

## Environmental management:

### Introduction:-

unplanned developmental activities as well as ever-increasing population have caused enormous strain on the environment resources and hence people across the world face several problems of environmental degradation.

\* It is necessary to maintain a balance between capacity of Environment and the sustainable utilization of resources. This is possible by understanding, Environment in total and principles of scientific management. Due to our continuous involvement in exploitation of nature for immediate gains, we contribute to Environmental degradation and depletion of natural resource. This should be arrested. It is necessary to understand the function and interaction of physical and biological elements of the environment and develop management programs to conserve natural resources.

Environmental management [EM] represents the management of various activities such as

- Environmental action plan
- Organization of resources
- Environmental status ~~Evaluation~~ Evaluation
- Environmental legislation and administration
- Implementation, monitoring, auditing & practice
- Real world issues.

## Aim of Environmental management:

- To minimize the damage caused to the environment
- To reduce the amount of waste
- An efficient use of natural resources
- Protection of biodiversity
- Climate Reduction of impact on climate & others, in the longer run
  - \* Companies may profit from a range of other benefits
  - \* To build a strong position of the Enterprise on the market
  - \* To acquire new business opportunities
  - \* To reduce costs in the individual areas of its business activities

## Environmental Quality Objectives.

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- 1) Reduced climate impact.
- 2) Clean air
- 3) Natural acidification only.
- 4) A non-toxic environment.
- 5) A protective ozone layer.
- 6) A safe radiation environment.
- 7) Zero eutrophication.
- 8) flourishing lakes and streams.
- 9) Good-quality groundwater.
- 10) A balanced marine environment, flourishing coastal areas.
- 11) Thriving wetlands.
- 12) Sustainable forests.
- 13) A varied agricultural landscape.
- 14) A magnificent mountain landscape.
- 15) A good built environment.
- 16) A rich diversity of plant and animal life.

### Reduced climate Impact:-

The UN framework convention on climate change stabilization of concentrations of greenhouse gases in the atmosphere at levels ensure that human activities do not have a harmful impact on the climate system.

Goal achieved - Biological diversity is preserved, food production is assured and other goals of sustainable development.

All countries must have responsibility for achieving global objectives.

## 2) Clean Air.

The air must be clean enough not to represent a risk to health or to animals, plants or cultural assets. It should not cause

## 3) Natural Acidification Only:-

Acidifying effects of deposition<sup>in land</sup> and deposition<sup>in water bodies</sup> must not exceed the limits that can be tolerated by soil and water. Deposition of acidifying substances must not increase the rate of corrosion of material or cultural artefact and buildings.

## 4) A Non-Toxic Environment.

The environment must be free from man-made or extracted compound and metals that represent a threat to human health or biological diversity.

## 5) A protective Ozone layer:-

A Ozone layer must be replenished so as to provide long-term protection against harmful UV radiation.

## 6) A Safe Radiation Environment:-

Human health and biological diversity must be protected against the harmful effects of radiation in the external environment.

## 7) Zero Eutrophication:-

Excessive levels in soil and water

Adversely affect human health.

Biological diversity.

Possibility of varied use of land and water use.

### 12) Sustainable Forests:-

The Value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreation assets are safeguarded.

### 13) A Varied Agricultural Landscape:-

The Value of the farmed landscape and agricultural land for biological production and food production must be protected, at the same time as biological diversity and cultural heritage assets are preserved and strengthened.

### 14) A Magnificent Mountain Landscape:-

The pristine character of the mountain environment must be largely preserved, in terms of biological diversity, recreational value, and natural and cultural assets. Activities in mountain areas must respect these values and assets, with a view to promoting sustainable development.

Particularly valuable areas must be protected from encroachment and other disturbance.

### 15) A Good built Environment:-

Cities, towns and other built-up areas must provide a good, healthy living environment and contribute to a good regional and global environment.

Natural and cultural assets must be protected and developed.

Buildings and amenities must be located and designed in accordance with sound environmental principles and in such a way as to promote sustainable management of land, water and other resources.

## 8) Flourishing Lakes and Streams:-

Lakes and watercourses must be ecologically sustainable and its variety of habitats must be preserved.

Natural productive capacity, biological diversity, cultural heritage assets and the ecological and water conserving function of the landscape must be preserved, at the same time as recreational assets are safeguarded.

## 9) Good-Quality Groundwater:-

Groundwater must provide a safe and sustainable supply of drinking water.

## 10) A Balanced Marine Environment and Flourishing coastal areas

The sustainable productive capacity, and biological diversity must be preserved.

coasts must be characterized by a high degree of biological diversity and a wealth of recreational, natural and cultural activity.

Industry, recreation and other utilization of the sea, coasts must be compatible with the promotion of sustainable development.

Particularly Valuable areas must be protected against encroachment and other disturbance

## 11) Thriving Wetlands:-

The ecological and water conserving function of wetlands in the landscape must be maintained, and Valuable wetlands preserved for the future.

## 16) A rich Diversity of plant and animal life :-

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Biological diversity must be preserved and used sustainably for the benefit of present and future generations.

Species habitat and ecosystem and their function and processes must be safeguarded.

Species must be able to survive in long-term viable populations with sufficient genetic variation.

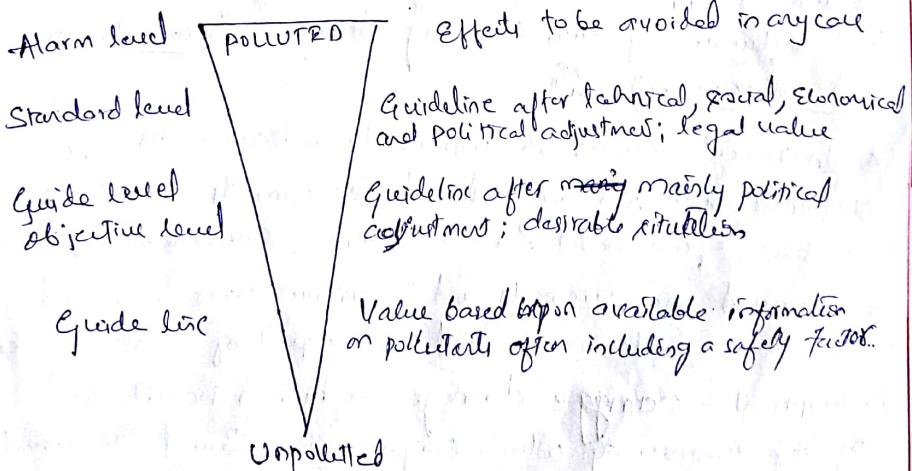
People must have access to a good natural and cultural environment rich in biological diversity, as a basis for health, quality of life and well-being.

## Rationale of Environmental standards

\* Environmental standards are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment. Environmental standards are typically set by government and can include prohibition of specific activities, mandating the frequency and methods of monitoring and requiring permits for the use of land or water.

\* Environmental standards may be used to produce quantifiable and enforceable laws that promote environmental protection. The basis for the standards is determined by scientific opinions from various disciplines, the views of the general population and social context.

\* Environmental problems such as air pollution, water pollution, soil pollution etc. are manifold and complex. In all of these cases one might attempt to set values indicating the levels which should not be exceeded, to guarantee health, environmental quality (or other policy targets). This value can be a standard, Guide line, Guideline and alarm levels determine to significant extent the context of environmental standards.



\* Standards are policy instruments. They belong to group of physical instruments for environmental policy.

\* Standards can be used to support sustainable development which is a more recent target for environmental policy. Avoiding adverse health impacts from high pollution levels, protecting the environment and contributing to sustainable development are the main targets of environmental standards.

\* If standards are targeted towards individuals (or) individual organizations, they are a rule part of permits.

Key characteristics of environmental standards are as follows:

- Set a general rule for one specific aspect
- Adress health, Environment, materials (or) pollution sources
- Set purely quantitative values, for pollutants, which should not be exceeded
- Be targeted towards ecosystems (or) populations rather than to individuals



### Development of Environmental standards

\* Historically, the development of environmental standards were influenced by two competing ideologies i.e. environmentalism and anthropocentrism.

\* In recent decades, the popularity and awareness of environmentalism has increased and developments in science have been fundamental for the setting of environmental standards.

\* Improved measurements and techniques have allowed scientists to better understand the impact of human caused environmental damage damage on human health and the biodiversity which comprises the natural environment.

- \* Therefore, Environmental standards in modern times are set with the view that humans do have obligations toward the environment, but they can be justified in terms of obligation toward other humans.
- \* The basis for the standards is determined by scientific opinions from varying disciplines, the views of the population and social context.
- \* Statistical methods are used to determine the specific states and limits the enforceable environmental standards.

### Governmental institutions setting Environmental standards are:-

#### a) United nations (UN)

The UN, with 193 member states, is the largest intergovernmental organization. The Environmental policy of the UN has a huge impact on the setting of international Environmental standards. At the Earth summit in 1992, held in Rio, the member states acknowledged their negative impact on the Environment for the first time. During this and the ~~following~~ millennium declaration, the first developmental goals for the Environmental issues were set.

#### b) United states (US)

In the United States, the development of standards is decentralized. These standards were developed by more than a hundred different institutions, many of which are private. The method of handling Environmental standards is a partly fragmented plural system, which is mainly affected by ~~the market~~ and climate standards have increasingly become site of conflict in the politics of global warming.

### c) European union :-

Within the treaty on the functioning of the European union, the union integrates a self-commitment towards the environment, protecting the European Environment Agency (EEA) consults the member states about environmental issues including standards.

### Non-Governmental institutions setting Environmental standards:-

#### a) International organization of standardization (ISO)

- \* The international organization of standardization (ISO) develops a large number of voluntary standards. The standards set by ISO were often transmitted into national standards by different nations.
- \* About 3,63,000 companies and organizations worldwide have ISO: 14001 certificate, a standard for environmental management created to improve the environmental performance of an organization and legal aspects as well as reaching environmental units.
- \* Most of the national and international environmental management standards include the ISO 14000 series.
- \* In light of the UN sustainable Development Goals, ISO has identified several families of standards which help ~~meet SDGs~~ to meet sustainable development Goals (SDG) which is focused on climate action for global warming.

#### b) Greenpeace:-

Greenpeace is a popular non-governmental organization that deals with biodiversity and the environment. Their activities have had a great global impact on

Environmental issues. Greenpeace Encourages public attention and Enforce governments (or) companies to adopt and set Environmental standards through activities regarding Special Environmental issues. Their main focus is on forests, the sea, climate change and toxic chemicals.

### Environmental Standards in India

Environmental standards The central pollution control board (CPCB) has developed national standards for effluents and emissions under the statutory powers of the water (prevention and control of pollution) Act, 1974 and the air (prevention and control of pollution) Act 1981.

These standards have been approved and notified by the Government of India, ministry of Environment & forests, under Section 25 of the Environmental (protection) Act, 1986.

Till now, Effluent standards for 37 categories of industries and emission standards for 31 categories of industries have been evolved and notified. Besides standards for ambient air quality, ambient noise, automobile and fuel quality specifications for petrol and diesel. Guidelines have also been developed separately for hospital waste management.

### Effluent and stream standards

We can maintain the stream quality by following the below standard

- \* Effluent standards
- \* Stream standards.

## Effluent standards

"The quality of standards established for the wastewater that has been processed from the unit"

- \* They are generally established for the effluents from industry and municipality waste water treatment plant to be discharge into streams, land, sewer, ocean etc.
- \* Effluent standard system is carried out to control the following stream standard system.
- \* No detailed stream analysis is required to determine exact amount of waste treatment, effluent standard can serve as a guide to establish the stream classification (or) during organisation of any pollution abatement programme.
- \* until the effluent standards are upgraded, this system does not provide any effective protection for an over loaded stream.
- \* Main disadvantage of this type of standards is that there is no control over total volume of polluting substances added to stream each day.

~~Some~~ standard values of effluent parameters are

Parameter	Standard Values			
	Intake surface water	Public sewer	land for irrigation	Moving coated areas
Colour and odour	All effluents should be made to remove colour & unpleasant odour as far as possible			
Temperature	shall not exceed 5° above the prevailing water temp	-	-	shall not exceed 5°c above the surface water temperature
pH Value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
BOD [3 day 25°C] mg/l max	30	350	100	100
COD, mg/l max	250	-	-	250

## Stream standards

\* The system is based on establishing classification (or) Standard quality for a stream for regulating any discharge to the extent, necessary to maintain the established stream classification (or) water quality.

\* The primary objective of stream standards is to protect and preserve each stream for its best usage on a equitable basis for both upstream & downstream uses.

\* The stream standard system is the prevention of excessive pollution regardless of type of industry (or) other factors such as location of industry (or) municipality.

\* Pollution abatement should be considered in the decisions concerning location of a plant just as carefully as the labourers, transportation, market and other conditions.

\* It also allows the public to establish goals for maintaining quality of water for present as well for future needs.

SL.NO	CHARACTERISTICS	STREAM CLASSIFICATION				
		A	B	C	D	E
1	Dissolved oxygen (mg/l)	6	5	4	4	-
2	Biological oxygen Demand (mg/l) Max	2	3	3	-	-
3	Total coliform organism, MPN/100ml	50	500	5000	-	-
4	Total dissolved solids mg/l (max)	500	-	1500	-	2100
5.	chloride (as Cl mg/l (max))	250	-	600	-	600

Effluent disposal standards based on stream classification

## Clean of stream      Designated Best use

- A - Drinking water source without conventional treatment after disinfection
- B - outdoor bathing
- C - Drinking water with conventional treatment followed by disinfection
- D - propagation of wild life & fisheries
- E - Irrigation, Industrial cooling controlled wastewater disposal.

## Concentration and Mass standards

Concentration is the mass of a pollutant in a defined volume of water  $\text{e.g. mg/l, }\mu\text{g/m}^3$

Load is the amount of pollutant that is discharged into a water body during a period of time (t) amount of pollutant ~~is~~ is produced after processing definite amount of substance

Ex  $1\text{ kg}/1000 \text{ tonne of substance processed}$   
 $\rightarrow 1\text{ tonne of sediment per year}$

NOTE:- Both Concentration and load provide information of environmental significance, but each has limitations

The air (pollution and control of pollution) Act 1981 was enacted by the central government with the objective of arresting the deterioration of air quality. This act describes the main functions of the central pollution control board (CPCB) as follows:

- \* To advise the central government on any matter concerning the improvement of the quality of air, the prevention, control and abatement of air pollution.
- \* To plan and to be Executed a nationwide programme for the prevention, control and abatement of air pollution.
- \* To provide technical assistance and guidance to the state pollution control board (SPCB).
- \* To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
- \* To collect, compile and publish technical and statistical data related to air pollution.
- \* To lay down annual standards of the quality of air.

## Environmental Performance Evaluation: (EPE)

\* Environmental Performance Evaluation is a management tool that provides managers with information about how well an organization's environmental system is performing and whether the aims of its environmental policy are achieved.

\* EPE is a useful auditing tool for assessing whether environmental aspects, objectives, targets and other environmental performance criteria are being met.

\* EPE is an ongoing process that explores any changes to an organization's activities, products and services that might affect environmental performance and accounted for in its EMS.

\* The main difference b/w EPE and ~~other~~ Environmental audit is that EPE is an ongoing process that tracks performance trends over time - ~~with~~ unlike an Environmental audit which is a summary of the EMS performance at a given point in time.

"The indicators which are used for Environmental Performance Evaluation are called "Environmental performance indicators". (EPI). Environmental performance indicators provide information that helps evaluation and decision making within organizations that engage in environmental efforts. [See definition <sup>EPE</sup> see 2 page later]

### Purpose of EPI :

1. Environmental performance indicators provide information that helps evaluation and decision making within organizations that engage in environmental efforts.

2. Environmental performance indicators provide a common foundation of information for organizations and external interested parties (such as consumers, business partners, residents in local communities, shareholders, and financial institutions) and → → → →
  3. It helps interest parties' proper understanding of activities of the organization and their environmental efforts.
3. Environmental performance indicators provide a common foundation of information that helps the integration of environmental policies of the national and local government, such as basic environment plans and environmental activities of organizations.
- Objectives of EPI:-
1. To measure and evaluate environmental burden, environmental problems that need to be solved and outcomes of environmental efforts comprehensively in order to promote environmental activities of organization and to obtain information that helps decision making regarding these activities.
  2. To provide a common foundation of information between an organization and interested parties in order to facilitate that interested parties, such as consumers, business partners, residents in local communities, shareholders and financial institutions understand environmental activities of the organization.
  3. To provide a common foundation of information for macro-level environmental policies of the national and local government.

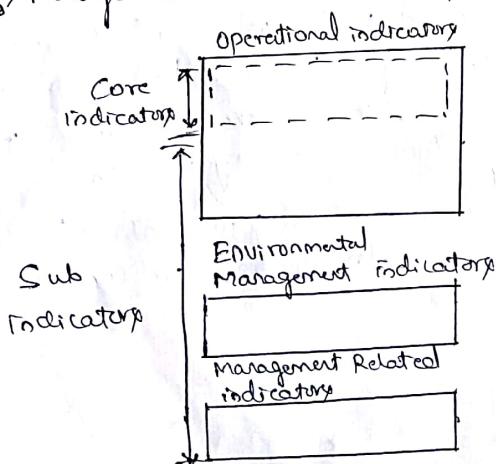
\* Environmental Performance Indicators are the indicators which precisely are required for measuring and evaluating the impacts or burden of organization's activities on the Environment and the outcomes of Environmental actions [Environmental performance].

\* Environmental performance indicators promote Environmental efforts of business organizations because business organizations use them for Internal Evaluation and decision making and business organizations use them with qualitative information when business organizations publish Environmental activity reports.

### Classification / Framework of Environmental performance indicator :-

The Environmental performance indicators are classified into the following three categories

- 1) Operational indicators → Core indicators  
Sub indicators
- 2) Environmental management indicators
- 3) Management related indicators.



## ④ Operational indicators

"Indicators that measure Environmental burden caused by business activities" In order to calculate materials and energy within business activities, only controlling environmental burdens released at the end of pipe is not enough.

⑤ If it is necessary to know and control what materials are inputted into the business activity, how they are used and what materials are released, and how they are released and it is necessary to have strategies to reduce these environmental burdens from the time of input.

Some of operational indicators are

### a) core indicators

#### i) input indicators

→ total amount of Energy input

→ total amount of material input

→ amount of water input.

#### ii) output indicators

→ amount of greenhouse gas emissions

→ chemical substance release and transfer

→ Total amount of waste generation

→ amount of final disposal of waste and

→ total amount of water drainage etc.

### b) Sub indicators That Qualitatively Supplement the core indicators

## 2) Environmental Management Indicators (Sub-indicators)

These are indicators that measure methods and organizations that manage and operate resources for business activities and their environmental activities or contributions to the society. Ex: Environmental management system

\* Environmental Accounting

\* Green procurement

\* Technology for Environmental protection and

\* Research and development for designing for the Environment friendly products and services etc.,

to identify performance gaps.

### b) practice benchmarking

\* involves gathering and comparing qualitative information about how an activity is conducted through people, processes and technology.

### c) Internal benchmarking

Compare metrics (performance benchmarking) and/or practices (practice benchmarking) from different units, product lines, departments, programs, geographies etc., within the organization

### d) External benchmarking

Compares metrics and/or practices of one organization to one or many others.

## Pollution POLLUTION CONTROL AND POLLUTION PREVENTION

Pollution prevention means avoiding (or) minimizing the generation of wastes that produce pollutants, thereby restricting their release into the environment.

Pollution control focuses on measures taken after waste have been produced to limit the damage they may cause. It is often more difficult and expensive to control pollution as it has been released into the environment.

Pollution control is the process of reducing or eliminating the release of pollutants into the environment. It is regulated by various environmental agencies which establish pollutant discharge limits for air, water and land.

- Air pollution control strategies can be divided into two categories

\* Control of particulate Emissions.

\* Control of gaseous Emissions.

There are many kinds of Equipment which can be used to reduce particulate Emissions. physical separation of the Particulates from the air using gravitational settling chamber, Cyclone collectors, impingers, wet scrubbers, Electrostatic precipitators, and filtration devices, are all process that are typically Employed.

### POLLUTION PREVENTION

Pollution prevention means avoiding (or) minimizing the generation of wastes that produce pollutants, thereby restricting their release into the environment.

\* Pollution prevention is any practice that reduces, eliminates (or) prevents pollution at its source. pollution prevention is also known as "source reduction".

\* Reducing the amount of pollution produced means less waste to control, Treat (or) dispose of.

\* Less pollution means less hazards posed to public health and the environment.

Pollution prevention approaches include

i) increasing efficiency in energy use

ii) use of ~~harmful~~ Environment friendly fuel sources.

Some of the pollution prevention approaches are

In the Industrial sector :-

\* Modifying a production process to produce less waste

- \* Using non-toxic (or) less toxic chemicals as cleaners, degreasers and other maintenance chemicals.
- \* Implementing water and energy conservation practices
- \* Reusing materials such as drums and pallets rather than disposing of them as waste

#### In the agriculture sector

- \* Reducing the use of waste water and chemical inputs
- \* Adoption of less Environmentally harmful pesticides (or) cultivation of crop strains with natural resistance to pests and
- \* protection of sensitive areas.

#### In homes and schools

- \* Using reusable water bottles instead of throwaways
- \* Automatically turning off lights when not in use
- \* Repairing leaky faucets and hoses
- \* Switching to "green" cleaners.

- f) Fear of production interruption
- g) limited access to necessary resources
- h) worker fear of job loss

### 3. Educational barriers to pollution prevention

- a) lack of top level support
- b) insufficient faculty motivation and training
- c) insufficient student interest
- d) inflexible curriculum requirements
- e) lack of instructional materials

### 4. Institutional Barriers to pollution prevention

- a) lack of top management support
- b) lack of clear communication of priorities (or) support.
- c) organizational structures may separate environmental decisions from production decisions.
- d) lack of involvement of affected workers etc,

## Cleaner production

### CLEANER PRODUCTION

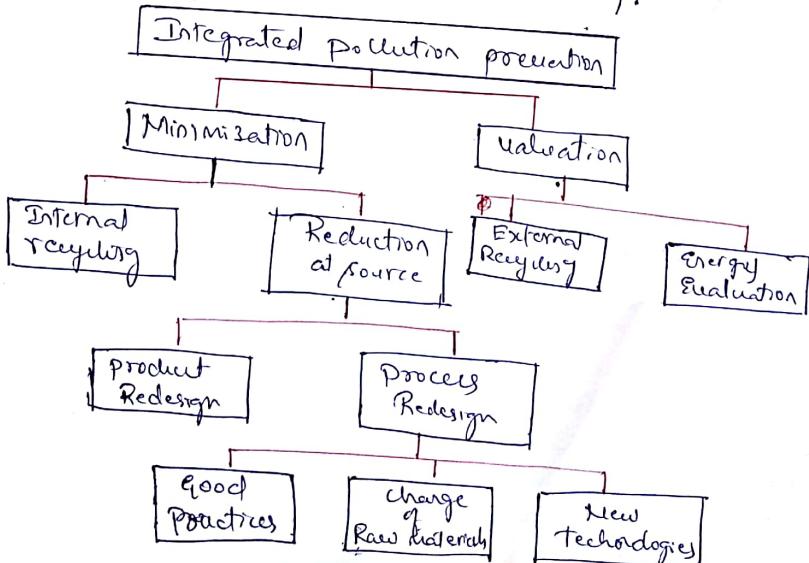
\* cleaner production is a preventive, company-specific Environmental protection initiative. It is intended to minimize waste and emissions and maximize product output.

\* By analyzing the flow of materials and energy in a company, one tries to identify options to minimize waste and emissions out of industrial process through source reduction strategies.

\* Improvement of organization and technology help to reduce (a) Suggest better choices in use of materials and energy and to avoid waste, waste water generation, and gaseous emissions and also waste heat and noise.

\* In accordance with the United Nations Environment programme (UNEP), cleaner production is under no mean

"The continual application of an integrated Environmental protection strategy in process, products and services, with the aim of reducing risks for humans and the environment, to increase the company's competitiveness and guarantee its economic viability!"



## Cleaner production options:

Examples of cleaner production options are:

- Documentation of consumption [as a basic analysis of material and Energy flows]
- Use of indicators and controlling [to identify losses from poor planning, poor education and training, mistakes]
- Substitution of raw materials and auxiliary materials (especially renewable materials and energy)
- Increase of useful life of auxiliary materials and process liquids [by avoiding drag in, drag out, contamination]
- Improved control and automation
- Reduce of waste (internal or external)
- New, low waste processes and technologies.

## Cleaner production allowing:

- Savings to be made in raw materials, water and energy
- The disposal, reduction and/or replacement of hazardous materials
- The reduction in quantity and hazardousness of waste and emissions
- The reduction of impact during a product's life cycle from the reception of raw materials to the final waste product.

This concept of integrated Environmental prevention is known by several names of very similar meaning: minimization, reduction at source, pollution prevention, cleaner production, eco-efficiency etc;

## Advantages of clean production -

1. Reduction of risk to the Environment, health and of industrial accidents
2. Economic savings on raw materials, water and Energy
3. Savings in waste flow management and Treatment
4. Improvement of corporate image.
5. Better quality of the product
6. Fewer products which do not conform to specifications.
7. Rationalization of the work structure
8. Improvement of routine habits and rethinking of processes and procedures
9. Optimization of processes and resources.
10. Fulfillment of the company's Environmental requirements and a commitment to its sustainable development.

## CLEAN TECHNOLOGY

- \* Clean technology, is often cleantech, is any process or product (or service) that reduces negative environmental impact through significant Energy efficiency improvements, the sustainable use of resources (or) Environmental protection activities.
- \* Clean technology include a broad range of Technology related to recycling, renewable energy, information technology, green transportation, electric motors, green chemistry, lighting, grey water and more.
- \* Clean technology is also referred to as cleantech, green technology and greentech.
- " It defines a set of technologies that either reduce (or) optimize the use of natural resources, whilst simultaneously reducing the

negative effect that technology has on the planet and its ecosystems.

### CLOSED LOOP RECYCLING / CLOSING THE LOOP:-

Closed-loop recycling is the process by which a product (or) material can be used and then turned into a new product (or) converted back to raw material indefinitely without losing its properties during the recycling process.

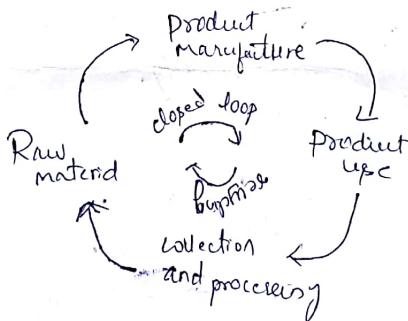
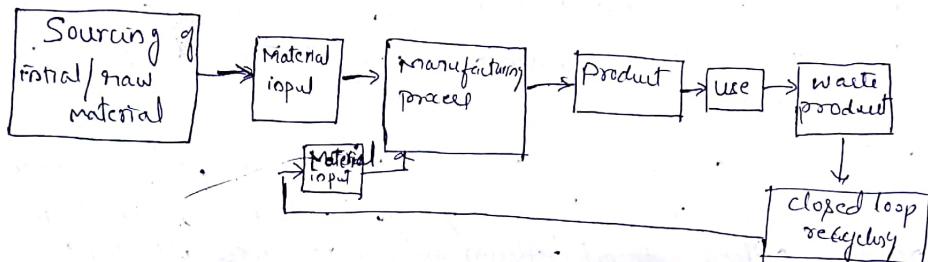


Fig: Flowchart showing closed loop recycling

- \* In ideal systems, materials are recycled indefinitely with practically no net change in quality (or) properties. This allows the same bits of a resource to be extracted, manufactured, used and recycled back into the same product forever. waste is considered a resource in itself, closing the loops of resource production.

- \* Recycled resources require less labour and energy to convert into new products, which reduces environmental pollution and production costs. Therefore, closed-loop recycling recycling may be considered part of Environmental Sustainability programs.
- \* Closed-loop recycling involves collecting and sorting recycled materials, and using those resources as inputs in the manufacturing of products practically identical to the original. Recycled materials are collected from homes, business and recycling banks.
- \* Closed-loop recycling systems may reduce landfill contributions, allowing landfill plots to last longer. For example, one ton of plastic in a closed-loop system saves about 74 cubic yards of landfill space.
- \* One goal of closed-loop recycling is to reuse materials ~~in~~ in an identical role as before recycling. In contrast, open-loop recycling systems do not return all of a resource, whether by design (or) due to the physical and chemical properties of the materials, (or) degraded in quality.
- \* Closed-loop recycling is suitable for:
  - a) materials like aluminum, glass and plastic etc., These are known to maintain their quality throughout many cycles of extraction, production, use and recycling. For example: Aluminium cans, Glass bottles can be recycled and turned into new cans and bottles with practically no material degradation (or) waste.
  - b) Closed-loop recycling is common in specialized industries, such as the computer and battery industry. These industries use expensive (or) complex materials that are not easily broken down into ~~one~~ constituent resources.

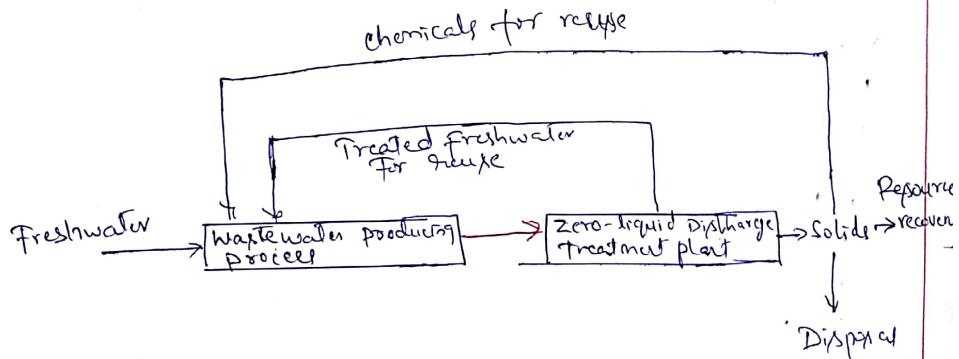
## Benefits of closed loop recycling

- \* Reduces the use of virgin materials, preserving natural resources
- \* Saves space in landfill of non-recyclables
- \* Reduces pollution - creating materials from virgin resources is far more labour intensive and therefore produce far more emissions.
- \* Lessens the risk of harm to the environment
- \* Lessen the risk of harm to wildlife.

## Zero liquid Discharge Technology

\* Zero liquid discharge (ZLD) is an engineering approach to water treatment where all water is recovered and contaminants are reduced to solid waste.

\* ZLD technology ~~process~~ includes pre-treatment and evaporation of the industrial effluent until the dissolved solids precipitate as crystals. These crystals are removed and dewatered with a filter press (or) a centrifuge. The water vapour from evaporation is condensed and returned to the process.



A ZLD system is generally comprised by two steps:

- pre-concentration:

pre-concentrating the brine is usually achieved with membrane brine concentrators (or) Electrodeionization (ED). These technologies concentrate the stream to a high salinity and are able to recover upto 60-80% of the water.

- Evaporation/crystallization:

The next step will thermal process (or) evaporation. Evaporates all the leftover water, collects it and drives it for reuse. The waste that is left behind then goes to a Crystallizer which boils all the water until all the impurities crystallizes and are filtered out as a solid.

ZLD is the most demanding Target since the next cost and challenge of recovery increases as the wastewater gets more concentrated.

The exact components of ZLD system Treatment system will largely depend on

- a) volume of dissolved material present in the waste
- b) System's required flow rate
- c) what specific contaminants are present

But in general, a basic ZLD Treatment system typically includes some type of

- a) clarifier and (or) reactor
- b) chemical feed
- c) Filter press
- d) RO/ultrafiltration (UF)
- e) Reverse osmosis
- f) Brine concentrator
- g) Evaporator
- h) Crystallizer.

If a plant requires a system that provides a bit more cost optimization, there might be some features (or) technologies you will need to add one depending on need of treatment.