Overview of environmental pollution and its effects. Environmental pollutants and their sources. **Industrial Waste Management:** Waste and waste management. Industrial water cycle –source of water supply.Contaminants. Effects of contaminants on process and plant. Methods of treatment for supply water. Legislation and regulations for discharge. Permissible levels for discharge. Clean technology – approaches to minimize waste. Change of chemicals, processes, plant; Reuse-Recycle; Effluent/waste systems. Solids treatment. Gas emissions and treatments. Sewage treatment works. **By-products in Leather Industry:** Processes involved in the use of leather by-products. Use of leather industry waste as a source of raw material for animal feed, gelatin, leather-board and alternative uses. **Occupational Health and Safety:** Occupation heath risks and hazards, chemical agents, physical agents, mechanical agents, infectious agents and psychosocial factors; control of occupational hazards and accident prevention. Health, Safety and Environmental legislation. Environmental Impact Assessment. International Conventions and Protocols. Global environmental issues.

JLS 400

OVERVIEW OF ENVIRONMENTAL POLLUTION AND ITS EFFECTS

Environmental pollution had been a fact of life for many centuries but it became a real problem since the start of the industrial revolution.

Definition

Environmental pollution is "the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected"."Pollution is the introduction of contaminants into the environment that cause harm or discomfort to humans or other living organisms, or that damage the environment" which can come "in the form of chemical substances, or energy such as noise, heat or light".

Or

Pollution is "the addition of any substance or form of energy (e.g., heat, sound, radioactive) to the environment at a rate faster than the environment can accommodate it by dispersion, breakdown, recycling, or storage in some harmless form".

"Pollutants can be naturally occurring substances or energies, but are considered contaminants when in excess of natural levels."

One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing grave and irreparable damage to the earth. Environmental pollution consists of five basic types of pollution, namely, air, water, soil, noise and light. All types of pollution – air, water and soil pollution – have an impact on the living environment.

The effects in living organisms may range from mild discomfort to serious diseases such as cancer to physical deformities; ex., extra or missing limbs in frogs.

Environmental Pollution Effects on Humans

We know that pollution causes not only physical disabilities but also psychological and behavioural disorders in people.

Air Pollution Effects

The following pollution effects on humans have been reported:

• Reduced lung functioning • Irritation of eyes, nose, mouth and throat • Asthma attacks • Respiratory symptoms such as coughing and wheezing • Increased respiratory disease such as bronchitis • Premature death	• Reduced energy levels • Headaches and dizziness • Disruption of endocrine, reproductive and immune systems • Neurobehavioral disorders • Cardiovascular problems • Cancer

Water pollution effects

Waterborne diseases caused by polluted drinking water:

• Typhoid • Amoebiasis • Giardiasis (Giardiasis is an infection in your small intestine. It's caused by a microscopic parasite called *Giardia lamblia*. Giardiasis spreads through contact with infected people. Pet dogs and cats also frequently contract giardia)	• Ascariasis • Hookworm

Waterborne diseases caused by polluted beach water:

- Rashes, ear ache, pink eye
- Respiratory infections
- Hepatitis, encephalitis, gastroenteritis, diarrhoea, vomiting, and stomach aches

Conditions related to water polluted by chemicals (such as pesticides, hydrocarbons, persistent organic pollutants, heavy metals etc):

- Cancer, incl. prostate cancer and non-Hodgkin's lymphoma
- Hormonal problems that can disrupt reproductive and developmental processes
- Damage to the nervous system
- Liver and kidney damage

- Damage to the DNA
- Exposure to mercury (heavy metal):
    - *In the womb:* may cause neurological problems including slower reflexes, learning deficits, delayed or incomplete mental development, autism and brain damage
    - *In adults:* Parkinson's disease, multiple sclerosis, Alzheimer's disease, heart disease, and even death

Other notes:

- Water pollution may also result from interactions between water and contaminated soil, as well as from deposition of air contaminants (such as acid rain)
- Damage to people may be caused by fish foods coming from polluted water (a well-known example is high mercury levels in fish)
- Damage to people may be caused by vegetable crops grown / washed with polluted water

Soil Pollution Effects

- Causes cancers including leukaemia
    - Lead in soil is especially hazardous for young children causing developmental damage to the brain
    - Mercury can increase the risk of kidney damage; cyclodienes can lead to liver toxicity
    - Causes neuromuscular blockage as well as depression of the central nervous system
- Also causes headaches, nausea, fatigue, eye irritation and skin rash

Other causes

- Contact with contaminated soil may be *direct* (from using parks, schools etc) or *indirect* (by inhaling soil contaminants which have vaporized)
- Soil pollution may also result from secondary contamination of water supplies and from deposition of air contaminants (for example, via acid rain)
- Contamination of crops grown in polluted soil brings up problems with food security
- Since it is closely linked to water pollution, many effects of soil contamination appear to be similar to the ones caused by water contamination

Soil and Water Pollution, Kenya

Environmental Pollution Effects on Animals

Air Pollution

- Acid rain (formed in the air) destroys fish life in lakes and streams
- Excessive ultraviolet radiation coming from the sun through the ozone layer in the upper atmosphere which is eroded by some air pollutants, may cause skin cancer in wildlife
- Ozone in the lower atmosphere may damage lung tissues of animals
- **Water Pollution**
- Nutrient pollution (nitrogen, phosphates etc) causes overgrowth of toxic algae eaten by other aquatic animals, and may cause death; nutrient pollution can also cause outbreaks of fish diseases.

- Chemical contamination can cause declines in frog biodiversity and tadpole mass
- Oil pollution (as part of chemical contamination) can negatively affect development of marine organisms, increase susceptibility to disease and affect reproductive processes; can also cause gastrointestinal irritation, liver and kidney damage, and damage to the nervous system
- Mercury in water can cause abnormal behaviour, slower growth and development, reduced reproduction, and death.
- Persistent organic pollutants (POPs) may cause declines, deformities and death of fish life
- Too much sodium chloride (ordinary salt) in water may kill animals

Other causes:

- We also assume that some higher forms of **non-aquatic animals** may have similar effects from water pollution as those experienced by humans, as described above

Soil Pollution

- Can alter metabolism of microorganisms and arthropods in a given soil environment; this may destroy some layers of the primary food chain, and thus have a negative effect on predator animal species.
- Small life forms may consume harmful chemicals which may then be passed up the food chain to larger animals; this may lead to increased mortality rates and even animal extinction.

Environmental pollutants and their sources.

Pollutants

- Sulfur dioxide.
- Nitrogen oxides.
- Ammonia.
- Carbon monoxide.
- Volatile Organic Compounds (VOCs)
- Persistent Organic Pollutants (POPs)
- Airborne particles.

Sources

Although pollution had been known to exist for a very long time (at least since people started using fire thousands of years ago), it had seen the growth of truly global proportions only since the onset of the industrial revolution during the 19th century. The industrial revolution brought with it technological progress such as discovery of oil and its universal use throughout different industries. Technological progress facilitated by super efficiency of capitalist business practices (division of labour – cheaper production costs – overproduction – overconsumption – overpollution) had probably become one of the main causes of serious deterioration of natural resources.

At the same time, development of natural sciences led to the better understanding of negative effects produced by pollution on the environment. Environmental pollution is a problem both in developed and developing countries. Factors such as population growth and urbanization invariably place greater demands on the planet and stretch the use of natural resources to the maximum. It has been argued that the carrying capacity of Earth is significantly smaller than the demands placed on it by large numbers of human populations. And overuse of natural resources often results in nature's degradation.

INDUSTRIAL WASTE MANAGEMENT:

Waste and waste management

Waste is a material, substance, or by-product eliminated or discarded as no longer useful or required after the completion of a process

Because no single waste management approach is suitable for managing all waste streams in all circumstances, EPA developed a hierarchy ranking the most environmentally sound strategies for municipal solid waste. The hierarchy places emphasis on reducing, reusing, and recycling the majority of wastes and demonstrates the key components of EPA's Sustainable Materials Management Program (SMM).

SMM is an effort to protect the environment and conserve resources for future generations through a systems approach that seeks to reduce materials use and their associated environmental impacts over their entire life cycles, starting with extraction of natural resources and product design and ending with decisions on recycling or final disposal.

Source Reduction and Reuse

Source reduction, also known as waste prevention, means reducing waste at the source. It can take many different forms, including reusing or donating items, buying in bulk, reducing packaging, redesigning products, and reducing toxicity. Source reduction also is important in manufacturing. Light-weighting of packaging, reuse and remanufacturing are all becoming more popular business trends. Source reduction can:

- Save natural resources;
- Conserve energy;
- Reduce pollution;

- Reduce the toxicity of our waste; and
- Save money for consumers and businesses alike.

Recycling/Composting

Recycling is a series of activities that includes the collection of used, reused or unused items that would otherwise be considered waste; sorting and processing the recyclable products into raw materials and remanufacturing the recycled raw materials into new products. Consumers provide the last link in recycling by purchasing products made from recycled content. Recycling also can include composting of food scraps, yard trimmings and other organic materials.

Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for our children's future, and reduces the need for new landfills and combustors.

Energy Recovery

Energy recovery from waste is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE).

Treatment and Disposal

Landfills are the most common form of waste disposal and are an important component of an integrated waste management system. Landfills that accept municipal solid waste are primarily regulated by state, tribal, and local governments. EPA, however, has established national standards these landfills must meet in order to stay open. The federal landfill regulations have eliminated the open dumps of the past. Today's landfills must meet stringent design, operation, and closure requirements. Methane gas, a by-product of decomposing waste, can be collected and used as fuel to generate electricity. After a landfill is capped, the land may be used for recreation sites such as parks, golf courses and ski slopes.

Industrial water cycle

Water cycle is the continuous movement or process by which water is circulated throughout the earth and the atmosphere through evaporation, condensation, precipitation, and the transpiration of plants and animals. Industrial water cycle is the acquiring water for industrial use from source, treating it to the required standard, using and disposing of the treated wastewater back to the environment. The water for industrial uses comes mainly (80%) from self-supplied sources, such as local wells or withdrawal points in rivers, but some water comes from public-supplied sources, such as the county/city water department.

Contaminants

The contaminants found in wastewater are varied and numerous. They include, but are not limited to, organic material, pathogens, metals, salt, ammonia, pesticides, pharmaceuticals, and endocrine disruptors. Some, such as pathogens and heavy metals, are undesirable in all treatment plant effluents as they are harmful to both humans and the environment. Others, such as nitrates and phosphorus, can be deleterious if the effluent is being discharged to receiving waters but advantageous if the effluent is going to be reused for agricultural irrigation. Therefore, it is important to understand that different uses of wastewater effluent will require different levels of contaminant elimination.

Most conventional wastewater treatment plants discharge into streams, lakes and rivers (receiving waters). These plants must have a NPDES (National Pollutant Discharge Elimination System) permit that determines the type and amount of contaminants they can discharge into the receiving water. Most NPDES permits regulate BOD, TSS, pH, coliforms, and nutrients although the acceptable levels will vary depending on the wastewater treatment process and the use and health of the receiving waters.

Contaminants, such as metals, TDS, pharmaceuticals, and endocrine disruptors, may or may not be included in NPDES (National Pollutant Discharge Elimination System) permits; however, they can be detrimental to water reuse. Some of these contaminants are just now being studied and their effects on the environment, humans, and reuse are unknown.

Biochemical Oxygen Demand (BOD)

BOD is a measure of how much organic material is in the wastewater plant effluent calculated by the amount of oxygen used by microorganisms in the oxidation of organic matter. If the amount released in the effluent is too high, microorganisms in the receiving waters will eat the organic material utilizing dissolved oxygen as they do so. This depletes the dissolved oxygen available to aquatic life and results in fish kills, invasions of weeds, and changes in the body of water.

Total Suspended Solids (TSS)

Total suspended solids are organic and inorganic solid materials that are suspended in water. High concentrations of suspended solids can lower water quality by absorbing light. Waters then become warmer which lessens the ability of the water to hold oxygen necessary for aquatic life. Because aquatic plants also receive less light, photosynthesis decreases and less oxygen is produced. Suspended solids can also clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. The material that settles fills the spaces between rocks and makes these microhabitats unsuitable for various aquatic insects.

pH

pH is a measure of the acidity of the water. Most organisms thrive in a fairly neutral environment, pH of 6 - 9, and will die or have reproductive problems if the pH is too high or too low.

Coliform bacteria

Coliform bacteria are found in abundance in raw wastewater but their numbers are reduced through the disinfection step of the treatment process. These organisms do not normally cause disease but are used as indicator organisms for disease-causing organisms called pathogens. If a wastewater plant's effluent contains large numbers of coliform bacteria, it is likely that a large number of pathogens are also being released into the environment. These pathogens can present a major health hazard.

Nutrients

Nutrients, especially nitrates and phosphorus, can also cause problems in receiving waters. Large amounts of these nutrients will lead to extensive growth of aquatic plants, algae, and plankton. This process is called eutrophication. It disturbs the eco-system and damages the biodiversity and flora. As a result, the plants use up more oxygen when they decompose, and this leads to oxygen depletion in the water resulting in the death of fish and other aquatic creatures. Phosphorus in wastewater comes from food, pesticides, and industries. Nitrates in wastewater come from ammonia being converted to nitrates by bacteria in the treatment process.

Metals

Metals are present in wastewater mainly due to manufacturing processes, industries, and piping in household plumbing and collection systems. Heavy metals found in wastewater include lead, silver, mercury, copper, nickel, chromium, zinc, cadmium, and tin. These metals, when found in sufficient concentrations, can be detrimental to human health as well as the environment. If wastewater is used to irrigate fields without having the metals removed, they will accumulate in the soil and may infiltrate the groundwater or render the fields useless.

Total Dissolved Solids

Total dissolved solids comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) found in wastewater. Effluent with high levels of TDS are not suitable for irrigation or landscaping because many plants are intolerant of the chlorides and the TDSs may leach into the groundwater. TDSs are also not desirable for industry reuse because they will cause corrosion and incrustation.

Pesticides/Endocrine Disruptors

An endocrine disruptor is a synthetic chemical that when absorbed into the body either mimics or blocks hormones and disrupts the body's normal functions. This disruption can happen through altering normal hormone levels, halting or stimulating the production of hormones, or changing the way hormones travel through the body, thus affecting the functions that these hormones control. Chemicals that are known human endocrine disruptors include diethylstilbesterol (the drug DES), dioxin, PCBs, DDT, and some other pesticides.

These chemicals are present in wastewater due to pesticide use and application, manufacturing, and industries. While human health effects of endocrine disruptors are still being investigated, numerous studies have shown that these chemicals have negative effects on the environment. Releasing them into the environment or to humans through wastewater discharge and/or reuse may cause unknown problems now and into the future.

Pharmaceuticals

Since most medications are not wholly absorbed into the body, the excess is eliminated and enters the sewer system. In addition, many people, hospitals, and nursing homes dispose of unused medications down the toilet. These pharmaceuticals make their way to the wastewater treatment plant where little is done to remove them. They are then released into the receiving waters dosing wildlife and even humans with drugs they don't have prescriptions for. Studies are underway to determine the effects these medications are having but it is clear that eliminating them before reuse and/or discharge will be necessary in the near future.

Effects of contaminants on process and plant

Water pollution can have dire consequences for plants, animals and even ecosystems as a whole. The specific effects vary depending on what pollutants enter the environment. Sometimes, water pollution causes an explosion of new plant growth by providing necessary nutrients and food. Other times, it can harm or kill plants by changing growing conditions, such as by raising or lowering the environment’s acidity.

Fertilizer

Plants must take in nutrients from the surrounding environment to grow. Nitrogen and phosphorous, in particular, encourage growth because they are instrumental in photosynthesis. This is why they are common ingredients in plant fertilizers. When agricultural runoff pollutes waterways with nitrogen- and phosphorous-rich fertilizers, the nutrient-enriched waters often see blooms of growth. Sometimes, too much growth can be harmful, as when plant-like algae bloom in polluted waters and create oxygen-depleted dead zones. One solution is to plant seaweed farms in areas that get a lot of farm runoff. Seaweed can soak up the excess nutrients and be harvested for consumption.

Marine Debris

Marine debris is garbage that accumulates in the ocean. Plastic debris that builds up at or near the water's surface impedes sunlight from fully reaching plants below. Plants rely on energy from sunlight to drive the photosynthesis process and create glucose food molecules. By blocking sunlight, marine debris prevents plants from creating glucose at full capacity, which stunts their growth.

Acid Rain

Water pollution that alters a plant's surrounding pH level, such as acid rain, can harm or kill the plant. Acid rain forms because of atmospheric sulfur dioxide and nitrogen dioxide, which are emitted from natural and human-made sources. These include volcanic activity and burning fossil fuels. These compounds interact with common atmospheric chemicals, including hydrogen and oxygen, to form sulfuric and nitric acids in the air. These acids return to earth through precipitation, such as rain or snow. Once acid rain reaches the ground, it flows into waterways that carry its acidic compounds into bodies of water. Acid rain that collects in aquatic environments lowers water pH levels, killing plants that cannot live in these more acidic conditions.

Phytotoxicity

When chemical pollutants build up in aquatic or terrestrial environments, plants can absorb these chemicals through their roots. Phytotoxicity occurs when toxic chemicals poison plants. Signs of phytotoxicity include poor growth, dying seedlings and dead spots on leaves. For example, mercury poisoning -- which many people associate with fish -- can also affect aquatic plants, as mercury compounds build up in plant roots and bodies. This begins a chain of bioaccumulation as animals feed on polluted food and increasing levels of mercury work their way up the food chain.

METHODS OF TREATMENT FOR SUPPLY WATER

Water treatment is any process that makes water more acceptable for a specific end-use. The end use may be drinking, industrial water supply, irrigation, river flow maintenance, water recreation or many other uses including being safely returned to the environment. Water treatment removes contaminants or reduces their concentration so that the water becomes fit for its desired end-use.

Waste water treatment

Wastewater treatment is the process that removes the majority of the contaminants from wastewater or sewage and produces both a liquid effluent suitable for disposal to the natural environment and a sludge. Biological processes can be employed in the treatment of wastewater and these processes may include, for example, aerated lagoons, activated sludge or slow filters. To be effective, sewage must be conveyed to a treatment plant by appropriate pipes and infrastructure and the process itself must be subject to regulation and controls. Some wastewaters require different and sometimes specialized treatment methods. At the simplest level, treatment of sewage and most wastewaters is carried out through separation of solids from liquids, usually by sedimentation. By progressively converting dissolved material into solids, usually a biological floc, which is then settled out, an effluent stream of increasing purity is produced.

Industrial water treatment

Industrial Water Treatment can be classified into the following categories: Industrial wastewater treatment, Boiler water treatment and cooling water treatment. Water treatment is used to optimize most water-based industrial processes, such as: heating, cooling, processing, cleaning, and rinsing, so that operating costs and risks are reduced. Poor water treatment lets water interact with the surfaces of pipes and vessels which contain it. Steam boilers can scale up or corrode, and these deposits will mean more fuel is needed to heat the same amount of water. Cooling towers can also scale up and corrode, but left untreated, the warm, dirty water they can contain will encourage bacteria to grow, and Legionnaires' Disease can be the fatal consequence. Also, water treatment is used to improve the quality of water contacting the manufactured product e.g. semiconductors, and/or can be part of the product e.g. beverages, pharmaceuticals, etc

Legislation and regulations for discharge

WASTE MANAGEMENT REGULATIONS

These Regulations apply to all categories of waste. These include: • Industrial wastes; • Hazardous and toxic wastes; • Pesticides and toxic substances; • Biomedical wastes; • Radio-active substances. These regulations outline requirements for handling, storing, transporting, and treatment/ disposal of all waste categories.

Disposal of waste by NEMA licensed company.

Attach ISWM2_WasteManagementRegulations

"Radioactive Waste" means any radioactive material that has been, or will be, discarded as of being of no further use.

"Recycling of waste" means the processing of waste material into a new product of similar chemical composition.

"Reprocessing" means the processing of waste into a new product of different chemical composition.

"Reuse" means waste reused with or without cleaning and/or repairing. "Segregation" means any activity that separates waste materials for processing.

"Sludge" means a none flowing mixture of solids and liquids.

"Storage" means temporary placement of waste in a suitable location or facility where isolation, environmental and health protection and human control are provided in order to ensure that waste is subsequently retrieved for treatment and conditioning and/or disposal.

"Toxic Chemical" means any substance, which on entry into an organism through ingestion, inhalation and dermal contact is injurious, causes physiological, or biochemical disturbances or otherwise causes deterioration of the functions of the organism in any way.

"Treatment" means any method, technique or process for altering the biological, chemical or physical characteristics of wastes to reduce the hazards it presents.

"Waste Generator" means any person whose activities or activities under his or her direction produces waste or if that person is not known, the person who is in possession or control of that waste.

"Waste Management" means the activities, administrative and operational, that are used in handling, packaging, treatment, conditioning, reducing, recycling, reusing, storage and disposal of waste.

PERMISSIBLE LEVELS FOR DISCHARGE

Rules and Regulations

	Items of Analysis	**Watercourse**	**Controlled Watercourse**
		(Units in milligram per litre or otherwise stated)	
1	Temperature of discharge	45ºC	45ºC
2	Colour	7 Lovibond Units	7 Lovibond Units
3	pH Value	6 - 9	6 - 9
4	BOD (5 days at 20°C)	50	20
5	COD	100	60
6	Total Suspended Solids	50	30
7	Total Dissolved Solids	- **(2000)	1000
8	Chloride (as chloride ion)	- ** (600)	250**(400)
9	Sulphate (as SO4)	- ** (500)	200
10	Sulphide (as sulphur)	0.2	0.2
11	Cyanide (as CN)	0.1	0.1
12	Detergents (linear alkylate sulphonate as methylene blue active substances)	15	5
13	Grease and Oil	10 (Total) 10 (Hydrocarbons)	1 (Total)
14	Arsenic	0.1 ** (1)	0.01 ** (0.05)
20	Manganese	5	0.5
21	Phenolic Compounds (expressed as phenol)	0.2	Nil
22	*Cadmium	0.1	0.003
23	*Chromium (trivalent and hexavalent)	1	0.05
24	*Copper	0.1	0.1
25	*Lead	0.1	0.1
26	*Mercury	0.05	0.001

	Items of Analysis	Watercourse	Controlled Watercourse
27	*Nickel	1	0.1
28	*Selenium	0.5	0.01
29	*Silver	0.1	0.1
30	*Zinc	1	0.5
31	*Metals in Total	1	0.5
32	Chlorine (Free)	1	1
33	Phosphate (as PO4)	5	2
34	Calcium (as Ca)	- ** (200)	150
35	Magnesium (as Mg)	- ** (200)	150
36	Nitrate (as NO3)	-	20

CLEAN TECHNOLOGY

Clean Technology is a broad base of processes, practices and tools, in any industry that supports a sustainable business approach, including but not limited to: pollution control, resource reduction and management, end of life strategy, waste reduction, energy efficiency, carbon mitigation and profitability.

Approaches to waste minimization

Waste minimization is a process of elimination that involves reducing the amount of waste produced in society and helps to eliminate the generation of harmful and persistent wastes, supporting the efforts to promote a more sustainable society. Waste minimization involves redesigning products and/or changing societal patterns, concerning consumption and production, of waste generation, to prevent the creation of waste.

Waste Minimization Strategies

There are multiple tools and techniques that manufacturers can apply to their operations in order to minimize their waste streams. For example, representatives from each area of operations can form a “green team” to communicate ideas and progress up to senior leadership and down to department employees, ensuring an integrated and comprehensive approach to waste minimization throughout the facility. The reduction of packaging materials can also affect the overall waste stream volume. Manufacturers can redesign their product packaging to minimize the amount of material used and to maximize the amount of recyclable or degradable packaging content.

The use of “green chemistry” is another effective way to minimize the toxicity of a process along with the potential for releases to the environment. By designing chemical products and processes that minimize the generation of hazardous wastes, companies using “green” or “sustainable chemistry” products also have opportunities to reduce waste volumes and toxicities along with energy and other resources. A large component of many manufacturers’ waste streams is wastewater and industrial sludge. These materials are often costly to treat and dispose of or discharge. In order to minimize this element of the waste stream, manufacturers should consider ways to reduce the amount of water needed for manufacturing processes; gains in water efficiency also reduce costs associated with the purchase of fresh water. Wastewater sludge should be profiled as to their constituents. Some sludge is high in organic content or other materials that could be beneficially reused by other firms. Decreasing the volumes of wastewater and wastewater sludge helps to conserve natural resources and reduces the potential for environmental contamination. If green chemistry cannot be used to reduce the volume and toxicity of wastewater, the EPA Sustainable Chemistry Hierarchy suggests establishing closed loop manufacturing systems. This technique can also be applied to other parts of the manufacturing process where wastes (such as solvents) are generated. Using closed loop systems minimizes the amount of new chemicals that must be purchased by maximizing their efficiency and prolonging their useful life. It also reduces losses due to accidental releases or evaporation, along with the potential for soil or groundwater contamination and air emissions.

Effluent Treatment Plant Systems

Industrial wastewater treatment covers the mechanisms and processes used to treat wastewater that is produced as a by-product of industrial or commercial activities. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Most industries produce some wastewater although recent trends in the developed world have been to minimize such production or recycle such wastewater within the production process. However, many industries remain dependent on processes that produce wastewaters.

Because domestic wastewater does not exhibit great variability in regard to its content of organic and inorganic materials, its treatment is generally similar throughout large regions. In contrast, the content of industrial effluents varies from one industry to another, and therefore requires varying treatment, based on the specific industry producing it. The specifications for releasing various types of industrial effluents into the public sewer network or to surface watercourses is not only determined by the concentration of biological oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids, but also by the content of organic and inorganic elements, which vary from country to country. In general, therefore, selecting a treatment method for industrial effluents depends primarily on the following factors:

- Identifying the various pollutants present in the effluent;
- Characterizing the effluent;
- Regulating the sewers and separating the waste streams;
- Selecting the treatment technology based on the different available physical, chemical or biological treatment capabilities.

Technology Description

Industrial effluents contain various materials, depending on the industry. Some effluents contain oils and grease, and some contain toxic materials (e.g., cyanide). Effluents from food and beverage factories contain degradable organic pollutants. Some effluents contain, while others lack, nutritious materials suitable for microbiological growth. Effluents of canned fruit and soda beverages, for example, contain high percentages of sugar, very low percentages of protein, and little nitrogen or phosphorus. Biological growth in these effluents, therefore, is rather weak. Thus, every industrial effluent (and pollutants) require a specific treatment technology.

In order to design a suitable method for treating an industrial effluent, the following major parameters must be determined:

1) Daily wastewater volume;
2) Maximum and minimum water discharges;
3) Chemical characteristics of the water used in the industry;
4) Continuous and intermittent manufacturing stages;
5) Intensity and periods of pollution peaks;
6) Possibility of separating waste streams;
7) Possibility to carry out local or partial treatment, or recycling;
8) Probability of secondary pollution incidents, even if slight or occasional, that can worsen treatment plant operation (appearance of glues, fibers, oils, sand, etc.).

In general, when a treatment plant is designed, these parameters must be determined through analysis of the different manufacturing processes in the industrial facility, and comparison of the results with information from other similar industrial facilities.

When a treatment plant is constructed for a factory, the quantity of pollutants in the effluent must be precisely determined through continuous and routine analysis of the water, and compared with chemicals used in the factory.

Despite the fact that every pollutant requires a certain treatment technology, these different technologies include the following stages:

- Separate treatment – for the purpose of separating materials that require special treatment. This is important when the wastewater contains high concentrations of BOD, COD, H_2S, NH_4 or poisonous materials. It may be costlier to dispose of the water than to treat it in certain ways;
- Preliminary treatment – useful for all industries and important for food and agricultural industries. It includes

    (1) Grit removal in some cases (iron and steel foundries, rainwater and sandpits),

    (2) Oil removal for hydrocarbons and oils, and

(3) Equalization of liquid flow and pollutant load. (the process of controlling hydraulic velocity, or **flow** rate)

- Physical-chemical treatment -- this treatment can be an intermediate or final stage, based on the type of treatment. It is conducted for

  (1) Settling of poisonous minerals or salts,

  (2) Removal of oils in emulsions, and other suspended substances,

  (3) Clarification and dilution of colloidal BOD and COD concentrations (the pH has to be maintained in a relatively narrow range depending on the nature of the used process, either settling, crystallization or absorption), and

  (4) Floatation units for oil and fiber removal.

  The physical-chemical treatment is preceded, or followed, by other methods such as

  (1) Electric neutralization,

  (2) Oxidation or reduction, and

  (3) Degassing or stripping.

- Biological treatment -- the use of this treatment depends on the biodegradable contents of the wastewater.
- Removal of non-biodegradable material -- the biological purification process is considered one of the best methods for reducing the BOD concentration and the COD resulting from decayed organic compounds of different types (solvents, aromatic materials, hydrocarbons).
- Industrial sludge – although organic sludge exists in some cases, the sludge is primarily inorganic in nature. Industrial wastewater contains large quantities of sludge, resulting particularly from physical-chemical treatment methods. All the methods used in treating activated sludge from wastewater treatment plants can be used in the industrial context.

The leather processing industry produces large amounts of solid organic wastes in the form of un-tanned (trimmings , fleshings, splits) and tanned (trimmings, splits and shavings) waste from raw hides and skins, semi-processed leather, as well as sludge as a result of wastewater treatment. If these solid wastes are not properly treated and disposed of, they can cause environmental damage to soil and groundwater as well as emissions of odour and poisonous greenhouse gases into the atmosphere.

Utilization or safe disposal of sludge generated by tannery effluent treatment plants poses a challenge worldwide; landfill disposal should be considered only in case when no other viable option is possible. Unfortunately, in some areas and/or developing countries properly designed and constructed landfills are not available.

Typically, only small part of fleshing is used for manufacture of glue and animal protein while the major part is dumped as waste at landfill or disposed of along with other solid wastes. The unutilisedfleshings, containing high concentration of lime and sulfide, putrefy and produce obnoxious odour. They also cause groundwater pollution, attract flies, rodents and stray dogs and thus represent a public nuisance. Due to high moisture content handling and transportation of fleshings is quite difficult.

With increasing pressure from the pollution control authorities, tanners in many countries of the world are faced with the urgent task of utilization or safe disposal of solid wastes from tanneries, particularly fleshings and trimmings. Likewise, sludge generated by tannery effluent treatment plants has to be either put to use or safely disposed.

Due to climatic conditions the scope for green processing is limited in many countries, sodium chloride is widely used to preserve raw hides and skins. It contributes to a high volume of total dissolved solids (TDS) in the soak waste liquor. No commercially viable technology for treating effluent has been developed to date. A large amount of the salt sticking to the hide and skin surface can be removed by shaking the hides mechanically or manually.

Pollution Control in the Tanning Industry has been actively looking for solutions to tackle saline tannery effluent. The following technologies have been tested at pilot scale demonstration units:

- Mechanical/manual removal of excess salt from wet salted hides and skins
- Reverse osmosis (RO) of treated tannery effluent
- Improved (accelerated) solar evaporation
- Recycling of floats in the beamhouse
- Use of ultrafiltration in tannery effluent.

PRODUCTION OF CLEAN ENERGY

Out of 1000 kgs of raw hide, nearly 850 kgs is generated as solid wastes in leather processing. Only 150 Kgs of the raw material is converted into leather. A typical tannery generate huge amount of waste:

1. Fleshing: 56-60%
2. Chrome shaving, chrome splits and buffing dust: 35-40%
3. Skin trimming: 5-7%
4. Hair: 2-5%

Over 80 per cent of the organic pollution load in BOD terms emanates from the *beamhouse* (pre-tanning); much of this comes from degraded hide/skin and hair matter. During the tanning process at least 300 kgs of chemicals (lime, salt etc.) are added per ton of hides. Excess of non-used salts will appear in the wastewater.

Because of the changing pH, these compounds can precipitate and contribute to the amount of solid waste or suspended solids.

Anaerobic Digestion of Tannery Wastes

The conventional leather tanning technology is highly polluting as it produces large amounts of organic and chemical pollutants. Wastes generated by the leather processing industries pose a major challenge to the environment. Everyday a huge quantity of solid waste, including trimmings of finished leather, shaving dusts, hair, fleshing, trimming of raw hides and skins, are being produced from the industries. Chromium, sulphur, oils and noxious gas (methane, ammonia, and hydrogen sulphide) are the elements of liquid, gas and solid waste of tannery industries.

Anaerobic digestion (or biomethanation) systems are mature and proven processes that have the potential to convert tannery wastes into energy efficiently, and achieve the goals of pollution prevention/reduction, elimination of uncontrolled methane emissions and odour, recovery of bio-energy potential as biogas, production of stabilized residue for use as low grade fertilizer.

Anaerobic digestion of tannery wastes is an attractive method to recover energy from tannery wastes. This method degrades a substantial part of the organic matter contained in the sludge and tannery solid wastes, generating valuable biogas, contributing to alleviate the environmental problem, giving time to set-up more sustainable treatment and disposal routes. Digested solid waste is biologically stabilized and can be reused in agriculture.

Potential Applications of Biogas

Biogas produced in anaerobic digesters consists of methane (50%–80%), carbon dioxide (20%–50%), and trace levels of other gases such as hydrogen, carbon monoxide, nitrogen, oxygen, and hydrogen sulfide.

Biogas can be used for producing electricity and heat, as a natural gas substitute and also a transportation fuel. A combined heat and power plant system not only generates power but also produces heat for in-house requirements to maintain desired temperature level in the digester during cold season.

Wastes originate from all stages of leather making, such as fine leather particles, residues from various chemical discharges and reagents from different waste liquors comprising of large pieces of leather cuttings, trimmings and gross shavings, fleshing residues, solid hair debris and remnants of paper bags.

Use of leather industry waste as a source of raw materials

Gelatin from hide/skin waste

Gelatin is a translucent, colourless, brittle, flavourless foodstuff, derived from collagen obtained from various animal by-products. It is commonly used as a gelling agent in food, pharmaceuticals, photography, and cosmetic manufacturing. Gelatin is an irreversibly hydrolyzed form of collagen. Household gelatin comes in the form of sheets, granules, or powder. Instant types can be added to the food as they are; others need to be soaked in water beforehand. Gelatin is a substantially pure protein food ingredient, obtained by the thermal denaturation of collagen, which is the structural mainstay and most common protein in the animal kingdom. Gelatin is also used as a foaming, emulsifying, and wetting agent in food, pharmaceutical, medical, and technical applications due to its surface-active properties.

Animal feed uses

The appropriate destination for the waste generated by tanneries has been a factor for concern among environmental authorities. Among all stages of the leather production chain, the tanning stage is that which generates greatest quantities of wastewater and solid waste. The wastes of leather tanned with chrome (wet blue) are classified as dangerous by environmental authorities in many countries. This means that it is dangerous to the environment and animals, including men. These wastes consist of scraping and shavings which are contaminated with chromium which prevents a conventional disposal in landfills and other uses such as animal feed. A technology was developed (Oliveira, 2004) for the recovery of the chromium contained in the scrapings and shavings. This allows the chrome reuse in the tanning process and generates a material composed mainly of collagen as final product, with low levels of chromium. However, alternatives to use this waste must be sought out, contributing to the reduction of the tanning industry wastes disposed in the environment.

The high crude protein content of the leather residues that undergo chromium extraction indicates that they can be used as a protein supplement in animal feed. The technique of chromium extraction of wet blue leather residues, with consequent attainment of leather waste without chrome, makes this material highly degradable in the rumen and highly digestible in the abomasum, providing it with great nutritional potential.

Leather boards

Waste is produced during the manufacture of leather: Waste such as cuttings, leather dust and shavings. The amount of this waste may be around 3% of the weight of the leather produced. To reduce or correct the thickness of leather, the material is usually shaved with knife rolls, normally after the chrome tannage. These shavings can be treated with a latex and possibly further tanning agents on a paper-making machine to produce leather board.

OCCUPATIONAL HEALTH AND SAFETY

Occupational health, or workplace health and safety (WHS), is a multidisciplinary field concerned with the safety, health, and welfare of people at work. The goals of occupational safety and health programs include fostering a safe and healthy work environment. OSH may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment.

Occupation health risks and hazards

Although work provides many economic and other benefits, a wide range of workplace hazards also present risks to the health and safety of people at work. These include but are not limited to, "chemicals, biological agents, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks," and a broad range of psychosocial risk factors. Personal protective equipment can help protect against many of these hazards.

Chemical agents

Dangerous chemicals can pose a chemical hazard in the workplace. There are many classifications of hazardous chemicals, including neurotoxins, immune agents, dermatologic agents, carcinogens, reproductive toxins, systemic toxins, asthmagens, pneumoconiotic agents, and sensitizers. Authorities such as regulatory agencies set occupational exposure limits to mitigate the risk of chemical hazards. An international effort is investigating the health effects of mixtures of chemicals. There is some evidence that certain chemicals are harmful at lower levels when mixed with one or more other chemicals. This may be particularly important in causing cancer.

Physical agents

Physical hazards affect many people in the workplace. Occupational hearing loss is the most common work-related injury in many countries of the world, with millions of workers exposed to hazardous noise levels at work and an estimated $242 million spent annually on worker's compensation for hearing loss disability.

Mechanical agents

Falls are also a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance. Machines have moving parts, sharp edges, hot surfaces and other hazards with the potential to crush, burn, cut, shear, stab or otherwise strike or wound workers if used unsafely.

Infectious agents

Biological hazards (biohazards) include infectious microorganisms such as viruses and toxins produced by those organisms such as anthrax. Biohazards affect workers in many industries; influenza, for example, affects a broad population of workers. Outdoor workers, including farmers, landscapers, and construction workers, risk exposure to numerous biohazards, including animal bites and stings,urushiol from poisonous plants, and diseases transmitted through animals such as the West Nile virus and Lyme disease. Health care workers, including veterinary health workers, risk exposure to blood-borne pathogens and various infectious diseases, especially those that are emerging.

Psychosocial factors

Psychosocial hazards include risks to the mental and emotional well-being of workers, such as feelings of job insecurity, long work hours, and poor work-life balance.

Control of occupational hazards and accident prevention

Prevention means the act or practice of stopping something bad from happening. In the sense of OSH it means the avoidance of the risk or hazard at work. In contrast to prevention, control is the term to describe mitigation activities where the risk cannot be prevented. The principles of prevention and control strategies are enshrined in several pieces of EU Health and Safety (H&S) legislation. The OSH Framework Directive (89/391/EEC) is of fundamental importance; it is basic H&S law which lays down general principles concerning prevention and protection of workers against occupational accidents and disease and establishes the framework for safety and health management at the workplace.

The Framework Directive contains general principles concerning:

1. Prevention of risks,
2. Protection of safety and health, assessments of risks,
3. Elimination of risks and accidents,
4. The informing, consultation, balanced participation in accordance with national laws and/or practices
5. Training of workers and their representatives,
6. General guidelines for the implementation of the said principles.
7. Obligations of employers, employees and other groups.

Health, Safety and Environmental legislation

Environmental, health and safety (EHS) departments, also called SHE or HSE departments, are entities commonly found within companies that consider environmental protection, occupational health and safety at work as important as providing quality products, and which therefore have managers and departments responsible for these issues. EHS management has two general objectives: prevention of incidents or accidents that might result from abnormal operating conditions on the one hand and reduction of adverse effects that result from normal operating conditions on the other hand.

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to International Standards that are generally considered to be achievable in new facilities at reasonable costs by existing technology.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent. If less stringent levels or measures than those provided in the EHS Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. This justification must demonstrate that the choice for any alternate performance levels is consistent with the objectives of Performance Standard.

The technical reference documents for environment of EHS Guidelines with general and industry-specific examples of Good International Industry Practice are:

1. Air Emissions and Ambient Air Quality
2. Energy Conservation
3. Wastewater and Ambient Water Quality
4. Water Conservation
5. Hazardous Materials Management
6. Waste Management
7. Noise
8. Contaminated Land and Remediation
9. Releases to water
10. Releases to land
11. Use of raw materials and natural resources
12. Energy emitted, heat/radiation/vibration
13. Waste and by-products

ENVIRONMENTAL IMPACT OF TANNERY WASTES

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of aproposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. UNEP defines EIA as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

Although legislation and practice vary around the world, the fundamental components of an EIA would necessarily involve the following stages;

1. **Screening** to determine which projects or developments require a full or partial impact assessment study;
2. **Scoping** to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the development, finding alternative designs or sites which

avoid the impacts, incorporating safeguards in the design of the project, or providing compensation for adverse impacts), and finally to derive terms of reference for the impact assessment;

3. **Assessment and evaluation of impacts and development of alternatives**, to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternatives;
4. **Reporting the Environmental Impact Statement** (EIS) or EIA report, including an environmental management plan (EMP), and a non-technical summary for the general audience.
5. **Review of the Environmental Impact Statement**, based on the terms of reference (scoping) and public (including authority) participation.
6. **Decision-making** on whether to approve the project or not, and under what conditions;
7. **Monitoring**, **compliance**, **enforcement and environmental auditing**. Monitor whether the predicted impacts and proposed mitigation measures occur as defined in the EMP. Verify the compliance of proponent with the EMP, to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion.

INTERNATIONAL CONVENTIONS AND PROTOCALS

One of the ways that WMO (World Meteorological Organization) contributes to sustainable development is through international environmental governance as enshrined in various United Nations and other international conventions. The data collected from WMO's networks of ground and space-based systems, combined with the application of improved scientific knowledge and computing technology, provide the information products, services and assessments necessary for the formulation of relevant policy decisions on which international environmental governance may build.

WMO, with relevant partners, co-sponsors several programs for scientific research and assessments to support intergovernmental legal agreements on major global environmental concerns such as ozone-layer depletion, climate change, desertification and biodiversity. WMO also coordinates the observing systems which provide the necessary data to assess atmospheric-ocean processes and interactions, such as El Niño/La Niña, and water-resources availability.

- UN Framework Convention on Climate Change
- United Nations Convention to Combat Desertification
- Vienna Convention on the Protection of the Ozone Layer
- Convention on Biological Diversity
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

- Convention on Long-range Transboundary Air Pollution
- Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)

GLOBAL ENVIRONMENTAL ISSUES

ClimateChange – Global warming is the most systemic and long-range threat to environmental health. All concerns are now geared and working on ways to combat climate change, with a focus on developing legal tools and regulatory frameworks that will help move human societies toward energy sustainability and protect those most harmed by rising sea levels and changing weather patterns.

Human Rights and Environment – WHO knows that environmental health and human health are two sides of the same coin: human rights violations and environmental degradation are often closely related. In many cases, infrastructure development and natural resource extraction projects are some of the worst offenders. WHO identifies the biggest threats and leverages the law to defend fundamental human rights.

Marine Protection – There is widespread legal advocacy to ensure that marine resources are being harvested sustainably, and that threatened ecosystems and marine species are being adequately protected. All countries of the World are encouraged to work towards strengthening laws that promote sustainable aquaculture and limit resource extraction in protected marine areas.

Environmental Governance – UN works to strengthen environmental governance and encourage public participation in the countries of the World. They are encouraged to educate local lawyers and provide informational materials to key decision makers. The most powerful change comes from the bottom up – by forging international alliances and equipping stakeholders with the knowledge and tools to get involved, UN builds capacity and expands citizen opportunities for participation.

Fresh water Preservation – Clean freshwater is a cornerstone of human health and biodiversity protection. UN litigates to safeguard freshwater from depletion and harmful contamination.