Mini guide to Cleaner Production ...a 'preventive' approach towards pollution



GUJARAT CLEANER PRODUCTION CENTRE

ENVIS Centre on: Cleaner Production & Clean Technology Supported by: Ministry of Environment, Forest and Climate Change Government of India





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About us

Gujarat Cleaner Production Centre (GCPC) was established by Department of Industries and Mines, Government of Gujarat in the year 1998, with technical support of United Nations Industrial Development Organization (UNIDO). GCPC acts as an environmental advisor of GIDC, Government of Gujarat to solve environmental problems faced by SMEs at GIDC industrial estates. GCPC is actively engaged in promotion of Cleaner Production (CP) and Clean Technology (CT) through its various activities such as orientation/awareness programmes and conducting CP & CT assessment projects.

GCPC is regular member of RECP net – The Global Network on Resource Efficient and Cleaner Production of UNIDO and CTCN – Climate Technology Centre and Network, a working arm of UNFCCC - The United Nations Framework Convention on Climate Change.

GCPC is acting as an Environmental Information System (ENVIS) Centre for Ministry of Environment, Forest and Climate Change, Government of India since 2005, with objective to disseminate and promote the theme of 'cleaner production and clean technology' and other environmental practices across industries for making industry 'Clean and Green'.

GCPC provides guidance to industries in implementing cleaner production, conducting cleaner production orientation programmes, training and dissemination programmes and conducting cleaner production assessment projects to achieve sustainable industrial development in the state.

GCPC has played an active role in framing Gujarat Industrial Policy 2004, 2009 and 2015 and many financial assistance schemes, pertaining to Cleaner Production and Clean Technology in the state of Gujarat.

GCPC has so far conducted more than 200 orientation programmes in various academic institutions and industries associations. The centre has successfully completed more than 100 Cleaner Production Demonstration Projects in various industrial sectors such as Textile, Dairy, Pulp & Paper, Chemical, Petrochemical, Pharmaceutical, Fish Processing, Ceramic etc.

Foreword



The concept of Cleaner Production is very simple 'prevention is better than cure'; a stitch in times saves nine. I feel Cleaner Production is about changing mindsets. Cleaner Production sees waste as a resource rather than liability. It requires a new way of thinking about processes and products, and about how they can be made less harmful to humans and the environment. Cleaner Production does not deny growth; it merely insists that growth be ecologically sustainable.

Cleaner production can reduce environmental risks and liabilities and lead to greater competitiveness. Demonstrating a commitment to cleaner production, companies can also improve their public image and gain the confidence of consumers.

The objective to prepare a mini-guide on 'Cleaner Production' is to provide guidance on the concept and benefits of cleaner production to industries and to promote the application of Cleaner Production in industries; to achieve sustainable industrial development in the state of Gujarat, India.

Environmental Information System (ENVIS) provides a single knowledge sharing platform. GCPC disseminates the concept of Cleaner Production and Clean Technology to industries, students, and academicians through ENVIS supported by Ministry of Environment, Forest and Climate Change, Government of India.

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Checklist

United Nations Environment Programme (UNEP) defines **Cleaner Production** as the **continuous**, application of an integrated **preventive** environmental strategy applied to **processes**, **products and services** in order to **increase efficiency** and **reduce risks** to **humans** and the **environment**.

- For production processes cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes;
- For products cleaner production includes the reduction of negative impacts along the life cycle of a product, from raw material extraction to its ultimate disposal; and
- For services cleaner production is to incorporate environmental concerns into designing and delivering services.

Traditional environmental thinking focuses on what to do with wastes and emissions after they have been created.

Cleaner Production avoids or minimizes waste and pollution even before it is generated!

The key difference between pollution control and cleaner production is one of timing. Pollution control is after-the-event, "react and treat" approach; **Cleaner Production** is a proactive, **"anticipate** and **prevent** philosophy". Prevention is always better than cure.

Cleaner Production is not simply a question of changing equipment: "Cleaner Production is a matter of changing attitudes". The objective of Cleaner Production implementation is to make companies more efficient and less polluting.

So what is cleaner production in practice? What kind of changes required transforming the production to a cleaner and more efficient production?

The changes, so-called "Cleaner Production Tools" can be grouped into:

- Waste reduction at source;
- Recycling; and
- Product modifications



A. Waste reduction at source

Going to the source of pollution is the fundamental idea of cleaner production.

i) **Good housekeeping** is the simplest type of the cleaner production options. Good housekeeping requires no investments and can be implemented as soon as the options are identified.

Good housekeeping is e.g. to repair all leaks and avoid losses by closing water taps and turning off equipment when not needed.

Even though good housekeeping is simple, it requires focus from the management and training of staff.

ii) Process Change includes four types of options: Change in raw material, Better Process Control, Equipment Modification and Technology Change.

As with good housekeeping, change in process requires improved monitoring and management focus.

- Change of Raw Material includes the use of less hazardous materials or raw materials of higher quality aimed at reducing the quantity / toxicity of waste generated from the process. Existing raw materials could be substituted with less polluting ones.
- Better process control aims at optimizing the process parameters / conditions like pH, temperature, pressure, residence time etc., to ensure operation of the existing processes at higher efficiency and with lower waste and emission generation. This may be achieved for example, by training the operators or by adding monitoring and control devices to the machinery.
- **Equipment Modification** includes small changes to existing equipment, such as installing drip pans, installing fluid coupling in blenders, pumps activation through level controlling mechanisms etc., which aims at reducing the waste generation caused due to poor equipment design. This may be achieved for example, by training the operators or by adding monitoring and control devices to the machinery.
- Technology Change constitutes the replacement of technology, processing sequence and / or synthesis pathway in order to minimize waste and emission generation during the production process.
- **B. Recycling** is the on-site recovery and reuse of wasted materials and energy. The recovered materials may be either be reused in the same process or used for another purpose.
 - **On-site Reuse and Recovery** includes reuse of the wasted materials in the same process for another useful application within the company (premises).
 - Creation of Useful By-Products is transformation of previously discarded wastes into materials that can be reused or recycled for another application outside the company.
- **C. Product Modification** involves altering of the product in order to reduce waste during manufacturing, use and disposal i.e., during the product life cycle.

Benefits of Cleaner Production

Cleaner Production is relevant to all industries, whether they are small or big, or whether they have a low or high consumption of raw materials, energy and water. For far the most companies, there is a potential of reduction the resource consumption with 10-15% without any big investments!

Overview of benefits:

- Improved production efficiency;
- More efficient utilization of raw materials, water and energy;
- Recovery of valuable by-products;
- Less pollution;
- Lower costs of waste disposal and waste water treatment;
- Improved image; and
- Improved occupational health and safety

Other benefits.....

i) Less use of raw materials and energy

The most convincing benefit of cleaner production is its ability to reduce the consumption of resource and materials. Savings in energy and materials bring direct reductions in production costs, which again make the company more competitive. With increasing cost of raw materials, energy and water, no company can afford to lose these resources in the form of waste.

ii) New and improved market opportunities

Increasing consumer awareness of environmental issues has led to a spurt in demand of green products in the international market. Consequently if you put in conscious efforts towards cleaner production, you open up new market opportunities and produce better quality products, saleable at a higher price.

iii) Better access to finances

Investment proposals based on cleaner production contain detailed information on the economic, technical and environmental feasibility of the planned investment. This gives a very solid basis for achieving financial support from banks or environmental funds.

On the international market, financial institutions are awakening to the problems of environmental degradation, and are now scrutinizing applications for loans from an environmental angle.

iv) ISO 14000 & ISO 50001

Cleaner production will make it much easier to implement an environmental management system such as ISO 14000 and energy management system ISO 50001, because most of the initial work already has been carried out through the cleaner production assessment.

v) Better working environment

Apart from improving the economical and environmental performance, cleaner production can also improve the occupational health and safety conditions for the employees.

Favorable working conditions can boost the morale of staff and at the same time foster a concern for controlling waste. Such actions will help your company gain a competitive edge.

vi) Better compliance with environmental regulations

Meeting the regulatory standards for discharge of wastes (liquid, solid and gaseous) requires often installation of expensive and complex pollution control systems like wastewater treatment plants.

With cleaner production the treatment of residual effluents normally becomes easier and cheaper. This is because cleaner production leads to an all round reduction in wastes: volume-wise; load-wise; and even toxicity-wise!

Cleaner Production Assessment

Requires...

i) Management commitment

A successful cleaner production assessment demands a strong commitment from the manager. It requires the direct involvement and supervision, and the seriousness has to be reflected in actions, not only in words.

ii) Operator's Involvement

Supervisors and operators should be actively involved right from the beginning of a cleaner production assessment. The shop floor staff is of great help in identifying and implementing measures for cleaner production.

iii) Systematic approach

For cleaner production to be effective and sustainable, it is essential to formulate and adopt a systematic approach. Initially, it may be alluring to work on a piecemeal basis as the immediate benefits might be more appealing. However, the interest soon drops if long-term sustainable benefits are not realized.

How to obtain management commitment?

- Estimate the value of resources lost as waste;
- Highlight the environmental (and legal) consequences of this waste generation; and
- Emphasize how cleaner production can improve the current situation.

To be able to identify cleaner production options, it is necessary to carry out a cleaner production assessment.

The cleaner production assessment focuses on:

- WHERE waste and emissions are generated;
- WHY waste and emissions are generated; and
- **HOW** waste and emissions can be minimized in your company.

Cleaner Production assessment is a useful tool to systematically investigate the existing production and to identify opportunities for improving the production or the products.

Six steps towards cleaner production

The cleaner production assessment is carried out in the following six steps:



Cleaner production is an ongoing process. Once finished with one cleaner production assessment, the next should be started to improve even more or to continue with another focus area.

Step:1 Getting Started

First of all the management should be committed to the cleaner production work. The cleaner production assessment will require working hours for gathering information and for developing options. Furthermore, some expenses are likely to occur, e.g. for installation of water meters and for having samples analyzed.

i) Form a cleaner production team

The manager should appoint a cleaner production team to carry out the cleaner production assessment. When doing so, the manager should keep in mind that the members should have the necessary authority, skills and time to carry out the cleaner production assessment.

The project team should consist of representatives from:

- Management level;
- Accounting and/or storage department;
- Production departments; and
- Technical departments, e.g. steam supply section and maintenance department.

Besides, it can be very useful to include external experts in the cleaner production team in order to have a third-eye approach.

ii) List process steps/units operations

Initially, the cleaner production team should make an overview of the entire company by listing all unit operations and their main inputs and outputs.

A detailed and elaborate flow diagram (or activity diagram) should be made. This is necessary to get a proper overview and understanding of the manufacturing process.

Special attention should be given to periodic activities, e.g. cleaning and regeneration, as they quite often are highly wasteful.

The inputs and outputs on the flow diagrams should be labeled appropriately for later reference.

iii) Identify and select wasteful unit operations

Based in the flow diagram and through site-inspection the team should identify wasteful unit operations.

Along with existing data on consumption of resources and materials, this work is the base for deciding the focus of the cleaner production assessment.

The focus area should be selected so it is likely that economically attractive cleaner production options can be identified. Unit operations that result in high losses of materials or products; or where there is a high reprocessing rate should be included in the focus area.

Step:2 Analyzing process steps

During this step detailed material and energy balances should be made in order to quantify the amount of waste, its costs and its causes. The balances will furthermore provide a baseline showing the resource consumption and waste generation before cleaner production.

For the selected focus area(s) the flow diagram(s) should be further elaborated, to ensure that all processes/activities are included, and that all inputs and outputs are listed on the diagrams.

Next, the data for making material and energy balances should be collected. This will require a lot of work and measurements. It can be necessary to install meters to measure the consumption of water and electricity.

Quantifying the inputs and outputs is the only way to identify losses that normally go by unnoticed.

How to make material balance?

- Determine how each input and output can be measured. Plan measurement for a normal production day, or record consumption/waste stream over a longer period.
- If an input or output cannot be measured, make a qualified estimate.

The material balance should be based on actual figures. Figures from work procedures, equipment specifications and other "how-it-ought-to-be" figures are of no use.

Energy balance

Making an energy balance can be even more complicated than the material balance. Instead of making an actual balance it can be very useful to make a survey of the inputs and the losses.

For steam supply system, you need to measure the amount of fuel used, the boiler losses, and estimate the heat losses from poorly insulated surfaces, steam leaks and discharged condensate.

Waste stream characterization

The waste stream characterization consists of three parts:

- Quantifying the waste streams (the figures should be obtained from the material balance);
- Describing the content and the environmental impact of the waste streams; and
- Assigning costs (e.g. value of lost materials and cost of treatment) of the waste streams.

The cost assignment gives a very good picture of how much money is lost with each waste stream. At the same times such figures creates commitment; indicates the potential of savings; and shows how high investments may be to avoid or minimize the waste streams.

Cause Analysis

For each important waste stream a cause analysis should be made with the aim to find the underlying cause for the waste stream.

It is not enough to stay that the cause is "old equipment" or "poor quality". You have to find the specific causes to the waste generation, e.g. "that the raw material contains more than 2% of impurities that are acceptable".

Hence, a very good understanding of the processes and the operation parameters is needed to make a proper cause analysis.

Asking Why?

The cause analysis is based on asking why. The four main questions are:

- Why this waste stream? Why is this step needed?
- Why such a high consumption of materials, chemicals and energy? Why so much waste?
- Why these properties of the waste? Why using this equipment and these process conditions?
- Why discharge? Why not recyclable?

Step:3 Generating cleaner production options

Based on the work made during the previous steps, this step aims at developing, listing and describing workable cleaner production options.

From cause to options

For each identified cause there will be one or more cleaner production options. It requires creativity and knowledge to identify the options.

Group discussion and "brain storming" might enhance the generation of options. A good cause analysis makes it much easier to develop good cleaner production options.

It is worthwhile to consider inviting experts from suppliers or consulting companies to participate in the generation of cleaner production options.

Select workable options

The list of proposed cleaner production options should be reviewed to identify:

- Options that can be implemented directly;
- Options that needs further study; and
- Options that can be rejected because they aren't realistic or feasible.

The options that can be implemented directly should be done so. Keep a list of the implemented cleaner production options to document the achievements of the cleaner production work.

The options that need further study should be evaluated during the next step.

Step:4 Selecting cleaner production options

For the more complicated cleaner production options, it is necessary to carry out detailed feasibility study focusing in technical, economical and environmental aspects.

Technical feasibility

Some of the aspects that should be covered during the technical feasibility are:

- Product quality;
- Production capacity;
- Space requirements;
- Close-down-time during installation;
- Compatibility with the existing equipment;
- Operation and maintenance requirements;
- Need for training; and
- Occupational health and safety aspects.

The following expected benefits are part of the technical feasibility study:

- Reduction in water and energy consumption;
- Reduction in material consumption; and
- Reduction of waste.

Financial viability

The financial viability should be calculated on basis of the expected investments and the expected savings.

Some methods for appraising the financial feasibility are:

- Cost comparison, for alternatives with similar income but different costs;
- Profit comparison: based on the income and the savings of each alternative;
- Return on investment: relates the profits with the invested capital;
- Payback period;
- Net Present Value (NPV); and
- Internal Rate of Return (IRR).

The payback period is commonly used because it is easy and fast to calculate. For cleaner production options that require big investment it is necessary to make a more detailed economical analysis, e.g. NPV and IRR.

Environmental feasibility

For most options the environmental feasibility is obvious; however, it should be evaluated whether any negative environmental impacts exceed the positive aspects.

Select options for implementation

The results of the technical, financial and environmental evaluation have to be combined in order to select the best options. This can be done using the weighed sum method shown below.

Step:5 Implementing cleaner production options

Many low-cost and no-cost options, e.g. repairing leaks, closing running taps or providing training to staff, should have been implemented during the first steps of the cleaner production assessment. It not, they should be implemented as soon as possible.

To be able to document the success of the cleaner production assessment it is very important to keep a list of options that have been implemented.

The remaining options that are selected for implementation should be implemented according to an action plan approved by the management.

It can be necessary to further document the options to obtain this approval or to get adequate funding.

When the options are implemented, it is important to monitor the new resource consumption/waste generation level to evaluate the success of the options.

If cleaner production is to take root and continually be successful, it is imperative that the cleaner production team does not lose momentum after it has implemented a few cleaner production options.

Monitor and evaluate results

Sustaining cleaner production is best achieved when it becomes part of the daily management. Routinely monitoring on company and process level is a key to sustaining cleaner production.

Continuously integrate cleaner production into daily management

Setting up an environmental management system, certified or not, will ensure that cleaner production is maintained on the agenda of the company.

Implementation of an ISO 14000 certified environmental management system can be a valuable continuation of cleaner production.

Cleaner production assessment check list

Step: 1

Step: 4

- Ensure top management commitment:
- Form a cleaner production team;
- List process steps and identify waste streams:
- Prepare process flow charts; and
- Select focus areas.

Step: 2

- Make material and energy balances;
- Characterize waste streams;
- Assign costs and waste streams; and
- Identify causes of waste generation.

Step: 3

- Generate workable cleaner production options; and
- Sort options into: "directly implementable"; "needs further study"; and "rejected options".

- Analyze technical feasibility of cleaner production options;
- Analyze economic viability of cleaner production options;
- Analyze environmental feasibility of cleaner production options; and
- Select cleaner production options for implementation.

Step: 5

- Make cleaner production action plan;
- . Implement the cleaner production options;

Step: 6

- Monitor and evaluate results;
- Report cleaner production results;
- Prepare for a new cleaner production assessment; and
- Continuously integrate cleaner production activities into daily management.

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