World Plumbing Council Scholarship

Report

Least Developed Country

2016

By

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About World Plumbing Council

The world plumbing council (WPC) scholarship planned to provide education exchange between different countries and motivate the plumbing industry training. This gives an opportunity to individual participants to gain knowledge and learn about the innovative technologies and training systems. I believe this is the route to improve the standards of plumbing in our won countries. This also increases awareness of how importantly plumbing industry is contributing towards the global health and environment or sustainability issues. The values of efficiency water to the community as well as plumbing industry.

About the WPC scholar 2016

I am 33 years of age and married to the lovely Maniesha a Registered Nurse in Fiji Island. I am a father of a child who's just born after my visit to Australia this year in July. I work as an Assistant Plumbing Lecturer in the School of Building & Civil Engineering at Fiji National University. My responsibilities are to develop and teach units at undergraduates in both theory and practice. Training programs includes Certificate III and IV in the field of Plumbing. However I have a Trade Certificate in Plumbing and Sheet Metal completing apprenticeship scheme under Training and Productivity Authority of Fiji. I have been awarded with a Gold Medal for excellence then Fiji Institute of Technology as well as the Best Apprentice award from Training and Productivity Authority of Fiji. After graduating I have served Ministry of Work & Energy for a year as a General Plumber.

To fine tune my teaching delivery I have successfully completed Graduate Certificate in Tertiary Teaching from University of the South Pacific which brings high level of intensity in my teaching. In addition to that I have been privileged with Australian Pacific Technical College to complete Certificate III in plumbing to gain Australian standard skills and training.

The Potentials have nourished within me a love for work, learning and an extremely great pleasure in passing down skills to the next generation of plumber the accumulated wisdom of the beautiful trade

Introduction

The purpose of this Report is to provide the World plumbing council a brief account of my experience and observations of the World Plumbing Council scholarship 2016 for least developed countries training/conference in Australia.

The conference was in Gold Coast in Drinking Water Treatment: principles, practice and applications by IWES – University of Queensland. The aim of this course is to identify key water issues, describe the major water treatment processes currently used and also outline the new approaches for improving water treatment.

This is a practical course and case studies are used extensively in teaching. The course concludes with an interactive design workshop to consider the issues and required treatment for a theoretical water source and water quality. A specific operating issue of the concern to participants was also discussed throughout the course.

IWES Course: Drinking Water Treatment: Principles, Practice and Applications

Introduction to Potable Water Treatments

The importance of safe and healthy drinking water free from pathogenic organisms and toxic compound is a well-established principle in modern society. Drinking Water quality is a global concern and is acknowledged by water authorities as well as medical experts. This has the greatest risk related to drinking contaminated water which is something every individual should take granted. The poor water quality and microbial pathogens in water leads to the spread of waterborne diseases which can be diarrheal or even serious illnesses. However it has been noted that each year the number of deaths caused by water related is nearly 3.4 million.

Indeed many developed countries are satisfied in their acceptance at has that water has been treated or simply disinfected is safe to drink. There has been an increased focus on the chemicals used to provide safe drinking and possible adverse outcomes that may be associated with their use. This is the leading concern with water treatment practices and calls to return to natural supplies. However waterborne outbreaks associated with contaminated catchment waters, poor treatment practices and lack of rigor in operation of these facilities have resulted in illness and the loss of human life. Avoiding adverse health effects continues to highlight the need for high quality drinking water and has highlighted the significance of not only establishing treatment facilities but also ensuring their effective operation.

The quality of water supplied is basically depends upon the location and site you live as well as the type of water resources it is supplied from such as Ground or Surface water. Surface water is sometimes runoff from urban, agriculture, industrial areas and other chemical spills. Although water is been treated and chemical disinfections are added such chlorine and fluoride but may not be free from pathogenic microorganisms. However water quality problems may also arise at water resource, during treatment process, distributions through pipework's from the treatment plant to the meter and plumbing systems.

In addition, there has also been an increased focus on the quality of water in catchments and chemicals used in treatment processes to provide safe drinking water. As a result it is necessary not only to remove any pathogenic organisms but also to ensure that the treatment processes used to remove chemicals of concern do not introduce problem contaminants themselves. Increased public concern ensures that the water industry continues to improve current operating procedures and to develop new technology with the ideal outcome of producing high quality water using non chemical treatment processes at an affordable pric

Australian Drinking water

The Australian Drinking water guidelines are a framework for good management of drinking water supplies that will assure safety at point of use.

There are six fundamental principles that are identified as the basis of effective drinking water management:

1. The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised.

2. The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply.

3. Any sudden or extreme change in water quality, flow or environmental conditions for example extreme rainfall or flooding should arouse suspicion that drinking water might become contaminated.

4. System operators must be able to respond quickly and effectively to adverse monitoring signals.

5. System operators must maintain a personal sense of responsibility and dedication to providing consumers with safe water, and should never ignore a consumer complaint about water quality.

6. Ensuring drinking water safety and quality requires the application of considered risk management approach.

However the management of drinking water supplies emphasise the need for a multiple barrier approach, system management, water treatment, monitoring, reporting, community consultations

Treatment Processes

Water clarification is aided generally by the addiction of chemicals. Yet it is not practised only to improve the appearance of the water on the other hand it improves the chemical and microbiological quality of water. The key need for the water treatment process is the removal of pathogen organisms. Chlorination alone is sufficient to produce a safe water supply and directly aid the removal of pathogens which is basically more effective disinfection.

Some pollutants of concern to human health are particles themselves, enclosed within particles or associated with solid particles such as disease-causing organisms, certain metals or synthetic organic chemicals. Therefore clarification of water is an important component of treatment for the removal of many health-related pollutants to ensure that the most effective disinfection is being practiced at the minimum doses possible and the best quality water is being supplied to the public. Suspended matter or particles present in water varies widely in origin, concentration and size. Some are constituents of land-based or atmospheric sources such as clays and silts and some are produced by chemical and biological means within the water such as the precipitation of chemicals or the action of algae or aquatic organisms. Particle size may vary by several orders of magnitude, from a few tens of nanometers example of viruses to hundreds of micrometers. Whereas larger particles can settle or be physically removed by gravity filtration through granular media, the smaller particles (generally smaller than one micron), usually called “colloidal”, are stable and will not be removed by settling or gravity filtration. However all of these can be removed effectively by properly designed and operated water treatment facilities. Natural organics are also present in all surface waters and are derived from soil, decayed wood and vegetation or produced within surface water and sediments by biological processes. They cause the yellow-brown colour sometimes observed in water. Even when waters may look low in colour, the level of organics in the water may still be high and these compounds can cause considerable problems in water treatment plants. They react with the chemicals added and increase the level of chemical needed to satisfactorily remove the particulate matter present in water. They may also react with some disinfectants to form by-products therefore minimizing these organics reduces the occurrence of these side reactions. Algal blooms have often been considered a nuisance in water supplies due to the formation of tastes and odours, which adversely affect public opinion of the water. However the recent identification of toxins produced by blue-green algae has ensured that these organisms have now also become a public health issue.

Clarification of water with the use of chemicals as an aid to settle out the particles is nothing new. After the collection water from streams and transported it in camel skin bags, it is placed it in wide, round-belly and rectangular vessels. They then smeared the mouth of the vessel with five sweet almonds, after which a person would plunge his arm into the water up to the elbow and twist it with a vigorous motion for an appropriate period of time. The arm was withdrawn and the crushed almonds were left in the jar. After about three hours settling, the water would be clear enough to store in earthen jars where it would become clearer and cooler. Conventional water treatment practiced today, although undertaken on a larger scale, still uses these same basic principles.

Conventional Water Treatment

Water treatment plants operating today are mostly based on conventional water treatment process. As such the treatment is applicable to all types of water quality to achieve however requires expensive infrastructure to implement. The sedimentation process can be eliminated if the raw water from the catchment has low solid content. Although there is a increase in membrane filtration but some forms of flocculation is frequently practised as a pre-treatment process.

Water can be taken either from a surface water source such as a river or a reservoir or from groundwater. Most Australian supplies are surface waters and hence are subject to blooms of algae which can occasionally occur and result in unsightly water and tastes and odours. Within the reservoir, these algal blooms can be treated with chemical algicides to kill the bloom. This is not possible in a moving water body such as a river and alternative means of solving this problem are discussed later. Another means of controlling algal growth within the reservoir is ensuring that the water body is adequately mixed or aerated as this prevents hotter layers forming on top and causing stratification which encourages algal growth.

Once the water is pumped from the water source, via a flow controller to enable accurate chemical dosing, it is passed through screens to remove large objects such as rocks or fish. It then passes into a mixing tank, where it is rapidly stirred to ensure adequate contact of the main chemical added at this point. This chemical reacts with colloidal particles in the water and causes them to destabilize and come together to form small particles called floc which are just visible to the eye. This process of particle destabilization and inter-particle collision by chemical addition (or in situ formation) is called coagulation. The major chemical used worldwide is aluminum sulphate (alum).

Other chemicals can be used, such as other aluminum salts, iron salts and more recently synthetic organic polymers have gained acceptance. Positively charged polymers are the most common type used in water treatment as they can act to destabilize the colloidal particles similarly to the inorganic. The main cationic polymer used is poly diallyldimethyl ammonium chloride which has a low molecular weight is between 10,000-100,000. Other types of polymers can be used, particularly to aid the growth of the floc. This generally occurs by the formation of bridges where segments of a polymer chain adsorb on more than one particle.

These polymers can be cationic, anionic or nonionic. The NHMRC has limited the types of polymers used in water treatment in Australia based on adverse health effects associated predominantly with the monomers used to form the polymers.

After a short period varying between 30 sec to 5 minutes, the water flows into another mixing tank, where the water is physically mixed slowly to enable the small particles to collide, come together and grow into larger settled floc. This process of physically producing inter-particle collisions resulting in floc growth is termed flocculation. After a 20-30 min mixing time, the water enters a sedimentation tank where the floc is allowed to settle under the influence of gravity, generally over a period of hours. The clean water is skimmed off the top at the end of the tank and enters the high rate filters.

Most filters used in Australia are multi-media and often consist of sand/anthracite. They remove any floc which has not settled ensuring perfectly clean water for disinfection. The settled sludge is pumped away at regular intervals and disposed of either to the sewer or by drying and/or pressing the sludge to a much thicker consistency and disposing of as landfill.

Alternative methods of disposal of the sludge and, in particular sludge reuse, need to be considered as land for disposal becomes limited and environmentally unacceptable. Addition of alum decreases the natural pH of the water making it more acidic.

It is therefore necessary to increase the pH to prevent corrosion of pipework and this is generally done using quicklime (calcium hydroxide). The quantity required is dependent on the alum dose used and the natural alkalinity of the water. Addition of fluoride to prevent dental caries and disinfection generally using chlorine are the final steps prior to supplying clean, disinfected water to the public.

With some water supplies containing low suspended solids load it is possible to eliminate the sedimentation stage and filter the flocculated water directly - this is termed direct filtration. Elimination of the flocculation stage as well as the sedimentation stage is sometimes applied and this is termed in-line or contact filtration. The latter approaches are used where possible as the capital costs are reduced due to less infrastructure requirements. The large water treatment plant

(3000ML/day) treating Prospect Reservoir water in Sydney is a contact filtration plant, utilizing a four stage coagulation process.

DISSOLVED AIR FLOTATION

Addition of alum to water with little suspended material present but more colour results in very light, fluffy, often smaller particles being formed. These particles do not settle as readily in the conventional treatment process described and it is sometimes necessary to use coagulant aids to form larger floc or even a weighting agent to make the floc heavier. An alternative to trying to settle this light floc is to introduce air under pressure with water at the end of the flocculation stage. The bubbles of air then join onto the particles and float them to the surface rather than letting them settle with gravity. The floated sludge can then be skimmed off the tank and the clear water filtered as previously. This is known as dissolved air flotation and is extremely effective for highly coloured waters with little sediment present and also for waters high in algal cells.

Disinfection

Disinfection is the process where drinking water is been treated to prevent waterborne disease. A good quality water is can be treated directly or agents used for disinfection of water includes chlorine, chlorine dioxide, ozone, bromine, iodine, solver ultraviolet radiation, filtration and changes to physical and chemical properties.

The greatest risks to consumers of drinking water are pathogenic microorganism. Protection of water sources and treatment are of paramount importance and must never be compromised.

The drinking water system must have and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply.

The ideal disinfectant should:

i. Effectively inactive pathogens over a range of physical and chemical conditions
ii. Produce no by-products
iii. Be easily generated and safe to handle
iv. Be cost effective

No disinfectants meets all requirements however the process often involves series of compromises based on the quality of the source water. As such several disinfection experiments are carried out to determine the time to achieve a 99% kill of test microorganisms. The major methods of disinfection for drinking water are use today is chlorination, chlorination, and zonation. Moreover a lesser extent is chlorine dioxide treatment and ultraviolet radiation.

Chlorine

This process was introduced in early 20th century and still is the major disinfectant method in the world. It is a very strong disinfectant and excellent bactericidal properties at a short contact time. It also is a strong oxidising agent which bleaches water and the tastes and odours produce by algae.

Natural water contains inorganic and organic compounds that react with chlorine, therefore sufficient disinfectant must be added to the water to satisfy this demand and provide the required dose for disinfection. These reactions with organic matter produce a range of chlorinated by-products, the most well-known being trihalomethanes, of which chloroform (CHCl3) is generally the most prevalent. Trihalomethanes have been shown to be carcinogenic in tests with animals at high doses and are therefore undesirable in drinking water. Chlorine may also react with compounds such as phenols and impart a taste and odour.

Chloramine

Addition of ammonia with chlorine forms chloramines. Dichloramine is a stronger disinfectant than monochloramine however it is also less stable and has a distinct disagreeable odour. Nitrogen trichloride has an extremely offensive odour but is readily destroyed by sunlight. Low pH and high chlorine to ammonia ratios favour the formation of the less stable chloramines so the ratio of Cl:NH3 is controlled at levels of 3:1 to 4:1 to ensure that monochloramine is the major species formed at normal pH levels. Monochloramine is a weak disinfectant, requiring for equivalent disinfection, 25 to 100 times the contact time of free chlorine. However chloramine persists further into distribution systems and continues to exert a disinfecting effect in the extremities of long systems.

There are other disadvantages also associated with the use of chloramines. Low levels of chloramines are acutely toxic to a variety of aquatic organisms and must be removed in aquariums. Similarly exposure of dialysis patients to chloramines is potentially fatal and attention must be given to effective treatment of water used in dialysis. As chloramines are less effective disinfectants than chlorine it is essential that sufficient contact time is allowed for disinfection and this can be an issue for consumers close to dosing stations. Operational control of chloramination is more complex both because of the need to control pH, mixing and chlorine/ammonia ratios to optimise formation and lifetime of chloramines and also because the growth of nitrifying bacteria at the ends of systems can cause loss of chloramine residuals which are then difficult to reintroduce.

Ozone

Ozone is generated onsite by passing an electric discharge through clean dry air or oxygen. The resultant ozone is a very strong biocide and oxidizing agent and is effective in reducing colour, iron, manganese, taste and odour. It is more expensive than chlorine, has low solubility in water and is unstable above pH 8 (at pH 8, half of the ozone is lost in less than half an hour). Consequently a residual cannot be maintained in a distribution system particularly as temperature increases. This is a major disadvantage in the use of ozone as a disinfectant. Ozone does not react with natural organics to form chlorinated trihalomethanes because the only available chlorine atoms are those in the organic material. Since the adoption of stringent limits for trihalomethanes in Europe and the United States, and because of the need for a strong oxidant and primary disinfectant, ozone is replacing chlorine as a primary disinfectant.

However the low level chlorination is still necessary to maintain a residual in the distribution system. Ozonation is rarely used in Australia at the present time for disinfection of municipal water supplies, but is being applied for oxidation and control of other compounds. Ozone, however, is a sufficiently powerful oxidant to convert bromide to bromine and this can lead to the formation of brominated trihalomethanes and bromates both of which have health implications and are identified in the Australian drinking water guidelines. Low molecular weight aldehydes such as formaldehyde and acetaldehyde have been determined as by-products of ozonation although they also appear to be by-products of chlorination. These compounds are biodegradable and unless effectively removed can result in increased bacterial growth within a distribution system unless a residual disinfectant is maintained.

Ultraviolet Radiation

Ultraviolet light can be effectively produced by the use of mercury vapor lamps in either low pressure monochromatic lamps or medium pressure lamps. The latter produce polychromatic radiation in the range 200-280 nm and have a much greater intensity at the germicidal wavelength of 254 nm (UV-C). Fewer lamps must be installed when using medium pressure lamps, reducing the size of the UV reactor vessel although low pressure lamps have a considerable longer lifetime than medium pressure lamps. The contact times for UV disinfection can be quite short, however as there is no residual, some additional disinfection process is usually required. The mechanism of inactivation by UV light is deleterious changes to the nucleic acid structure of the organisms exposed, damaging the ability of the organism to replicate.

Thymine bases on the nucleic acids (DNA and RNA) are particularly reactive to UV light and form dimers (thymine-thymine double bonds) that inhibit transcription and replication of nucleic acids. Some microorganisims possess the ability to repair the thymine dimers, termed "photoreactivation" in the presence of light, or "dark repair" if light is absent. As a result of this repair phenomenon, the strategy in UV disinfection has been to provide a high enough dosage that enough nucleic acid damage occurs to prevent effective repair of the organism. Recent evidence that inactivation of *Cryptosporidium parvum* oocysts was effected by low UV radiation of 20 J m-2 has increased the use of UV radiation for disinfection, particularly for the effective control of protozoan cysts

Major advantages of UV disinfection are the rapid effectiveness and ease of application of UV systems, particularly for independent and remote operation. The potential for by-product formation is low since the energy required to effect organic compounds is much higher than that required for disinfection. The disadvantages are the impact of water quality on radiation effectiveness, the possibility of photoreactivation, the dependence on hydraulic design and the difficulty of measuring radiation exposure within the reactor. Operationally, maintenance programs must be employed to prevent the fouling of surfaces which may limit penetration of radiation

Other Treatment Options

Adorption

Algal blooms in the raw water can result in tastes and odours in the treated water. Recently, some algal blooms have resulted in the production of toxins which can affect human health. Chemical treatment in a reservoir can be undertaken to kill the bloom and the subsequent treatment process itself is effective in physically removing the algae. However the products that cause taste and odour and the algal toxins may be released into the water and are not removed during the treatment process described. These compounds need to be chemically or physically adsorbed from the water and the most effective way that is known is the use of activated carbon.

The activated carbon is available in two forms, powdered or granular. Powdered activated carbon (PAC) can be added in treatment plants at the rapid mixing stage described above where it can adsorb compounds and then be enmeshed with the settled particles formed and removed with the sludge

Oxidation

All the chemical disinfectants discussed are also strong oxidants and can be used to oxidise and remove contaminants. For example the presence of iron and manganese in water supplies can result in dirty water complaints from customers as they can deposit and stain both plumbing fixtures and laundry if not removed. Oxidation of these compounds to their insoluble form within a water treatment plant is often the most effective means of control. The oxidants most often used for this purpose are chlorine and potassium permanganate, although chlorine dioxide and ozone are also effective. Oxidation has also shown to be effective for the removal of a range of other contaminants including the algal toxins microcystin, and synthetic organic compounds such as trichloroethylene and atrazine. These oxidants are often added at the head of the conventional treatment plant, prior to or at the coagulation stage but they can also be applied after clarification and filtration when a substantial proportion of the oxidant demand has been removed. This oxidant demand is predominantly the NOM and as discussed earlier can result in the formation of disinfection by-products which can have adverse public health effects.

Ozone is often the oxidant of choice for removal of contaminants due its strong oxidising ability. Recently the combination of ozone and hydrogen peroxide or UV and hydrogen peroxide, termed advanced oxidation process (AOP), has become popular for removal of contaminants. This is due to the lower ozone or UV doses required to achieve the same oxidation efficiency when combined with hydrogen peroxide.

Oxidation whilst removing the toxicity associated with contaminants may in some circumstances result in the formation of oxidised contaminants which may also affect public health.

Biological Filtration

Ozone reacts with organics to produce lower molecular weight compounds which are more biodegradable and promote the growth of bacteria in water supplies. This can be used to advantage in biological filtration processes consisting of ozonation followed by a bed of granular activated carbon where bacterial growth is promoted to reduce organic levels and facilitate removal of pollutants. The removal of these organics as a food source for bacteria reduces the bacterial growth in distribution systems and minimizes the level of disinfectant required. This process is used extensively in Europe as the final polishing step in water treatment plants and is gaining acceptance in the United States. A number of water treatment plants around Australia are now utilizing ozone followed by a GAC filter to control algal toxins.

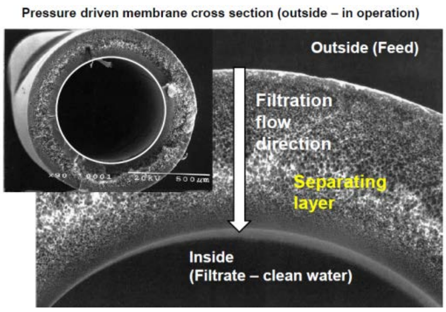
Other examples of biological filtration for improving water quality are the use of slow sand and river bank filtration. Riverbank filtration in particular has been applied to enable the natural bacterial populations to reduce available biodegradable organic carbon so that the resultant water no longer supports bacterial growth in distribution systems. This has reduced (or in some cases removed), the need for a residual disinfectant. Recently, interest in biological filtration has increased as a means of reducing both man-made and natural contaminants.

Membrane Filtration

Membranes are essentially physical semi-permeable barriers that separate two phases and restrict transport of various chemicals across the barrier. The extent of transport across the membrane is dependent on the different pore size of the membrane, the membrane material and the applied pressure. Microfiltration (MF) can remove particles greater than 0.1 m in size, including bacteria and a significant quantity of colloidal material. Ultrafiltrations (UF) can particles as small as 0.005 m, including viruses and colour. MF and UF pathogens and particles from water, and as pre-treatment to membrane desalination systems. Nano filtration (NF) is a membrane process that targets the removal of NOM, multivalent salt ions those responsible for hardness and to a lesser degree, simple salts such as fluoride and chloride. NF can also remove trace organic micro pollutants, such as pesticides. Reverse osmosis (RO) is a membrane process that removes a very high proportion of all dissolved salts from water to produce pure water and is used for desalination. For example, a seawater RO membrane can reduce the salinity of seawater from 39,000 mg/L to less than 300 mg/L in a single pass. High pressures (50-70 bars) are required to achieve this. NF is often referred toas “loose” RO because it operates at much lower pressures and allows a much greater fraction of dissolved salts to pass through to the product water.

Submerged Membrane

Membrane was developed in mid 1990s of different designs.is made as such that it is open to atmosphere so lower pressure and it extracts permeate by suction. Solid concentration in tank is continuously removing waste stream and during backwash run to waste.



Australian Drinking Water Guidelines

The concentration of all chlorination by-products can be minimised by removing naturally occurring organic matter from the source water, reducing the amount of chlorine added, or using an alternative disinfectant (which may produce other byproducts). Action to reduce trihalomethanes and other byproducts is encouraged, but must not compromise disinfection.

There are numerous waterborne pathogens, each differing with respect to source, treatment sensitivities and effects on health.We can simplify into 3 major groups

– Enteric (intestinal) bacteria

Campylobacter, E. coli O157 and Salmonella

– Enteric protozoan parasites

Cryptosporidium and Giardia

– Enteric viruses

Enterovirus, Rotovirus, Adenovirus andHepatitis

Effectiveness of Disinfections

The capability of different disinfectants to achieve 99.9% removal

Summary

Consideration	Chlorine	Chloramination	Ozone	Chlorine Dioxide	UV
Bacteria	Excellent	Good	Excellent	Excellent	Good
Viruses	Excellent	Fair	Excellent	Excellent	Fair
Protozoa	Fair to poor	Poor	Good	Good	Excellent
Contact Time	Moderate	Moderate	Short	Moderate	Short
pH dependent	Yes	Yes	Yes	Slight	None
Residual	Moderate	Long	None	Moderate	None
By-Products	Yes	Yes	Yes	Yes	None known

Six Fundamental principles:

i. The greatest risk to consumers of drinking water is pathogenic micro-organisms. Protection of water sources and treatment are of paramount importance and must never be compromised.

ii. The drinking water system must have and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply.

iii. Any sudden or extreme change in water quality, flow or environmental conditions such as extreme rainfall or flooding should arouse suspicion that drinking water might become contaminated.

iv. System operators must be able to respond quickly and effectively to adverse monitoring signal.

v. System operators must maintain a personal sense of responsibility and dedication to providing consumers with safe water, and should never ignore a consumer complaint about water quality.

Some of the water quality risks are pathogens, cyanobacteria, micro pollutant and disinfection by product.

Natural Organic Matter

i. Colour

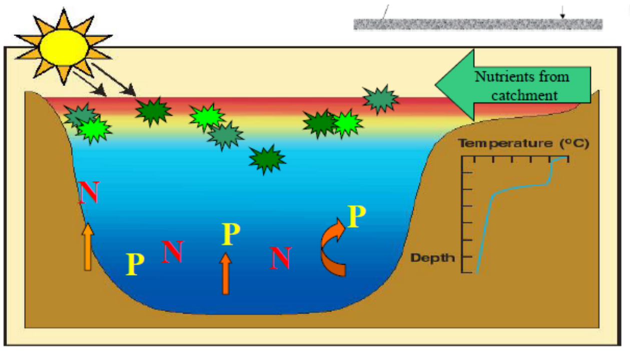
ii. Reacts with disinfectants to form by products

Other issues are hardness, arsenic, nitrate, fluoride, bromide and iodide.

Sources Water Protection

i. Catchment management

ii. Reservoir management – prevent stratification



Stratification

Anoxic condition at base of reservoir

Causes release from sediment of nutrients and also iron and manganese

Algal blooms

Coagulation

Sweep Floc is the addition of coagulant in concentration that results in formation of solids metal hydroxide. The colloidal particles physically caught up in floc.

Factors affecting coagulation are

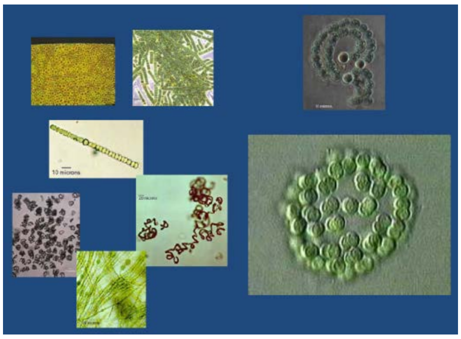
i. Coagulant type and the doses

ii. Water quality pH, amount of particulates or turbidity, NOM concentration and type colour and temperature.

iii. Physical process basically rapid mixing to ensure contact.

Treatment of Cyanobacteria

Metabolites can be contained within the cell or dissolved. However the cells can be removed by conventional treatment processes. The extracellular and dissolved metabolites can be removed by physical, chemical or biological processes.



Removal of Cyanobacteria

Conventional treatments are coagulation, flocculation and filtration. Metabolites can be up to 98% intracellular which can be separated by cell removal. In practice intracellular can be 0 to 100% by always optimising coagulation for particles removal. But conventional treatment does not remove dissolved metabolites.

• The presence of algae/cyanobacteria didn't impact alum dose, settled water turbidity or UV absorbance removal

• Investigative sampling through the plant indicates >98% removal of cyanobacteria by coagulation and clarification

Biological Processes

Is a low technology which requires relatively little maintenance, low infrastructure and running cost. The processes involve removal of contaminants without the addition of chemical and by product formation. Generally this process is very effective.

Why is NOM important?

• reacts with treatment chemicals for aesthetic or appearance and colour

• Increases chemical doses required

• forms by-products which have health impacts and/or water quality impacts

• affects associated treatment processes

• Directly and indirectly affects water quality

• impacts cost and efficiency of treating water

• Also forms other chlorinated by-products

e.g.: haloacetic acids, chloroketones, chlorophenols

• Up to 66% of by-products formed can be measured

• All chemical disinfectants react to form by-products

• Recently NDMA linked with chlorination

Types of Household Water Treatments

Filtration Systems

A water filter system is a device which has straining's or physical barrier to help remove particles and larger impurities. The pollutants are being absorbed in the filter pores in the system letting the clear water out. Water filters are basically designed to install in many ways such as tap installed or mounted with other household filtration systems. It also comes in extra features in some appliances like dispensers and refrigerators.

Advantages

Water filter removes excess chlorine and dangerous contaminants from water. It is very effective in eliminating protozoa. On the other hand filtered water is healthier in taste and smell. It also helps to develop our immune systems as well as reduce the risk of plenty gastrointestinal diseases.

Disadvantages

Filters have very less or moderate effect on eliminating viruses and bacteria. The system needs regular maintenance or replacing of the filters cartridge to operate effectively. It may be more harmful to drink water from a dirty filter than a tap.

Reverse Osmosis Systems

This is a natural process where the water is passed from extra concentrated to dilute solution. Then water is forced through a semi penetrable membrane. However this also includes filter pore size of about 0.001 micron which removes sediments.

Advantages

Reverse Osmosis System has a high efficiency of eliminating protozoa and bacteria such Giardia, shigella and campylobacter. Also the system removes all viruses.

Disadvantages

The installation unit may be expensive and in addition we also have to consider the maintenance costs. This system does not remove common chemical toxins which may be in drinking water from industrial runoff. It requires high pressure of water supply to force the water in the permissible membrane. The wastage of water during this process is more than it treats.

Distillation Systems

This process is when impure water is heated up to the boiling point and begin to evaporate. During its condensation process the steam is than back to liquid and then is deposited in a separate chamber. This water is basically clear water without virus and bacteria and some minerals also are being removed. As such the debris and solid contaminants from the water remains. Distillation process is comparable with Reverse Osmosis and mostly used in developing counties where high risk of waterborne diseases.

Advantages

The system totally softens water and effective in killing bacteria, viruses and eliminates the inorganic contaminants. It also removes most hazardous metals from water.

Disadvantages

A distillation system is sometimes not effective to eliminate all organic pollutants from water. However it only eliminates common chemical pollutants as well as removes certain minerals. The unit installation can be expensive with additional maintenance costs. As such this is the slowest treatment process and clean water can only be supplies to one point of excess. Also 80% of water is being a waste and discarded and leads to a small amount of purified water.

Ultraviolet Treatment Systems

UV systems are very consistent and cost effective process of destroying 99.99% of pathogenic microorganisms, parasite and fungi by the electromagnetic spectrum of rays. Without the addition of any chemicals the UV light attacks the genetic core or DNA of microorganisms and eliminates them to function and therefore they cannot reproduce. This works simply by exposing the water to adequate intensity of ultraviolet rays to a particular period with a light wavelength of 254nm. Ultraviolet rays are similar like sunlight which basically slays the harmful microorganisms and they eventually die off. This assures the water is without bacteria and clean water to consume.

Advantages

This technology is highly effective and a very safe way to purify drinking water. It removes all bacteria, viruses and other harmful contiminants.The process is heat and chemical free that is no addition of chlorine and thus there is no change in taste, color and odor of drinking water. Moreover Ultraviolet systems are very easy to maintain and compactable to use. It needs very less energy as to light a bulb and requires very low maintenance work

Disadvantages

In order destroy all microorganisms the water must be filtered before purification so that the rays are absorbed and can be highly effective. Just require to replace the UV bulb yearly.

The risk of microbial pathogens and harmful pollutants in our drinking water can no longer be overlooked. This is a major concern for every nation as the correlation between water contamination and health issues are on high rise. Although public water supply is been treated and have lowered the presence of contaminants but these treatment services cannot be infallible. Besides buying bottled water is very expensive and may contain more pollutants than the normal tap water.

However there are many household drinking water treatment alternatives which definitely purify and clean drinking water more than the public treatment facilities. Some common alternatives are Reverse Osmosis and Distillation process where it is effective at moderate level in terms of eliminating contaminants. On the other hand the best technology is now accessible for treating drinking water and eliminates undesirable bacteria, viruses and contaminants is Ultraviolet Treatment Systems This system is inexpensive and purifies as well as provides safer water to drink. However the water should be pre filtered to removes all particles which are stopping the rays or light passing through

However we had a good time with colleagues and the trainers at the get together in the evening at Queensland Number one Q1 building surfer's paradise Gold Coast. We know had great networking with the participants. I believe this was a brilliant for me to share their expertise from the different parts of people from Australia.

Moreover I have seen the gold coast beachfront market which is one of the largest in surfers' paradise beachfront markets. This includes variety of variety of products such as jewellery, accessories, artworks, beauty products and home wares.

Site Visit – Bray Park Water Treatment Plant

Bray park water treatment plant is one of the most advanced water treatment plants in Australia. The park was designed by Hunter Water Australia and the plant was commissioned in April 2010.Tweed Shire Council is very committed to supply high quality and safe drinking water up to the capacity of 150 mega litres per day.

The plant has the latest membrane technology of ultra-filtration which offers a much higher level of filtration. The Zee Weed membranes remove greater than 99.99% of suspended solids, bacteria and parasites from the raw water

The tweed water supply catchment covers an area of more than 570 square kilometres and is entirely located within the boundary of local tweed government area. An average rainfall of approximately 1600mm per day which basically travels through forests, farms and villages. All raw water is extracted at Bray Park Weir, a man made tidal barrier in the Tweed River which prevents salt water from getting into the fresh water supply.

Zee weed have 500 membranes resembles the prefrated staw where the inside diameter of the viber is 0.8mm. As such the membrane can filter out more organic matters and therefore very less coagulant is added. This Zee weed system deployed about 6.5 million membranes fibres to create large surface areas and achieve 150 mega litres per day of flow through out the membrane pores.

Visit to Plumbing Industry Climate Action Centre

PICAC is a practical training centre for plumbing industry education and training to promote the green aspects of plumbing. This is fully supported by the industry employee and employer groups such as Plumbing trade unions, master plumbers, air conditioning and mechanical contractors association of Australia, National fire industry association, Fire industry training and CEPUTEC

I was able to meet Mr Shayne La Combre – CEO, PICAC and Mr Ken Gardner - CEO, Master Plumbers Association.

I had a tour with Shayne La Combre around the PICAC building which a unique industry led training facilities in Australia. The innovative design Green house Building, Gas rooms, Water room, Plant room, Welding workshop, Roofing workshop.

Green House Building

The house model is projected within the PICAC as a demonstration of modern installations of water and energy efficiency. This is a working example of full house plumbing installation and leading edge technology.

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Welding

Had a tour around of 12 welding bays which includes grinding, cutting and preparation place. Also I have tried on the advanced and fully adjustable horizontal to vertical Lincoln electric

350 power wave welding machine.

PICAC also for training purpose has a full installation of UV filtration system which basically treats rain water to use for toilet flushing. Moreover grey water is used to flush the toilets throughout PICAC building instead of using the town water supply.

I also attended Scissor lift training at CEPUTEC which was a one day course addressing all aspects of scissor lift operations from routine daily checks and safety tips. Safe operations and also shutting down of Scissor lift.

Thanks for the plumbing tutors for providing me the gas installation (level 3) books. Also thanks to Marilyn Padgett for giving me the new plumbing standards and really appreciate for the assistance you have given me.

Healesville Sanctuary – Victoria Zoo

Healesville is the best place in Victoria to see and interact with the native Australian wildlife. The Sanctuary offers me an opportunity to come close up to unique Australian animals in a

beautiful bushland setting. Some animals I have seen for the first time are Rock Wallaby, Dingo, Echidna, Guthega skink, Koala, Pygmy possum, Kangaroo, Tasmanian devil, Wombat, Water Rats and many more.

Spirits of the Sky

I had great experience to be part of this spectacular daily show of Australia's majestic birds of prey and magnificent parrots. This was held at Healesville's world – renowned flight arena. The display of Australia's iconic parrots, from tiniest budgerigars to the largest cockatoos. The best loved birds show their ability to fly as well as skills. How they beautiful birds and parrots hand feed and listen to talks from the avian experts.

Had a wonderful time with these two beautiful people and enjoyed the day having delicious lunch with them. Thank you very much Marilyn Padgett for your wonderful support and assistance during my visit to Australia.

<u>Visit to Victorian Building Authority</u>

It was great pleasure to meet Manager Licensing and Development Mr Gary Bath of Victorian Building Authority. The VBA regulates building and plumbing practitioners to ensure the achievement of efficient and competitive building and plumbing industries in Victoria.

However meeting with him I learned the process of the Registrations, licensing and disciplining plumbers in Victoria. He also shared his expertise on plumbing and technical advice about the investigations and plumbing solutions to the industry. As such provided me some plumbing books and standards which have valuable informations.These reference standards form part of plumbing regulatory framework and therefore are part of the legal requirements for plumbing practitioners in Victoria.

However Australian standards are amended or updated by standards Australia and published by SAI GLOBAL.

What have learnt from this conference?

i. Public water supplies are an essential component of public health protection

ii. Implementation of multiple barriers from the source to the tap provides the safest outcome
iii. Understanding the individual systems and risks associated with them enables more effective management.
iv. Proactive management of these supplies is required to ensure safety
v. Complacency can be a killer

Conclusion

The IWES training and PICAC visit was one of the most interesting and productive experiences in my life. Through this training I have gained new insight and more comprehensive understanding about the water treatment processes as well as new plumbing technologies at PICAC centre. I have also experienced the direct involvement with plumbing related professionals and interaction with training colleagues/trainers who were from water sectors. My visit to PICAC centre was indeed a great learning experience as this will definitely help me to upgrade our plumbing standards in Fiji.

However disinfection is unquestionably the most significant step in the treatment of water for drinking water supplies. The microbial quality of drinking water should not be compromised because of concern over the potential long term effects of disinfectants. The risk of illness and death resulting for exposure pathogens in drinking water is greater risks. The microbiological quality of drinking-water is of paramount importance and must receive priority over any other considerations in relation to drinking-water treatment. The use of any chemical disinfectant results in the formation of by-products those themselves may be of health significance. As such we have gone through and discussed case studies which had water related issues and investigations in Australia and basically how they manage to eradicate the problems. Therefore I believe the best way to treat drinking water is Ultraviolet water treatment system.

Recommendations

An Ultraviolet water treatment system provides safer drinking water and is a protective health intervention to our community. As you know that our public water supply works extra mile to supply safe water but there can be some contamination during distribution. Therefore if the consumer wishes better health for their families than UV system gives you “peace of mind” which eventually performs as an insurance policy when it comes to drinking of contaminated water. Ultraviolet systems are the best technology to approach when you are looking for high quality and suitable way to accomplish disinfections in drinking water supply. I would strongly recommend that we can use this reliable technology to treat water.

Bibliography

IWES-Drinking Water Treatment, Principles, Practice & Application Course notes.

Glossary

Alum - aluminium sulphate

Floc – small particles formed as a result of chemical coagulation

NOM – natural organic matter

PAC – powdered activated carbon

UF – ultrafiltration

UV254 – UV absorbance at 254 nm {disinfection wavelength}

PICAC - Plumbing Industry Climate Action Centre

Turbidity – measure of suspended matter by scattering technique