozoa which are not disease-producing. When present, they give the water a fishy taste and odour. Some protozoa are aerobic, that is, they exist only where free oxygen is available. Some exist where no free oxygen is available. Others can either be aerobic or anaerobic.

NEMATODES

Nematodes belong to the worm family. They have long, cylindrical bodies which have no internal segments. Interestingly enough, those nematodes which are found in the bodies of men and warm-blooded animals are large enough to be visible to the naked eye; those living in fresh water or the soil are microscopic.

Nematodes can be a problem in drinking water because they impart objectionable tastes and odours to water. They are also under suspicion of being carriers of the type of disease-bearing bacteria found in the intestines of warm-blooded animals though studies show that possibility is somewhat remote. Nematodes are apt to be found in municipal waters derived from surface supplies.

VIRUSES

As yet not too well understood is that group of parasitic forms known as viruses. Too small to be seen under a microscope, viruses are capable of causing disease in both plants and animals. Viruses can pass through porcelain filters that are capable of screening out bacteria. At least one virus that produces infectious hepatitis is water born. Drinking water contaminated with this virus is hazardous.

SUMMARY

As you can see from even this brief summary, there is a tremendous variety of living organisms in water. To understand and classify the countless varieties requires an immense amount of knowledge and time. These organisms, whether plant or animal forms, are pathogenic or disease-producing; they make water unsafe to drink.

For obvious reasons, even where there is just a possibility that water contains pathogenic organisms, it must be considered contaminated. While there is a large and varied number of pathogens, no single contaminated water supply is apt to contain more than a few of these countless varieties. On one hand this is fortunate but, at the same time it makes detection of pathogens extremely difficult in terms of a routine water analysis.

Since both speed and accuracy are essential, laboratory scientists need a sure way to expedite detection of pathogens. They have a dependable answer in a group of readily identified organisms that indicate possible contamination. These indicator organisms are the coliform bacteria.

Study has proved that these coli form bacteria indicate the presence of human or animal wastes in water. Coli form bacteria naturally exist in the intestines of humans and certain animals. Thus, the presence of these bacteria in water is accepted proof that the water has been contaminated by human or animal wastes.

Although such water may contain no pathogens, an infected person, animal or a carrier of disease, could add pathogens at any moment! Thus, immediate corrective action must be taken. The presence of coli form bacteria shows water is contaminated by human wastes and is potentially contaminated with pathogens. In short, these bacteria become a measure of guilt by association.

The other side is this: the mere absence of coliform bacteria does not assure there are no pathogens. However, this is considered unlikely.

Just how can water be tested for the presence of coliform bacteria?

These organisms cause the fermentation of lactose (the crystalline sugar compound in milk). When water containing coli form bacteria is placed in a lactose culture, it will cause fermentation resulting in the form of gas. This confirms the suspicions.

The Maximum Acceptable Concentration (MAC) for coli forms in drinking water is zero organisms detectable per 100 mL. Recognizing the danger, what can be done to provide adequate protection against contamination? When a water supply becomes contaminated, correct the problem at once. This means going beyond treatment alone - important as this may be.

It is a basic rule of water sanitation to get to the source of the problem and eliminate it. If a well, for example, becomes badly contaminated, it is necessary to trace the contamination to its source and, if possible, remedy the situation. It may even be necessary to seek out a new source of supply.

WATER DISINFECTION METHODS

Treatment of a water supply is a safety factor, not a corrective measure. Keep this in mind in the discussion that follows:

There are a number of ways of purifying water. In evaluating the methods of treatment available, the following points regarding water disinfectants should be considered:

a) A disinfectant should be able to destroy all types of pathogens and in whatever number present in water.

b) A disinfectant should destroy the pathogens within the time available for disinfection.

c) A disinfectant should function properly regardless of any fluctuations in the composition or condition of the water.

d) A disinfectant should not cause the water to become toxic or unpalatable.

e) A disinfectant should function within the temperature range of the water.

f) A disinfectant should be safe and easy to handle.

g) A disinfectant should be such that it is easy to determine its concentration in the water.

h) A disinfectant should provide residual protection against recontamination.

Techniques such as filtration may remove infectious organisms from water. They are, however, no substitute for disinfection.

Now for specific methods of disinfecting water:

BOILING WATER

Place water in a container over heat. Bring it to the boiling point. Hold it at this temperature for one minute. This will disinfect the water. Perhaps you have used this technique after a flood or when a water main has burst as an emergency aid. Boiling water is an effective method of treatment because no important waterborne diseases are caused by heat-resisting organisms.

ULTRAVIOLET LIGHT(UV)

The use of ultraviolet light is an attempt to imitate nature. As you recall, sunlight destroys some bacteria in the natural purification of water. Exposing water to ultraviolet light destroys pathogens. To assure thorough treatment, the water must be free of turbidity and colour. Otherwise, some bacteria will be protected from the germ-killing ultraviolet rays. Since ultraviolet light adds nothing to the water, there is little possibility of its creating taste or odour problems. On the other hand, ultraviolet light treatment has no residual effect. Further, it must be closely checked to assure that sufficient ultraviolet energy is reaching the point of application at all times.

ADVANTAGES DISADVANTAGES

Automatic Low penetration power

No taste or odour Shielding by turbidity

Low contact time Slime layer develops of tube

No simple test or results

No residual effect

Ultraviolet tube gradually loses power.

VARIOUS CHEMICAL DISINFECTANTS

The most common method of treating water for contamination is to use one of various chemical agents available. Among these are chlorine, bromine, iodine, potassium permanganate, copper and silver ions, alkalis, acids and ozone. Let us review these briefly.

BROMINE

Bromine is an oxidizing agent that has been used quite successfully in the disinfecting of swimming pool waters. It is rated as a good germicidal agent. Bromine is easy to feed into water and is not hazardous to store. It apparently does not cause eye irritation among swimmers nor are its odours troublesome.

CHLORINE

One of the most widely used disinfecting agents to ensure safe drinking water is chlorine. Chlorine in cylinders is used extensively by municipalities in purification work. However, in this form chlorine gas (CL_2) is far too dangerous for any home purpose. For use in the home, chlorine is readily available as sodium hypochlorite (household bleach) which can be used both for laundering or disinfecting purposes. This product contains a 5.25% solution of sodium hypochlorite which is equivalent to 5% available chlorine.

Chlorine is also available as calcium hypochlorite which is sold in the form of dry granules. In this form, it is usually 70% available chlorine. When calcium hypochlorite is used, this chlorinated lime should be mixed thoroughly and allowed to settle, pumping only the clear solution.

For a variety of reasons not the least of which is convenience, chlorine in the liquid form (sodium hypochlorite) is more popular for household use. Chlorine is normally fed into water with the aid of a chemical feed pump. The first chlorine fed into the water is likely to be consumed in the oxidation of any iron, manganese or hydrogen sulfide that may be present. Some of the chlorine is also neutralized by organic matter normally present in any supply, including bacteria, if present.

When the "chlorine demand" due to these materials has been satisfied, what's left over -the chlorine that has not been consumed - remains as "chlorine residual". The rate of feed is normally adjusted with a chemical feed pump to provide a chlorine residual of 0.5 - 1.0 ppm after 20 minutes of contact time. This is enough to kill coli form bacteria but may or may not kill any viruses or cysts which may be present.

Such a chlorine residual not only serves to overcome intermittent trace contamination from coli form bacteria but, also provides for minor variations in the chlorine demand of the water. The pathogens causing such diseases as typhoid fever, cholera and dysentery succumb most easily to chlorine treatment. The cyst-like protozoa causing dysentery are most resistant to chlorine. As yet, little is known about viruses, but some authorities place them at neither extreme in resistance to chlorination.

CHLORINE DEMAND - There are three basic terms used in the chlorination process: Chlorine demand, chlorine dosage and chlorine residual. Chlorine demand is the amount of chlorine which will be reduced or consumed in the process of oxidizing impurities in the water.

Chlorine dosage is the amount of chlorine fed into the water. Chlorine residual is the amount of chlorine still remaining in water after oxidation takes place. For example, if a water has 2.0 ppm chlorine demand and is fed into the water in a chlorine dosage of 5.0 ppm, the chlorine residual would be 3.0 ppm.

IODINE

For emergency purposes, iodine may be used for treatment of drinking water. Much work at present is being done to test the effect of iodine in destroying viruses which are now considered among the pathogens most resistant to treatment. Tests show that 20 minutes exposure to 8.0 ppm of iodine is adequate to render a potable water. As usual, the residual required varies inversely with contact time. Lower residuals require longer contact time while higher residuals require shorter contact time. While such test results are encouraging, not enough is yet known about the physiological effects of iodine-treated water on the human system. For this reason, its use must be considered only on an emergency basis.

SILVER

Silver in various forms has been used to destroy pathogens. It can be added to the water as a liquid or through electrolytic decomposition of metallic silver. It has also been fed into water through an absorption process from silver-coated filters. Various household systems have been designed to yield water with a predetermined silver concentration. However, fluctuations in the flow rate often result in wide variations in the amount of silver in the water.

In minute concentrations, silver can be highly destructive in wiping out disease-bearing bacteria. While long contact time is essential, silver possesses residual effect that can last for days. Silver does not produce offensive tastes or odours when used in water treatment. Further, organic matter does not interfere with its power to kill bacteria as in the case with free chlorine. Its high cost and the need for long periods of exposure have hindered its widespread acceptance.

COPPER

Copper ions are used quite frequently to destroy algae in surface waters but these ions are relatively ineffective in killing bacteria.

ALKALIS AND ACIDS

Disease-bearing organisms are strongly affected by the pH of a water. They will not survive when water is either highly acidic or highly alkaline. Thus, treatment which sharply reduces or increases pH in relation to the normal range of 6.5 to 7.5 can be an effective means of destroying organisms.

OTHER AGENTS

There are numerous other agents which have proved to be successful in destroying pathogens. Many of these must still be subjected to prolonged testing with regard to their physiological effect on man. Among these are certain surfactants and chlorine dioxide. There are several types of surfactants which aid in destroying pathogens. The cationic detergents readily kill pathogens. Anionic detergents are only weakly effective in destroying pathogens. Surfactants have not been seriously considered for treating drinking water because of their objectionable flavour and possible toxic effects.

Chlorine dioxide has unusually good germ killing power. Up to the present time, no valid tests for its use have been developed because of the lack of means for determining low residual concentrations of this agent. It's such a strong oxidizing agent; a larger residual of chlorine dioxide would probably be needed than is the case with chlorine. At present, chlorination in one form or another is regarded as the most effective disinfectant available for all general purposes. It has full acceptance of health authorities. Still there are certain factors which affect its ability to disinfect waters. These should always be kept in mind. They are:

a) "Free" chlorine residuals are more effective than "combined" or "chloramine" residuals. Disinfection regardless of the type of chlorine becomes more effective with increased residuals.

CHLORAMINE is the compound formed by feeding both chlorine and ammonia to the water. This treatment has been used for controlling bacteria growth in long pipelines and in other appliances where its slower oxidizing action is of particular benefit.

b) A pH of 6.0 to 7.0 makes water a far more effective medium for chlorine as a disinfecting agent than do higher pH values of around 9.0 to 10.0.

c) The effectiveness of chlorine residuals increase with higher temperatures within the normal water temperature range.

d) The effectiveness of disinfection increases with the amount of contact time available.

e) All types of organisms do not react in the same way under various conditions to chlorination.

f) An increase in the chlorine demand of a water increases the amount of chlorine necessary to provide a satisfactory chlorine residual.

In order to ensure the destruction of pathogens, the process of chlorination must achieve certain control of at least one factor and, preferably two, to compensate for fluctuations that occur. For this reason, some authorities on the subject stress the fact that the type and concentration of the chlorine residual must be controlled to ensure adequate disinfection. Only this way, they claim, can chlorination adequately take into account variations in temperature, pH, chlorine demand and types of organisms in the water.

While possible to increase minimum contact times, it is difficult to do so. Five to ten minutes is normally all the time available with the type of pressure systems normally used for small water supplies. These authorities feel that satisfactory chlorine residual alone can provide adequate control for disinfection. In their opinion, superchlorination-dechlorination does the best job.

Briefly, what is this technique and how does it operate?

The success of superchlorination-dechlorination system depends on putting enough chlorine in the water to provide a residual of 3.0 to 5.0 ppm. This is considerably greater than chlorine residual of 0.1 to 0.5 ppm usually found in municipal water supplies when drawn from the tap. A superchlorination-dechlorination systems consists of two basic units. A chlorinator feeds chlorine into raw water. This chlorine feed is stepped up to provide the needed residual. A dechlorination unit then removes the excess chlorine from the water before it reaches the household taps.

The chlorinator should be installed so that it feeds the chlorine into the water before it reaches the pressure tank. A general purpose chemical feed pump will do the job. The size and the placement of the dechlorination unit depends on the type of treatment necessary. This will usually be an activated carbon filter. If pathogen kill is all that is required, a small dechlorination can be installed at the kitchen sink. This unit then serves to remove chlorine from water used for drinking and cooking. Since many families also drink water from bathroom taps, it may be necessary to install dechlorination at these locations as well.

The advantage in dechlorinating only a part of the water is obvious. A smaller filter unit does the job and since only a small portion of the total water is filtered under such conditions, the unit lasts longer before either servicing or replacement is necessary. Essentially dechlorination is not needed to ensure a safe drinking water. Once the water is chlorinated, the health hazard is gone. The chlorine residual is removed merely to make the water palatable. If the problem is compounded due to the presence or iron and/or manganese, all the water should be filtered. Under such conditions, a larger central filter is necessary and should be placed on the main line after the pressure tank.

The prime advantage of the superchlorination-dechlorination process is that it saturates water with enough chlorine to kill bacteria. Simple chlorination sometimes fails of its objective because homeowners may set the chlorine feed rate too low in order to avoid giving their water a chlorine taste. We have discussed at some length various types of pathogens and methods of destroying them in the process of making water potable - safe to drink. This is highly important but it's not the whole story; for water must be palatable as well as potable.

What makes water palatable?

To be palatable, a water should be free of detectable tastes and odours. Immediately, we come to a stumbling block. What constitutes a detectable taste or odour? Undoubtedly when you have traveled around the country, you have tasted waters which must have had unpleasant tastes or odours. Natives in the area may be surprised to note you reaction. For after drinking the water for many years, they find nothing peculiar to either the taste or odour of the water.

Then, there are those waters which have tastes and odours so obnoxious (hydrogen sulfide water, for example), even the long time inhabitant can't stomach them. Turbidity, sediment and colour play important roles in determining whether a water is a delight to drink.

Let's consider these various factors and their effects on water.

ODOURS AND TASTES

Various odours and tastes may be present in water. They can be traced to many conditions. Unfortunately, the causes of bad taste and odour problems in water are so many, it is impossible to suggest a single treatment that would be universally effective in controlling these problems. Tastes are generally classified in four groups - sour, salt, sweet and bitter.

Odours possess many classifications. There are 20 of them commonly used, all possessing rather picturesque names. In fact the names, in many cases, are far more pleasant than the odours themselves. To name a few of them - nasturtium, cucumber, geranium, fishy, pigpen, earthy, grassy and musty. Authorities further classify these odours in terms of their intensity from very faint, faint, distinct and decided to very strong.

Now your taste buds and olfactory organs are not necessarily of the same acuteness as your neighbours. So there may be some disagreement on the subject. Generally you or your neighbour should not be made aware of any tastes or odours in water if there is to be pleasure in drinking it. If you are conscious of a distinct odour, without specifically seeking for such, the water is in need of treatment.

In many cases, it is difficult to detect what constitutes a taste or an odour. The reason is obvious. Both the taste buds and olfactory organs work so effectively as a team, it is hard to realize where one leaves off and the other begins. To illustrate: hydrogen sulfide gives water an "awful" taste yet actually it is this gas's unpleasant odour that we detect rather than an unpleasant taste. Unfortunately, there is little in the way of standard measuring equipment for rating tastes and odours. Tastes and odours in water can be traced to at least five factors. They are:

1) decaying organic matter

2) living organism

3) iron, manganese and the metallic product or corrosion

4) industrial waste pollution from substances such as phenol

5) chlorination

6) high mineral concentrations

In general, odours can be traced to living organisms, organic matter and gases in water. Likewise, tastes can be traced generally to the high total minerals in water. There are some tastes due to various algae and industrial wastes.

Now how can these objectionable tastes and odours be removed from water?

Some tastes and odours, especially those due to organic substances, can be removed from water simply by passing it through an activated carbon filter. Other tastes and odours may respond to oxidizing agents such as chlorine and potassium permanganate. Where these problems are due to industrial wastes and certain other substances, some of the above types of treatment may completely fail. In some cases, for example, chlorination may actually intensify a taste or odour problem.

Potassium permanganate has been found to be extremely effective in removing many musty, fishy, grassy and moldy odours. Two factors make this compound valuable - it is a strong oxidizing agent and it does not form obnoxious compounds with organic matter. However, a filter must be used to remove manganese dioxide formed when permanganate is reduced. You may have to try a number of methods in an attempt to rid a water of objectionable tastes and odours. If methods considered here do not work, it may be more economical to seek out a new source of drinking water.

TURBIDITY and suspended matter are not synonymous terms although most of us use the terms more or less interchangeably. Correctly speaking, suspended matter is that material which can be removed from water through filtration or the coagulation process. Turbidity is a measure of the amount of light absorbed by water because of the suspended matter in the water. There is also some danger of confusion regarding turbidity and colour. Turbidity is the lack of clarity or brilliance in a water. Water may have a great deal of colour - it may even be dark brown and still be clear without suspended matter.

Pick up a glass of water and hold it to the light. Can you see any finely divided, insoluble particles suspended in the water? Does the water seem hazy? If so, the water is turbid. When water has a large amount of such suspended particles, we lose our zest for it. While it may be safe to drink, it seems offensive.

The current method of choice for turbidity measurement in Canada is the nephelometric method; the unit of turbidity measured using this method is the nephelometric unit (NTU). Turbidity in excess of 5 NTU becomes apparent and may be objected to by a majority of consumers. Therefore an Aesthetic Objective (AO) of <= 5 NTU has been set for water at the point of consumption.

The suspended particles clouding the water may be due to such inorganic substances as clay, rock flour, silt, calcium carbonate, silica, iron, manganese, sulpher or industrial wastes. Again the clouding may be due to a single foreign substance in water, chances are it is probably due to a mixture of several or many substances. These particles may range in size from fine colloidal materials to course grains of sand that remain in suspension only as long as the water is agitated. Those particles which quickly sink to the bottom are usually called, "sediment". There are no hard and fast rules for classifying such impurities.

If you take water from a swiftly flowing river or stream, you generally find that it contains a considerable amount of sediment. In contrast, you find that water taken from a lake or pond is usually much clearer. In these more quiet, non-flowing waters, there is greater opportunity for settling action. Thus all but very fine particles sink to the bottom. Least apt to contain sediment are wells and springs. Sediment is generally strained from these water as they percolate through sand, gravel and rock formations.

Turbidity varies tremendously even within these various groupings. Some rivers and streams have water that appears crystal clear with just trace amounts of turbidity in them especially at points near their sources. These same moving waters may contain upwards of 30,000 ppm of turbidity at other points in their course to the oceans. In fact, turbidity in amounts well over 60,000 ppm have been registered.

Again there are significant fluctuations in the amount of turbidity in a river at different times in a year. Heavy rainfalls, strong winds and convection currents can greatly increase the turbid state of both lakes and rivers. Warm weather and increases in the temperature can also add to the problem. For with warm weather, micro-organisms and aquatic plants renew their activity in the water. As they grow and later decay, these plant and animal forms substantially add to the turbid state of a water. Also, they frequently cause a heightening of taste, odour and colour problems.

Mechanical filtration will remove all forms of turbidity. Of course, the smaller the turbid particles, the finer the filter openings must be in order to strain them out. Under some circumstances, the openings may have to be so small that they cause an excessive pressure drop as the water creeps through the filter and the unit may be impractical. In many cases, filters containing specially graded and sized gravel and sand are effective in screening out turbid particles. With such units, a periodic backwashing to remove the filtered material is all the maintenance necessary.

Some filter manufacturers also provide a "filter-aid" which is added onto the top of the filter bed immediately after backwashing. The filter aid traps fine dirt particles producing a more a sparkling clear water and keeps dirt from penetrating the filter bed, insuring better bed cleansing during backwashing. In some cases, cartridge filters are effective. These will filter water used for cooking and drinking. Generally these cartridge filters are just installed on the drinking water lines. There are several reasons for this: (1) They produce a significant pressure drop. This would be a handicap if these filters were installed on the main water line. (2) Their replacement cost may be too high to justify their use in filtering all the water.

Municipal and industrial systems frequently make use of the coagulation process to aid in the removal of turbidity. In this economical process, a coagulating agent such as aluminum sulfate is fed into the water. After rapid mixing, the coagulating agent forms a "floc" generally in the form of a gelatinous precipitate. This floc gives the appearance of a soft, gentle snowfall. A settling period is then needed to allow the floc to fall gently through the water. As the floc forms and settles, it tends to collect or entrap the turbid particles and form them into larger particles which sink to the bottom. On large installations, huge settling basins provide the necessary time and space for the process.

After the settling period, the water flows through a filter to remove the last traces of the coagulant and any remaining turbid particles. Small coagulation-filtration systems are sometimes utilized for household purposes when turbidity is particularly offensive. The difficulties with the use of this process for home purposes are in determining what type of coagulant will give the best results and what equipment is required. Experience in this area is essential because the chemical properties of the water must be considered in relation to the coagulant or combination of coagulants employed. Further adequate mixing and coagulation time are essential. Coagulation-filtration also requires considerably more attention to maintenance than do the simple filtration processes mentioned earlier.

What colour is water?

Ordinarily we think of water as being blue in colour. When artists paint bodies of water, they generally colour them blue or blue-green. While water does reflect blue-green light, noticeable in great depths, it should appear colourless as used in the home. Ideally, water from the tap is not blue or blue-green. If such is the case, there are certain foreign substances in the water. Among these substances: Infinitely small microscopic particles add colour to water. Colloidal suspensions and non-colloidal organic acids as well as neutral salts also affect the colour of water.

The colour in water is primarily of vegetable origin and is extracted from leaves and aquatic plants. Naturally, water draining from swamps has the most intense colouring. The bleaching action of sunlight plus the aging of water gradually dissipates this colour, however. All surface waters possess some degree of colour. Like some shallow wells, springs and an occasional deep well can contain noticeable colouring. In general, water from deep wells is practically colourless.

An arbitrary standard scale has been developed for measuring colour intensity in water samples. When a water is rated as having a colour of five units, it means: The colour of this water is equal in intensity to the colour of distilled water containing 5 milligrams of platinum as potassium chloroplatinate per litre.

Highly coloured water is objectionable for most process work in the industrial field because excessive colour causes stains. While colour is not a factor of great concern in relation to household applications, excessive colour lacks appeal from an aesthetic standpoint in a potable water. Further, it can cause staining. The Aesthetic Objective (AO) for colour in drinking water is <= 15 true colour units. The provision of treated water at or below the AO will encourage rapid notification by consumers should problems leading to the formation of colour arise in the distribution system.

In general, colour is reduced or removed from water through the use of coagulation, settling and filtration techniques. Aluminum sulfate is the most widely used coagulant for this purpose. Super chlorination, activated carbon filters and potassium permanganate have been used with varying degrees of success in removing colour.