



Radiation Environmental Safety and Health

(Assessment of water quality: Measurement of parameters and pollutants)

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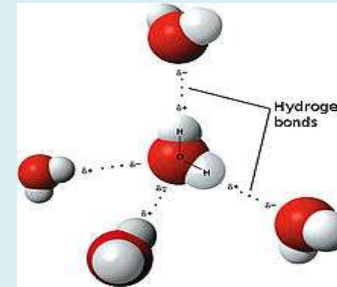
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Introduction

- What is water?
A chemical substances with the chemical formula H_2O



- Universal solvent - can dissolve the most types of substances.
- Tasteless, odorless, transparent
- Exists in 3 states:
liquid, solid and gaseous



Crystal structure
model ice

Introduction

- Types of water
- Fresh water
naturally occurring water with a very low content of dissolved salt - ponds, lakes, rivers etc
- Hard water
water that has high mineral content (hardness >100ppm)- magnesium (Mg) and calcium (Ca) and other dissolved compounds
- Soft water
Contains few or free of dissolved Ca or Mg

Introduction

- Surface water
related to water collecting on the ground or in a stream, river, lake etc
- Drinking water
treated tap water: filtration, distillation, reverse osmosis
- Mineral water
occur naturally: groundwater sources, spring water
(The U.S. FDA classifies mineral water as water containing at least 250 parts per million total dissolved solids (TDS))
- Distilled water
water that mineral content/impurities have been removed by distillation
usually municipal tap water
- Waste water
any water that is discarded after use.



Water Quality

- What is water quality?
- physical, chemical, biological and microbial characteristics of water
- the characteristics of water in relation to guideline values of what is suitable for human consumption and for all usual domestic purposes, including personal hygiene.

“a measure of the suitability of water for a particular use based on selected physical, chemical, and biological characteristics”

Water Quality

- Microbial/biological aspects
 - infectious diseases caused by protozoa, bacteria, viruses, helminths etc are the most common and widespread health risk associated with drinking water
 - Microbial hazards associated with drinking-water:
 - waterborne infection
 - Persistence and grow in water
 - consumption of drinking water contaminated with human and animal excreta
 - occur in source water
 - grow in piped water

Table 1: Waterborne pathogens and their significance in water supplies

Pathogen	Health significance	Persistence in water supplies	Resistance to chlorine
<p>Bacteria</p> <ol style="list-style-type: none"> 1. Burkholderia pseudomallei 2. Campylobacter jejuni, C. coli 3. Pathogenic 4. E. coli - Enterohaemorrhagic 5. Legionella spp. 	<p>Low</p> <p>High</p> <p>High</p> <p>High</p> <p>High</p>	<p>May multiply</p> <p>Moderate</p> <p>Moderate</p> <p>Moderate</p> <p>Multiply</p>	<p>Low</p> <p>Low</p> <p>Low</p> <p>Low</p> <p>Low</p>
<p>Viruses</p> <ol style="list-style-type: none"> 1. Adenoviruses 2. Enteroviruses 3. Hepatitis A virus 4. Hepatitis E virus 	<p>High</p> <p>High</p> <p>High</p> <p>High</p>	<p>Long</p> <p>Long</p> <p>Long</p> <p>Long</p>	<p>Moderate</p> <p>Moderate</p> <p>Moderate</p> <p>Moderate</p>
<p>Protozoa</p> <ol style="list-style-type: none"> 1. Cyclospora cayetanensis 2. Entamoeba histolytica 3. Giardia intestinalis 4. Naegleria fowleri 	<p>High</p> <p>High</p> <p>High</p> <p>High</p>	<p>Long</p> <p>Moderate</p> <p>Moderate</p> <p>May multiply</p>	<p>High</p> <p>High</p> <p>High</p> <p>High</p>
<p>Helminth</p> <ol style="list-style-type: none"> 1. Dracunculus medinensis 2. Schistosoma spp. 	<p>High</p> <p>High</p>	<p>Moderate</p> <p>Short</p>	<p>Moderate</p> <p>Moderate</p>

Water Quality

- Chemical aspects
 - presence of toxic chemicals in drinking water may cause health effects in human (as a consequence of prolong exposure)
 - source of chemical contaminants in drinking water:
 - natural sources - rocks, soil, climate
 - industrial sources - mining, processing industries
 - agriculture activities - fertilizer, pesticides
 - water treatment etc

Table 2: list of chemicals contaminants and their health effect

Contaminant	Potential health effects	Source of contaminant
Antimony (Sb)	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
Arsenic (As)	Skin damage or problems with circulatory systems, risk of getting cancer	Erosion of natural deposits; runoff from orchards, runoff from glass & electronics production wastes
Barium (Ba)	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Cadmium (Cd)	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints
Copper (Cu)	Short term exposure: Gastrointestinal distress Long term exposure: Liver or kidney damage	Corrosion of household plumbing systems; erosion of natural deposits
Chromium (Cr)	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits

Contaminant	Potential health effects	Source of contaminant
Mercury (Hg)	Kidney damage	Erosion of natural deposits, discharge from refineries and factories, runoff from landfills and croplands
Nitrate (measured as nitrogen)	Infants <6months: seriously ill and if untreated may die Symptoms: shortness of breath and blue baby syndrome	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits
Nitrite (measured as nitrogen)		
Benzene	Anemia, decrease in blood platelets, increased risk of cancer	Discharge from factories, leaching from gas storage tanks and landfills
Carbofuran	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	Liver problems, increased risk of cancer	Discharge from chemical plants and other industrial activities
Toluene	Nervous system, kidney or liver problems	Discharge from petroleum factories
Vinyl chloride	Increased risk of cancer	Discharge from PVC pipes or plastic factories

Water Quality

- Physical aspects

temperature: can affect the ability of water to hold oxygen, the rate of photosynthesis by aquatic plants and the metabolic rates of aquatic organisms.

turbidity: It is a measure of cloudiness in water (amount of soil particle in water)

- High amounts of soil in the water will block sunlight from reaching the bottom of a river/lake

- limit plant growth

- limiting the ability of fish and insects to survive (higher temperature)

odor, taste

MAN-MADE WATER PROBLEMS



Water Quality Parameters

- Water Quality Index (WQI)
- There many sources of water quality criteria and standards- originate in Malaysia or issued by international bodies - WHO, US EPA, UNEP GEMS water
- DOE Malaysia used WQI and INWQS to evaluate the river water quality and classify the rivers in class I, II, III, IV and V (Table 3)

Water Quality Parameters

Table 3: Water Quality Index (WQI)

Class	WQI	Treatment/utilization
I	>92.7	No treatment necessary Water supply I, fishery I
IIA	85.0 -92.7	Conventional treatment required Water supply II, fishery II
IIB	76.5- 85.0	Recreational use with body contact
III	51.9-76.5	Extensive treatment required Water supply III, fishery III
IV	31.0-51.9	irrigation
V	<31.0	None of the above

Water Quality Parameters

- What is Water Quality Index (WQI)?
 - a single number (standard) that express overall water quality at a certain location and time based on several water quality parameters
 - can be used to monitor water quality changes in particular water supply over time
 - Water Quality Index (WQI) is computed based on 6 main parameters
 - Biochemical Oxygen Demand (BOD)
 - Chemical Oxygen Demand (COD)
 - Ammoniacal Nitrogen (NH_3N)
 - pH
 - Dissolved Oxygen (DO)
 - Suspended Solids (SS)

Water Quality Parameters

- Biochemical oxygen demand (BOD)
a measure of oxygen used by microorganism (aerobic bacteria) to decompose organic waste in body water
- Chemical oxygen demand (COD)
a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals
- Ammoniacal Nitrogen
a measure for the amount of ammonia, a toxic pollutant often found in landfill leachate.

Water Quality Parameters

- Dissolved oxygen (DO)
a measure of the amount of oxygen is a relative measure of the amount of oxygen that is dissolved or carried in a given medium.
- pH
pH is a measurement of the acidity or basic quality of water.
pH of natural water is between 6.5 to 8.4
- Suspended Solids (SS)
include all particles suspended in water which will not pass through a filter, present in sanitary wastewater and many types of industrial wastewater, soil erosion from agricultural and construction sites.

Water Quality Parameters

Table 4: Interim National Water Quality Standards

Class/ parameter	I	II	III	IV	V
BOD	<1	1-3	3-6	6-12	>12
COD	<10	10-25	25-50	50-100	>100
NH ₃ N	<0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
DO	>7	5-7	3-5	1-3	<1
pH	>7	6-7	5-6	<5	>5
SS	<25	25-50	50-150	150-300	>300
WQI	>92.7	76.5-92.7	51.9-76.5	31.0-51.9	<31.0

Source: Department of Environment (DOE)

Table 5: The Role of Elements in Life Processes

Contaminant	Potential health effects	Role in life process
Arsenic (As)	Skin damage or problems with circulatory systems, risk of getting cancer	Growth, development and reproduction
Cadmium (Cd)	Kidney damage	involved with the metabolism
Copper (Cu)	Short term exposure: Gastrointestinal distress Long term exposure: Liver or kidney damage	Helps body to produce chemicals that regulate blood pressure, pulse, and healing.
Chromium (Cr)	Allergic dermatitis	it helps our bodies absorb energy from the food we eat and stabilizes the level of energy
Manganese (Mn)	effects on the developing nervous system	to make chemicals that help us digest the food that we eat, supports the immune system, regulates blood sugar levels, and is involved in the production of energy and cell reproduction.
Selenium (Se)	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	protects blood cells from certain damaging chemicals, helps our immune system produce antibodies, helps keep the pancreas and heart functioning properly.

Water Quality Parameters

- Guideline for drinking water quality
Derivation of guideline value:
2 principal sources of information on health effects resulting from exposure to chemicals:
 - studies on human population: drinking water consumption and body weight
(age, weight, sex, weather)
 - toxicity studies using laboratory animals
need to select the most suitable experimental animal study
create uncertainty as to the relevance of particular findings to human health - need to extrapolate the results from animals to humans

Water Quality Parameters

Criteria used in deriving guideline:

- credible evidence of occurrence of the chemical in drinking-water, combined with evidence of actual or potential toxicity
- the chemical is of significant international concern
- the chemical is being considered for inclusion or is included in the WHO Pesticide Evaluation Scheme (WHOPES) programme (approval programme for direct application of pesticides to drinking-water for control of insect vectors of disease).

Water Quality Parameters

Table 6: National Guidelines for Raw Drinking Water Quality

<i>Parameter</i>	<i>Acceptable value (mg/L)</i>	<i>Parameter (mg/L)</i>		
		<i>Mesra (petronas)</i>	<i>Cactus</i>	<i>Segar</i>
<i>Source : DOE</i>		<i>Source : Lot 643, Taiping, PK</i>	<i>Source : Lot 644, Taiping, PK</i>	<i>Source : Lenggeng, Negri Sembilan</i>
<i>Sulphate , SO4</i>	<i>250</i>	<i>18</i>	<i>11</i>	<i>6</i>
<i>Hardness, CaCO3</i>	<i>500</i>	<i>74</i>	<i>106</i>	<i>150</i>
<i>Nitrate, NO3</i>	<i>10</i>			
<i>Manganese, Mn</i>	<i>0.1</i>			
<i>Chromium, Cr</i>	<i>0.05</i>			
<i>Zinc, Zn</i>	<i>3</i>			
<i>Arsenic, As</i>	<i>0.01</i>			
<i>Selenium, se</i>	<i>0.01</i>			
<i>Chloride, Cl</i>	<i>250</i>	<i><1</i>	<i><1</i>	<i>3.5</i>
<i>Phenolics</i>	<i>0.002</i>			
<i>TDS</i>	<i>1000</i>	<i>159</i>	<i>162</i>	<i>188</i>
<i>Iron, Fe</i>	<i>0.3</i>			
<i>Copper, Cu</i>	<i>1.0</i>			
<i>Lead, Pb</i>	<i>0.01</i>			
<i>Cadmium, Cd</i>	<i>0.003</i>			
<i>Mercury, Hg</i>	<i>0.001</i>			

Water Quality Measurement

- Field testing method
 - Analysis for some physical, chemical and microbiological parameters can be carried out in the field.
 - Staff performing the analysis must be fully trained in chemical or microbiological analysis
 - The equipment always in the kit
 - Cleared procedure
 - Necessary for temperature, transparency and pH, conductivity (must be measured before adding any chemical preservative), dissolved oxygen, turbidity
- Advantage:
Fresh sample, not contaminated, unlikely to lose the label of the sample

Water Quality Measurement

- Physical and chemical analysis
- Chemical analysis is more applicable for point source pollution
 - preparation of glassware and reagents:
 - all glassware must be cleaned and treated with acid, accurately label (date, location, label)
 - use the best quality chemical reagent -analytical grade
 - preparation of standard:
 - prepared by well trained staff
 - sample handling/preparation of sample
 - sample must be preserved
 - pre-concentration
 - dilution
 - QA/QC

Water Quality Measurement

- Standard method
 - EPA method 6020a: method is for the determination of elements (metals) in aqueous matrices by ICP/MS.
 - EPA method 3005a: method is for the determination of elements (metals) in surface and ground water sample by FLAA and ICP/MS.
 - American Public Health
 - American Water Work Association
 - Water Environment Federation
 - UNEP GEMS/water programme

Messages from Water

Effect of the environment, human vibration energy, thoughts, words, ideas and sound affect to the molecular structure of water - by Japanese researcher Mr. Masaru Emoto



Slide 1: Pure water
(spring water)



Slide 2: Contaminated
water (river water)



Slide 3: Effect of music:
air on the G string



Slide 4: Effect of
music: heavy metal



Slide 5: Effect of the
words: Love and
Appreciation



Slide 6: Effects of
the words: You make
me sick I will kill you



Slide 7: Polluted and toxic
water from the Fujiwara
Dam in Japan.



Slide 8: the same water from
the Fujiwara Dam, after
Buddhist monks prayer over
it

TERIMA KASIH