Air pollution

The air in many cities of the world is polluted by smog produced mainly by emissions from cars. Smog, a combination of “smoke” and “fog”, is a brownish-grey bad-smelling haze whose products can affect human health and can cause damage to plants, animals and some materials.

Smog formation involves many different reactions, involving several chemicals.

Photochemical smog
Photochemical smog is a phenomenon typical of urban areas. High levels of O\textsubscript{3} (ground-level ozone) are produced as a result of the light-induced reaction of pollutants.

The cities most subject to photochemical smog are those with heavy vehicular traffic, warm climate, a lot of sunlight to speed up chemical reactions, and little movement of the air mass. Among them Mexico City, Tokyo, Los Angeles, and Rome. The chief reactants are the nitrogen oxide, NO, and unburned hydrocarbons emitted into the air as pollutants. Other ingredients are gaseous hydrocarbons and their derivatives, called volatile organic compounds (VOCs), and sunshine, which increases the concentration of free radicals in the chemical processes of smog formation. The most reactive VOCs in urban air are hydrocarbons containing a C=C bond.

The emission of all these reactants will have to be reduced in order to improve the quality of city air.

The final products of smog are ozone, nitric acid and organic compounds.

Acid rain
The term refers to atmospheric precipitation that is more acidic than “natural” rain.

Because of its damaging effects acid rain is one of the most serious world environmental problems.

The primary pollutants are sulfur dioxide, SO\textsubscript{2}, and nitrogen oxides, NO\textsubscript{x}. Most SO\textsubscript{2} is produced by volcanoes and by the oxidation of sulfur gases, some is emitted into the ground-level air, mainly in the Northern Hemisphere, some is produced by the burning of coal in power stations. Some of the primary pollutants are converted into the secondary pollutants sulfuric acid and nitric acid both of which are strong acids soluble in water.

Acids may be deposited on the ground as wet deposition, that is by aqueous solutions like rain, snow or fog, or by means of dry deposition of nonaqueous chemicals. In the latter case SO\textsubscript{2} is removed from air before it is oxidised. Oxidation and conversion to sulfuric acid occur after deposition.

Acid precipitations strongly affect areas where the soil has little capacity to neutralise the acid whereas they can be efficiently neutralised (“buffered”) by calcium carbonate present in limestone or chalk bedrock.

Acidified water systems have high concentrations of dissolved aluminium which, together with the acidity, is probably the cause of the death of most of the flora and fauna.

Particulates
Particulates are tiny solid particles or liquid droplets suspended in air. A collection of particles dispersed in air forms an aerosol.
Solid atmospheric particles are commonly called “dust” or “soot”, liquid particles are called “mist” or “fog”. The exhaust from diesel engines is one of the main sources of carbon-based atmospheric particulates. The larger solid particles (“dust”) derive mainly from non-chemical processes, like for example volcanic eruptions, stone crushing, or land cultivation. Large particles are less dangerous to human health than are small ones because they settle out quickly so their inhalation is reduced and anyway, when inhaled, they are filtered out by the nose and throat and they do not generally reach the lungs. Atmospheric particles include also mineral pollutants.

Health effects of air pollution
The most serious health problems derived from outdoor air pollution affect mainly the lungs. They arise from the combination of large concentrations of soot-based particulate matter and sulfur dioxide or its oxidation products.
In many large cities photochemical smog deriving from nitrogen oxides is more important than is sulfur-based smog. It consists of gases (like ozone) and water-soluble organic and inorganic compounds. At the molecular level ozone attacks substances containing components with C=C bonds, such as occur in the biological tissues of the lungs.
Particulate-based air pollution affects human health more than pollution produced directly by pollutant gases.

Indoor air pollution
The levels of air pollutants are often greater indoors than outdoors. The most important indoor air pollutant is formaldehyde, a gas which may be carcinogenic in humans. The main sources of indoor exposure to this gas are emissions from cigarette smoke and from synthetic materials containing formaldehyde resins; formaldehyde itself is used in the dyeing of carpets and fabrics. Combustion processes like the burning of fossil fuels in buildings release nitrogen dioxide which is an oxidant soluble in biological tissue, and carbon monoxide, a colorless, odorless gas which combines with the hemoglobin in blood impairing its ability to transport oxygen to cells.
Nitrogen dioxide may affect the respiratory system and high concentrations of carbon oxide may cause headache, unconsciousness and even death.
Environmental tobacco smoke consists of both gases – which include carbon monoxide, nitrogen dioxide, formaldehyde, aromatic hydrocarbons, other VOCs, and radioactive elements – and particles – the tar – containing nicotine and the less volatile hydrocarbons. ETS, or “passive smoking”, causes irritation to the eyes and airways, it may aggravate the symptoms of people suffering from asthma or angina pectoris and it is also believed to cause bronchitis, pneumonia and other infections.
Cigarette smoking and airborne asbestos fibres act synergistically, that is their combined effect is greater than the sum of their individual effects, in causing lung cancer. The term asbestos refers to fibrous silicate minerals composed of silicon atoms connected through oxygen atoms. Asbestos has been widely employed in buildings as insulation and fireproofing material because of its strength and resistance to heat. Its use has been sharply reduced because it is now known to be a human carcinogen.

From: Baird, Environmental Chemistry, Freeman & Co.
CONTENT

Questions about the text.

1. What is meant by photochemical smog?
2. What are the conditions which favour the formation of photochemical smog?
3. What are the initial reactants in the process?
4. Why is sunlight required?
5. What are the final products of smog?
6. How is natural sulphur dioxide produced?
7. What is the main anthropogenic source of SO₂?
8. What two acids predominate in acid rain?
9. What are the characteristics of the areas most affected by acid precipitation?
10. Why are large particles usually less dangerous to human health than fine particles?
11. What are the major health effects of air pollutants?
12. What are the main sources of formaldehyde in indoor air?
13. What are the main sources of nitrogen dioxide and of carbon monoxide in indoor air?
14. What are the health effects of NO₂ and CO?
15. What are the health effects of ETS?
16. Why is asbestos of environmental concern?

Ask suitable questions to these answers:

1. By smog produced mainly by emissions from cars.
2. Some of them are Mexico City, Tokyo, Los Angeles, Rome.
3. By reducing the emissions of reactants responsible for photochemical smog.
4. They are sulphur dioxide and nitrogen oxides.
5. The may be deposited as wet or dry deposition.
6. By calcium carbonate present in limestone or chalk bedrock.
7. It consists of both gases and nicotine-containing particles.
8. As insulation and fireproofing material in buildings.
## LANGUAGE

### Vocabulary

*Match words and definitions.*

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>carpet</td>
<td>black powder in the smoke of wood, coal, etc.</td>
</tr>
<tr>
<td>droplet</td>
<td>breathing organs</td>
</tr>
<tr>
<td>dust</td>
<td>chalky rock</td>
</tr>
<tr>
<td>dyeing</td>
<td>thick mist</td>
</tr>
<tr>
<td>exhausts</td>
<td>thin mist</td>
</tr>
<tr>
<td>fabric</td>
<td>colouring</td>
</tr>
<tr>
<td>fog</td>
<td>very small</td>
</tr>
<tr>
<td>fuel</td>
<td>substance that makes something dirty or impure</td>
</tr>
<tr>
<td>haze</td>
<td>material burned to produce heat or power</td>
</tr>
<tr>
<td>limestone</td>
<td>small mass of liquid</td>
</tr>
<tr>
<td>lungs</td>
<td>passage in the neck</td>
</tr>
<tr>
<td>pollutant</td>
<td>fine powder consisting of particles of earth, dust, etc.</td>
</tr>
<tr>
<td>soot</td>
<td>waste fumes or gases expelled from an engine</td>
</tr>
<tr>
<td>tar</td>
<td>piece of fabric used for covering floors</td>
</tr>
<tr>
<td>throat</td>
<td>woven cloth</td>
</tr>
<tr>
<td>tiny</td>
<td>black substance formed by burning tobacco</td>
</tr>
</tbody>
</table>

*Find in the passage or make up definitions for these words:*

1. smog  
2. acid rain  
3. particulates  
4. aerosol  
5. asbestos  
6. haemoglobin

1970 was the year before emission regulation in Europe. The level of pollution from toxic fumes emitted by cars was sixteen times the level in 1998 and is being continually reduced.
Microbiology of air

The microbial flora of air is both transient and variable. Air is not a medium in which microorganisms can grow; rather it is a carrier of particulate matter, dust and droplets which may be laden with microbes.

The numbers and types of microorganisms contaminating the air are determined by the source of contamination; for example sprays from coughing and sneezing are contaminated by the human respiratory tract and dust from the earth’s surface also carries microorganisms. Air-borne microorganisms may be carried on dust particles, in large droplets that remain suspended only briefly, and in droplet nuclei, which result when small liquid droplets evaporate. Organisms introduced into the air may be transported a few feet or many miles; some die in a matter of seconds, others survive for weeks or months. The ultimate fate of air-borne microorganisms is governed by a complex set of circumstances including the atmospheric conditions (e.g. humidity, sunlight, temperature), the size of the particles bearing the microorganisms, and the nature of the microorganisms, i.e. the degree of susceptibility or resistance of a particular species to the new physical environment.

Techniques for microbiological analysis of air

Air-borne microorganisms constitute a hazard in terms of contamination in the laboratory and home and in those industrial processes by which sterile products are manufactured or in which products are dependent upon the growth and metabolism of certain selected microorganisms. The sampling of air to determine its microbial content, particularly quantitatively, requires special instruments. Several devices have been designed for this purpose, and for the most part they are either solid impingement devices or liquid impingement devices. In solid impingement devices, the bacteria are collected, or ‘impinged’, directly on the solid surface of an agar medium or filter disk. Subsequent incubation of the sample results in development of colonies where organisms impinged. In liquid sampling devices, the air sample in the form of a fine spray is passed through a liquid such as a broth medium and the organisms become ‘trapped’ in the liquid. Aliquots of the liquid are then plated or cultured to determine its microbial content.

The microbial content of air

We have already pointed out that there are no microorganisms indigenous to air. However, air in our immediate environment as well as that several miles above the earth’s surface and hundreds of miles out to sea contains microorganisms in large or small numbers and of a variety of types depending upon the source. For example, air above the ocean would be expected to contain organisms indigenous to ocean water. The flora of the upper atmosphere consists predominantly of spore-forming bacteria and molds. Both these forms are capable of surviving the adverse conditions imposed by temperature and moisture changes as well as solar radiations. The number of microorganisms found at street level normally exceeds that at higher altitudes, as Pasteur observed in his experiments to disprove the concept of spontaneous generation. The air of crowded, enclosed quarters, unless special conditions prevail, is likely to contain large numbers of microorganisms representative of the human oral microflora. Thus many factors determine the number and kind of microorganisms inhabiting the air. Among these factors are:

1. Sources of organisms (soil, sea, sneezes, etc.).
2. Resistance of species to physical conditions (temperature, humidity, and sunlight).
3. Extent to which quarters are enclosed (number of occupants and their activities).
4. Outside environment (weather conditions and altitude).

Microbiologists are immediately concerned with the fact that practically all routine laboratory techniques produce aerosols (fine sprays producing droplets that remain suspended in air for a time) of the microorganisms involved. Certain operations create larger amounts of aerosols than
others: among these are inserting a hot loop in a culture, opening a lyophilized culture, streaking an inoculum on a rough agar surface, and centrifugation. If the organism under study is a pathogen, these operations present a hazard to the worker, and laboratory workers have acquired infections during microbiological investigations.

Control of microorganisms in air
Since certain infectious agents may be air-borne, air hygiene – measures to reduce the microbial population of air – is of great importance. Other situations encountered in microbiological operations require that the air be sterile; perhaps the simplest example is the air contained in a culture tube. However, there are large-scale industrial microbiological processes which require that organisms be grown in pure culture in a tank of several thousand gallons capacity under aerobic conditions. Aerobiosis is maintained in this instance by forcing large quantities of sterile air through the bulk culture. The level of air contamination can be reduced or the air can be sterilized as the situation demands, by the application of some physical and chemical agents.

From: Pelczar – Reid, Microbiology, McGraw Hill

AFTER READING

CONTENT

Questions about the text.
1. What substances may carry air-borne organisms?
2. What conditions determine the fate of air-borne microorganisms?
3. What devices are used to determine the microbial content of air?
4. What does the microbial flora of the upper atmosphere consist of? Why is it so?
5. What factors determine the number and type of microorganisms in air?
6. Which laboratory operations produce large quantities of aerosols?
7. How are aerobic conditions maintained when growing microorganisms in pure culture?
8. How can air be sterilized?

LANGUAGE

Vocabulary
Read ‘Microbiology of air’ again and decide which of the words in the box could be used instead of those in italics in the passage.

<table>
<thead>
<tr>
<th>brings about</th>
<th>carrying</th>
<th>confute</th>
<th>cultivated</th>
<th>danger</th>
<th>destiny</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimension</td>
<td>grown</td>
<td>higher</td>
<td>humidity</td>
<td>imprisoned</td>
<td>instead</td>
</tr>
<tr>
<td>instruments</td>
<td>is superior to</td>
<td>living in</td>
<td>loaded</td>
<td>momentarily</td>
<td></td>
</tr>
<tr>
<td>native</td>
<td>origin</td>
<td>probably</td>
<td>produced</td>
<td>pushing</td>
<td>rely on</td>
</tr>
<tr>
<td>requires</td>
<td>so</td>
<td>supposed</td>
<td>uneven</td>
<td>volatile</td>
<td>worried</td>
</tr>
</tbody>
</table>
Water

Water is the most common of all liquids. About two thirds of the Earth’s surface is covered with water. In this country we take it for granted that when we turn on the tap, fresh clean water will come out. In fact, we often complain that we have too much water.

Water is a very special liquid. It is needed by all living things. We can manage without food for several weeks, but we cannot last many days without water. It exists as a solid, liquid or gas over a relatively short range of temperature.

Chemically, water is a compound of hydrogen and oxygen (formula H₂O).

The water cycle

The water cycle describes the changes that happen to water in nature. Water is evaporated by the heat from the Sun. The water vapour rises into the atmosphere where it cools down and condenses into cloud formations. As the clouds get higher and colder the droplets of water get bigger and eventually fall out of the sky as rain.

The rain either soaks into the ground or runs into streams and rivers. Eventually the water makes its way back to the sea and the cycle is repeated.

Obtaining water for our use

Do you know where your domestic water comes from? In most places in Great Britain the domestic water supply comes from underground sources or reservoirs. Dams are often built in hilly areas to form large lakes to provide water for big cities.

The water from reservoirs is first filtered to remove solid particles. The filtering is done by letting the water pass through filter beds of sand and gravel. Small amounts of chlorine are then added to the water to kill bacteria. Sometimes other chemicals are added such as lime or fluoride. The purified water is stored high up in underground reservoirs, where gravity can be used to create the necessary water pressure to supply surrounding towns and villages.

Using water

We each use nearly 200 litres of water a day. About 70 per cent of your body is water and each day you need to drink about 2 litres of water. In addition to domestic use, industry uses large amount of water. Nearly all of this water finds its way back into streams and rivers. Unfortunately
it is not always very clean when it is discharged into them. This can cause serious problems to life in our river systems.

Water pollution
Water pollution is a serious problem. When we have finished using water we just let it go down the drain. If that unclean water was allowed to run into streams and rivers they would soon become unfit for life, dirty and smelly. At one time untreated sewage was simply discharged into the sea. Nowadays there is much stricter control over the disposal of sewage. Sewage is processed before it is allowed to be discharged into the environment.

1 Filters (strainers) remove large objects.
2 Non-organic waste settles out.
3 Solid organic waste settles out as a sludge in the sedimentation tanks.
4 Air is bubbled through the sewage. This provides extra oxygen for bacteria which break down the sewage.
5 Further solids are removed.
6 The purified water is discharged to nearby rivers.
7 The sludge is treated by bacteria and used to make organic fertilisers and the methane is collected and used as fuel.

Waste water from industry can contain all sorts of harmful chemicals. Some of those most dangerous to animal life contain metals such as mercury and lead. People have died after eating fish contaminated with mercury compounds. Careless discharge of industrial waste has killed nearly all living things in the water of the Great Lakes near Chicago and Michigan in the USA. Recent reports have shown concern over the pollution levels in the Rhine in Germany. In the UK some of the streams and rivers in our industrial cities have been heavily polluted.

The water authorities have been working hard over the last twenty years or so to clean up our waterways. There has certainly been a great improvement. Heavy fines can be imposed on firms found guilty of discharging chemicals into our rivers, though some still persist.

Apart from nitrogen, another source of pollution from farms is the use of pesticides. These are chemicals sprayed on crops to kill insects or other pests that are attacking the crop. Unfortunately, these can also get washed into nearby ponds and streams where they can harm plants and animal life. Some of these chemicals have a cumulative effect, e.g. DDT, which can build up in an animal eventually getting to a dangerous level.

If large amounts of detergents are released into rivers, the river may become covered with foam. Some detergents are harmful to river life. It is possible now to obtain biodegradable detergents that are broken down by naturally occurring bacteria.

Water as a solvent
Water is a very good solvent, i.e. it is very good at dissolving things. The sea tastes salty because of the dissolved sodium chloride (salt) in it. It also contains several other dissolved substance and it can be used as a valuable source of chemicals. Some gases also dissolve easily in water. Ammonia and sulphur dioxide are very soluble in water. Carbon dioxide is the most soluble of the gases in the air. Oxygen does not dissolve very well, but there is enough for fish and water plants to be able to obtain oxygen by diffusion.
Hard water

Hard water is water that will not easily form a lather with soap. It is caused by dissolved chemicals in the water. You may have noticed when you go to a different part of the country that the soap lathers better or worse than it does at home. This is because the hardness of water varies from place to place.

Hard water is caused by dissolved calcium and magnesium compounds in the water. Soaps are usually the sodium or potassium salts or fatty acids, e.g. sodium stearate. When soap is added to hard water the calcium and magnesium ions react with the stearate to form an insoluble compound, e.g. calcium stearate. These insoluble compounds cause an unpleasant scum and also remove the soap from the water, so stopping it lathering. This wastes money and prevents the soap working properly. There are two types of hard water, temporary hard water and permanent hard water.

Temporary hard water is caused by calcium hydrogen carbonate. Rain water contains a small amount of dissolved carbon dioxide which forms carbonic acids. When this rain falls on calcium carbonate rocks (limestone or chalk) some of the calcium carbonate reacts with the carbonic acid to form a solution of calcium hydrogen carbonate. When temporary hard water is boiled the reaction is reversed. The calcium carbonate formed will not dissolve in water and so cannot affect the soap. Temporary hard water is softened by boiling. This reversible reaction is also responsible for the formation of stalactites and stalagmites. The solution of calcium hydrogen carbonate drips from the cave roofs and changes back to calcium carbonate. A similar reaction can take place when the drops hit the ground.

Permanent hard water is caused by other calcium and magnesium compounds in the water. These compounds are unaffected by boiling so permanent hard water is not softened by boiling.

From: Stone-Andrews-Williams, Examining GCSE-Science, Stanley Thornes Ltd

AFTER READING

CONTENT

Questions about the text.

1. Where does water used for household purposes usually come from?
2. How is water purified?
3. What are the main uses of water?
4. How should sewage be treated before being discharged into the environment?
5. What pollutants may be contained in industrial wastes?
6. What pollutants may derive from farm chemicals?
7. What are “biodegradable” detergents?
8. What is meant by “hard” water?
9. What is water hardness caused by?
10. What is temporary hard water caused by? How can it be softened?
LANGUAGE

Vocabulary

a) Decide whether the words in the box have a positive or negative connotation.

b) Group the verbs in the box into pairs of antonyms

c) Referring to the meaning these words have in the passage, choose the right meaning for each of them.

1. fresh water: □ cool water □ water that is not salty and can be drunk
2. to complain: □ to express feelings of annoyance □ to say that you have a pain
3. to manage: □ to succeed in dealing with a process □ to direct a business
4. eventually: □ in case □ in the end
5. ground: □ surface of the earth □ floor at ground level
6. domestic (water): □ working in a house □ relating to the house
7. underground (source): □ under the ground surface □ secret, unofficial, illegal
8. dam: □ wall built across a river □ expression of anger
9. to provide: □ to take care of □ to supply
10. serious: □ worrying □ thoughtful
11. disposal: □ layout □ removal of something unwanted
12. processed: □ treated □ prosecuted
13. to affect: □ to love □ to influence
14. to take for granted: □ to buy at a reduced price □ to believe without questioning
15. to make one’s way: □ to head for □ to do something as you like it
16. at one time: □ in the past □ once
17. the other way round: □ in a curved shape □ facing in a different direction
18. to keep (+ing): □ to continue □ to maintain
d  Use the correct form of the verbs in the box to complete the sentences.

<table>
<thead>
<tr>
<th>come on</th>
<th>go out/off</th>
<th>light</th>
<th>put out</th>
<th>turn on</th>
<th>turn off</th>
<th>switch on</th>
<th>switch off</th>
</tr>
</thead>
</table>

1. What time do the street lights ________ in the evening?
2. It’s too dark in here, could you please ________ the light?
3. Have you got a match? I want to ________ a fire to warm up the room.
4. Please, ________ the light, I’m trying to get to sleep!
5. You have to ________ the gas before lighting the Bunsen.
6. ________ your cigarette! Smoking is not allowed here.
7. What is the hot water flowing for? ________ the tap immediately!
8. All of a sudden the lights ________ and we were left in the dark.

Grammar

Complete the table with comparative and superlative forms of the adjectives.

<table>
<thead>
<tr>
<th>Adjective</th>
<th>Intensified adjective</th>
<th>Comparative</th>
<th>Intensified comparative</th>
<th>Superlative</th>
<th>Intensified superlative</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g.: strict</td>
<td>very strict</td>
<td>stricter</td>
<td>much stricter</td>
<td>the strictest</td>
<td>by far the strictest</td>
</tr>
<tr>
<td>careless</td>
<td></td>
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<tr>
<td>cold</td>
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<td>common</td>
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<tr>
<td>dangerous</td>
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<td>dirty</td>
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<td>harmful</td>
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<tr>
<td>heavy</td>
<td></td>
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<tr>
<td>high</td>
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<tr>
<td>hot</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>valuable</td>
<td></td>
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</tr>
</tbody>
</table>

Reflecting on language: Which adverbs are used to strengthen the meaning of adjectives used in the positive, comparative and superlative degree?
Removal of organisms from processed water

Microorganisms are not necessarily removed by the filtration and coagulation stages in the treatment of water and positive steps have to be taken to remove them. Heat is not normally used as a sterilizing agent because of the very considerable costs which would be incurred. Other physical and/or chemical methods are both effective and, relative to heat, inexpensive.

Chlorination
Chlorination of water is a very effective method of reducing its microbial content – the sterilizing effect being brought about by the presence of the free chloride ions. For this purpose, liquid chlorine is used for large scale treatments, and either chlorine dioxide or hypochlorite for smaller scale treatments. The effectiveness of chlorination depends on the concentration used, the contact time, the pH, the temperature, the amount of organic matter present and the number of microorganisms. The problem of this method is that the chlorine reacts very readily with organic matter dissolved in the water, and, as a result, the ability of the chlorine to sterilize the water is considerably reduced because the chlorine is ‘bound’ and so not readily available. Sufficient chlorine must therefore be added to the water to satisfy this reaction – ‘the chlorine demand’ – and to leave enough free residual chlorine over to effect rapid disinfection – a method called ‘break point chlorination’. However, if water is contaminated with phenols and tars, chlorination produces compounds known as chlorophenols which give a very disagreeable taste to the water, even in minute quantities, and can cause tainting of food products.
An alternative method, called ‘superchlorination’, involves a much greater dose of chlorine being added than in the break-point chlorination method. Disinfection occurs and excess chlorine is removed from the water by contact with sulphur dioxide or by passage through activated carbon, leaving sterilized water.

Ozone
Interest in the use of ozone as a sterilant for water is increasing. It is considered to have superior bactericidal action to chlorine and creates no taste problems, in contrast to the risk of tainting by chlorophenols which may occur when chlorine is added to water. Also, once applied, ozone leaves behind no residual other than a high dissolved oxygen content.

Bacterial filtration
Another way of removing organisms is to pass the organisms through filters fine enough to retain them. This is only effective when the levels of suspended material are very low indeed, otherwise the filter very rapidly becomes blocked.

Ultra-violet light
UV light can be an effective microbicide. Since UV has very little penetrating power, it is most effective either for surface sterilization of objects or for treating clear liquids. It cannot be used with any certain effect for opaque or turbid liquids. The principle applied in water treatment is to allow UV light of microbicidal wavelength to penetrate thin layers of the water in which the microorganisms are suspended.

From. Parry – Pawsey, Principles of Microbiology for students of food technology, ST(P)
AFTER READING

CONTENT

Questions about the text.

1. Why is heat not commonly used in water sterilization?
2. What substances may be used to chlorinate water?
3. What factors influence the effectiveness of chlorination?
4. What are the drawbacks of chlorination?
5. What is meant by ‘chlorine demand’?
6. Under what circumstances are chlorophenols produced?
7. What is ‘superchlorination’?
8. How is excess chlorine removed from superchlorinated water?
9. What are the advantages of ozone over chlorine in sterilizing water?
10. How else may bacteria be removed from water?
11. Does bacterial filtration always work properly?
12. Why is UV light only effective with clear liquids?

LANGUAGE

Vocabulary

Match words and synonyms.

1. bound
2. brought about
3. enough
4. incurred
5. inexpensive

6. minute
7. positive
8. retain
9. stage
10. tainting

☐ brought on
☐ caused
☐ cheap
☐ decisive
☐ hold

☐ spoilage
☐ step
☐ sufficient
☐ tied
☐ tiny
CLASSROOM CHALLENGE

Look at these words from the passages. Microbiological assessment of water quality and Removal of organisms from processed water: undesirable, anaerobic, inexpensive, disagreeable. They are the antonyms of desirable, aerobic, expensive, agreeable. Who will be the quickest to write a, dis, in or un near the adjectives below according to the prefix to be used to make their antonyms? (Sometimes there is more than one possibility.)

1. able 11. common 21. exaustible 31. palatable 41. septic
2. appropriate 12. comparable 22. figuring 32. passionate 42. sexual
3. avoidable 13. comprehensible 23. finite 33. pleasant 43. significant
4. aware 14. connected 24. forgettable 34. pleased 44. similar
5. balanced 15. conscious 25. healthy 35. predictable 45. steady
6. bearable 16. consolate 26. honest 36. qualified 46. symmetric
7. breakable 17. content 27. hospitable 37. reasonable 47. tasteful
8. capable 18. delicate 28. interested 38. reputable 48. thinkable
9. certain 19. drinkable 29. limited 39. sane 49. typical
10. colouring 20. employed 30. natural 40. satisfied 50. willing

How long did it take you to decide the fifty prefixes?
More than 30’ – Poor me, you are unquestionably incapable of using prefixes fluently!
About 15’ – Well, you’re a bit uncertain at using prefixes, there’s room for improvement.
5’ – Congratulations! You’re undeniably insuperable at using prefixes!

YOUR OWN WORK

How good are you at analyzing water?
Use the words in the boxes to complete the passages.

Determining sanitary quality

Water can be perfectly ________ in appearance, ________ from peculiarities of odour and taste, and yet _________. Obviously special procedures are necessary to determine its sanitary quality.

Sanitary surveys – Inspection by a ________ sanitarian or engineer is called a sanitary survey. It includes inspection of 1) the source of the ________ water and the conditions that may influence its quality, 2) the operation of the water-purification plant or the construction of the well, and 3) the mechanism for distributing the water to the consumers. Since conditions that influence the quality of water are not static, ________ and comprehensive sanitary surveys are necessary. The data obtained from these surveys are of ________ value.
Potability can be determined only by chemical and bacteriological laboratory tests. Chemical analysis indicates whether water is polluted and provides other information as well; however it is not sensitive or specific enough to detect degrees of sewage contamination. On the other hand, bacteriological tests have been designed which are extremely and specific in revealing evidence of pollution.

Bacteriological evidence of pollution – It is known that the pathogens that gain entrance into bodies of water arrive there via intestinal discharges. Furthermore, certain species, particularly *Escherichia coli* and related organisms designated as coliforms, faecal streptococci (e.g. *Streptococcus faecalis*), and *Clostridium perfringens*, are inhabitants of the large intestine of man and other animals and are consequently present in faeces. Thus the presence of any of these bacterial species in water is evidence of excretal or pollution of human or animal origin. If these organisms are present in water, the way is also open for pathogens to gain entrance, since they too occur in faeces.

*Bacteriological techniques.*

<table>
<thead>
<tr>
<th>Past participles:</th>
<th>avoided</th>
<th>collected</th>
<th>given</th>
<th>stored</th>
<th>submitted</th>
<th>taken</th>
<th>tested</th>
</tr>
</thead>
</table>

It is essential that strict attention be to the following details when water samples are for bacteriological analysis:

1. The sample must be in a sterile bottle.
2. The sample must be representative of the supply from which it is.
3. Contamination of the sample must be during and after sampling.
4. The sample should be as promptly as possible after collection.
5. If there is a delay in examination of the sample, it should be at a temperature between 0 and 10°C.

*The standard plate count.*

<table>
<thead>
<tr>
<th>Prepositions:</th>
<th>at (2)</th>
<th>for (3)</th>
<th>in (1)</th>
<th>of (5)</th>
<th>on (1)</th>
<th>per (2)</th>
<th>to (2)</th>
</tr>
</thead>
</table>

According this technique, usually 1 ml and 0.1 ml the sample are plated the prescribed medium. The plates are incubated either 20°C 48 hours or 35°C 24 hours; then a colony count is made and the number bacteria millilitre the sample is calculated. Water good quality is expected to give a low count, less than 100 millilitre. Plate counts are useful determining the efficiency
operations ____ removing or destroying organisms, e.g., sedimentation, filtration, and chlorination. A count can be made before and after the specific treatment, and the results indicate the extent _____ which the microbial population has been reduced.

d Tests for the presence of coliform bacteria

Several selective and differential _______ greatly expedite the process of examining water for coliform organisms. The ________ involves three successive steps: 1) the presumptive test, 2) the confirmed test, and 3) the completed test.

The presumptive test consists of incubating lactose-broth _______ with appropriate amounts of the water ________, incubating the _________ at 35°C, and observing them for evidence of _________ production after 24 and 48 hours. The _________ of gas after 48 hours is evidence that the sample contains no coliforms since this group of _________ is characterized in part by their _________ to produce gas from lactose. Gas produced in the lactose-broth tubes is interpreted as presumptive _________ of the presence of coliforms. However, since it is possible that the gas formation may be due to _________ other than coliforms, it is necessary to perform additional _________ to obtain positive evidence for the _________ of coliforms. This is accomplished in the confirmed test and the completed test.