

Asia-Pacific Economic Cooperation

Eco-Efficiency in Small and Medium Enterprises – Paper and Printing Industry

APEC Small and Medium Enterprises Working Group

1998

FOREWORD

This Manual has been prepared as a guide for the introduction of eco-efficiency practices in the PAPER AND PRINTING INDUSTRY. It is specifically aimed at small to medium sized enterprises, and provides practical guidance for identifying and evaluating opportunities for eco-efficiency in the workplace.

This manual will help you to identify opportunities for reducing costs and improving environmental performance at your company. This can be achieved through reductions in raw materials and the costs of waste management; creation of marketable by-products, new markets and increased market shares; energy savings, reduced pollution and consent charges, reduced fees and penalties; and worker health and safety.

The Manual is one of a series covering a range of industrial sectors, and has been developed following research conducted under the funding and direction of the Asia Pacific Economic Co-operation (APEC). Other sectors covered in the series include:

- the chemicals and plastics industry;
- the textile industry;
- the steel and metal products industry;
- machinery and electrical equipment industry;
- the leather products industry;
- the vehicle parts and assembly industry; and
- the food and beverage industry.

THIS MANUAL CONTAINS THE FOLLOWING SECTIONS:

1. ECO-EFFICIENCY - MAKING BUSINESS MORE PROFITABLE	P.1
<i>Explains the background to the eco-efficiency concept and the benefits to small and medium enterprises.</i>	
2. ASSESSING OPTIONS FOR ECO-EFFICIENCY IN THE WORKPLACE	P.4
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Outlines the importance of measuring the benefits and maintaining the drive for improvement.

1 ECO-EFFICIENCY – MAKING BUSINESS MORE PROFITABLE

1.1 OVERVIEW AND COST SAVINGS

What is Eco-Efficiency?

The concept of eco-efficiency parallels that of industrial efficiency - or *good business sense*. By reducing waste (here we refer to all types of waste, including time, energy, money and resources), industrial activities can move toward efficient and profitable operation. As a management practice, therefore, eco-efficiency *aims to do more with less*.

Eco-efficiency measures need not incur large financial investment into new technologies or processes, but can often be brought about simply through better housekeeping. In this context eco-efficiency includes *...any initiative or measure undertaken by an industry which results both in reduced environmental impact and increased efficiency and resulting cost savings for the company concerned. Typical examples of eco-measures are waste minimization, clean technology, and the reduced use of energy or materials per unit output. An eco-measure may also be management, process, technology, or production orientated, but will generally not include “end-of-pipe” treatment.*

Eco-Efficiency Saves Money

Cost savings may be immediate financial returns that appear directly on the balance sheet, such as material, energy and water savings. However additional savings may well arise in the future, perhaps from the reduced ‘clean-up’ required for contaminated land. The following shows some examples of eco-efficiency initiatives in the paper and printing industry in Chile and their associated savings.

Eco-Option	Financial Information
In Chile, solvents used for press cleaning were recycled, reducing solvent discharges into the sewer by 10,000 liters per year.	The implementation cost was \$100 pesos per year and savings amounted \$1000 pesos per year.
In Chile, rotary ink was recovered and reused, reducing ink waste to landfill by 660kg per year.	The process change resulted in a financial benefit of \$4400 pesos per year.
In Chile, the fountain solution used in the printing process was replaced with a solution containing fewer volatile organic compounds	In addition to reducing the use of VOCs by 24,000kg per year, the exposure of employees to dangerous

Eco-Option	Financial Information
(VOCs).	vapors was significantly reduced.
1.2 WHY SHOULD YOU BE CONCERNED WITH ECO-EFFICIENCY	

Are You Operating Within the Law?

As economies continue to expand and develop, the regulations adopted by governments to protect the environment will become more stringent and better enforced. Businesses have in the past addressed tougher regulations by using more and more ‘end of pipe’ technologies to reduce pollution. However, these technologies are costly, and often need upgrading to keep pace with the new regulations.

An alternative approach, adopted by more forward thinking companies, is to change their existing practices to eliminate or reduce the wastes they produce. This adoption of eco-efficiency minimizes the for end-of pipe technologies and hence directly reduces costs.

Are You Missing Key Opportunities?

A good eco-efficiency program will identify and exploit the market opportunities associated with good environmental practice. Many firms have discovered new business opportunities as a result of their efforts to solve pollution problems (for example the sale of waste by-products as a raw material to other businesses) and the promotion of ‘green’ products. These opportunities, if properly pursued, can not only offset the costs of the program, but can lead to increased profits

Moreover, effective eco-efficiency programs can identify other opportunities for reducing production costs, meeting customer and supplier requirements, improving worker health and safety, enhancing the company’s public image and preventing potential future liability problems.

How is Eco-Efficiency Linked to the ISO 14000 series?

The International Standards Organization (ISO) 14000 series of standards is the main vehicle defining and supporting the application of environmental management systems (EMS). ISO 14001, the standard appropriate to most manufacturers, requires that an organization identify the “*environmental aspects of its activities, products or services that it can control and over which it can be expected to have an influence, in order to determine those which have or can have significant impacts on the environment.*”

ISO 14001 includes routine internal monitoring of environmental

performance against defined targets for improvement. It is then important to note that the successful implementation of the ISO 14001 standards in many ways parallels or supports particular eco-efficiency objectives, for example to reduce raw material usage and waste production.

ISO 14001 is already required for many industrial operations in Western Europe and in North America. In addition, and with regard to international trade, overseas markets are increasingly making ISO 14001 a requirement of their suppliers, and interest is continuing to increase throughout Asia.

2 ASSESSING OPTIONS FOR ECO-EFFICIENCY IN THE WORKPLACE

This section describes how to go about identifying and evaluating potential opportunities for improving eco-efficiency in your workplace. This process is in principle the same for all types of industry, and consists of four basic steps:

- Step 1 - preparing for the assessment;
- Step 2 - identifying opportunities for eco-efficiency;
- Step 3 - measuring the baseline; and
- Step 4 - evaluating the options.

The key elements of each of these steps are summarized in the following illustration.



2.1 STEP 1 - PREPARING FOR THE ASSESSMENT

Commitment from Senior Management

Like all important business decisions, eco-efficiency requires the full commitment and support of top management for its successful implementation. Before anything else, the management must first develop its strategy for the eco-efficiency assessment. The key factors to be defined by the strategy are the objectives (what management hopes to achieve), the timescale for the assessment, and the resources which will be required (both human and financial). Once these factors have been defined, they can be put forward as an *Action Plan*, which allocates responsibilities to each of the team members.

The Focus of the Assessment

A key element of the *Action Plan* is to define the focus of the assessment, which must be made clear during this preparation stage. For example, the assessment may focus on the whole facility, or perhaps on the operations of just one unit. On the other hand, the assessment may just look at key issues of concern, such as:

- raw material losses;
- wastes that cause processing problems;
- wastes considered to be hazardous or for which regulations exist;
- wastes which are or will be costly to treat and dispose of; or
- high energy consumption.

In whichever case, it is important to use simple flow diagrams of the operations and processes which are being investigated to keep track of the assessment. As a first step, the following information should be collected and reviewed:

ECO-EFFICIENCY ASSESSMENT DATA

- the quantities and costs of raw materials, water and energy;
- the processes that consume high water volumes;
- the processes that generate high wastewater volumes;
- the sources and quantities of each type of waste;
- waste management costs (storage, collection and disposal);
- discharge points of wastewater; and

- points of air emission.

Getting Started

The size of the assessment team will of course depend upon the scale and complexity of the processes to be investigated. A more complicated process may require at least 3 or 4 individuals including technical, production and accounts staff. Informing employees of the aims of the assessment will also help the process, encouraging their cooperation and increasing their employee awareness.

The assessment should be undertaken during normal working hours so that machine operators can be consulted, actual operations can be observed, and wastes quantified.

2.2 STEP 2 - IDENTIFYING OPPORTUNITIES

The following checklist gives a general approach to identifying options for improved eco-efficiency in facilities of all types. Invest a little time in walking around your facility and ask yourself the following questions.

Resource Use

1. Are batch sizes maximized and batches sequenced to minimize unnecessary cleaning and equipment warm-up or cool-down?
2. Could high-pressure water cleaning replace chemical cleaning?
3. Can process chemicals or additives be replaced by less damaging substances or mechanical processes?
4. Can alternative processes produce the same results with fewer resources and less waste?
5. Would overflow alarms for any tanks and vessels produce cost savings?
6. Do your processes have adequate and accurate monitoring and gauging techniques? Are raw materials or additives used in excess?
7. Are you aware of any incidents of production line personnel using more of a particular chemical '*just in case*'.

Waste Management

1. Are you aware of all wastes and can you characterize them in terms of composition and quantity?
2. Are waste materials properly segregated and separately stored for appropriate disposal and possible re-use?
3. Is hazardous waste mixed with non-hazardous waste? If so, are non-hazardous wastes treated by costly hazardous waste techniques?

4. Is packaging and product filler kept to a minimum? Are products combined or condensed to reduce packaging?
5. Are all drums and containers thoroughly emptied before cleaning or disposal?

Material Purchasing and Storage

1. Do you know the shelf life and ordering system for raw materials? Does this affect loss through ageing?
2. Do your suppliers accept the return of outdated supplies? Do they keep their packaging to a minimum?
3. Can materials in store be inspected visually to identify corrosion or leaks?
4. Can materials be contaminated by others in the store? Are containers damaged by forklift trucks, etc?

Re-use and of Recycling

1. Is there any potential for mutually beneficial activities with neighboring industries? Could you utilize their by-products as a material resource, or sell your by-products to others?
2. Could your waste be used as a source of energy, by yourself or others?
3. Could packaging received from your suppliers be returned and re-used?
4. Could the packaging you give to your customers be returned and re-used?

Water Conservation

1. Would high pressure nozzles on hoses save water in cleaning equipment and workspaces?
2. Could taps and faucets be fitted with automatic shut-offs or flow restricters?
3. Is fresh water discharged after a single use? Is there potential to recirculate used water (for example from cooling) for re-use for other purposes such as cleaning?

Energy Conservation

1. Are you familiar with your overall energy profile and quarterly energy consumption levels and costs?
2. Are staff aware of energy issues, eg turning off equipment and lighting if not in use?
3. Are boilers, lights and refrigeration units old and efficient? How long

- would energy efficient plant take to pay for itself in savings?
4. Could more efficient motors replace old and inefficient ones? Are compressed air systems leaky?
 5. How much energy might be saved through the use of better timer and thermostatic controls?
 6. Do you have adequate thermal insulation on heating or cooling lines?

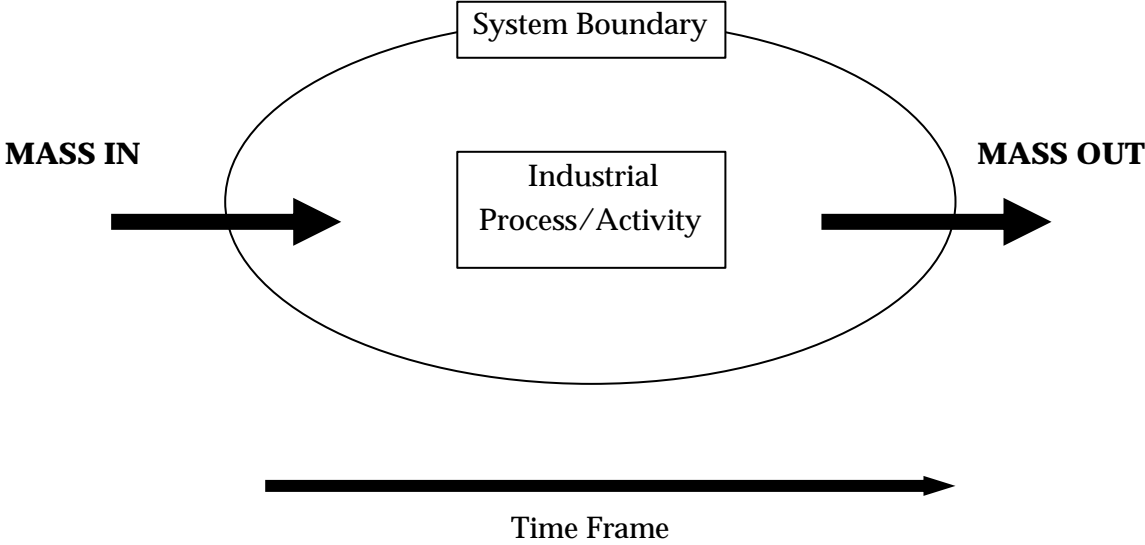
The answers to these questions will help identify where eco-efficiency can be improved, through changes in management or the processes and materials used.

2.3 STEP 3 - MEASURING THE BASELINE

Before eco-efficiency opportunities can be assessed, the current 'baseline' position needs to be quantified. Establishing the baseline situation will allow the benefits of eco-efficiency options (for example to reduce waste) to be quantified, both in terms of environmental improvement and cost savings.

Undertaking a Mass Balance

The simplest way to establish the baseline position is to undertake a *mass balance*. A mass balance measures the quantities of the inputs (raw materials, energy, water consumption, etc) going into a process, and the outputs (finished products, solid waste, effluent and air emissions, etc) which are produced as a result. In addition to measuring quantities, the mass balance is also applied to the associated costs (for raw materials, energy, water, and waste disposal, etc). The concept of the mass balance is illustrated below.



A mass balance can be undertaken to varying degrees of precision and depth. In evaluating eco-efficiency opportunities for small and

medium sized companies, it is prudent to limit the detail of the initial studies of the processes under investigation. Further detail can be added when the most promising areas for savings have been identified. The secret to a good mass balance, however, lies in its systematic and methodological approach.

Measuring Inputs and Outputs

The quantification of the inputs to a process includes two approaches:

- analyze purchasing records for materials and utility bills for energy and water to determine overall quantities involved; and
- measure actual quantities entering the process by counting, weighing or metering.

The output side of the mass balance consists of the same two principles:

- analyze waste disposal records for liquid and solid wastes, effluents, and production records for end products and by-products; and
- measure quantities leaving the process by counting, weighing or metering.

The most common area in which mistakes are made with a mass balance lies within the timescale over the analysis is undertaken. Particular care is needed in choosing an appropriate time period, and this is dictated by whether a continuous or batch process is being considered. For continuous processes, the times of any starts and stops must be accurately recorded. For batch processes, several batches should be measured (perhaps over the period of a week) to give a representative analysis.

Balancing the Inputs and Outputs

In an ideal mass balance, the quantity of materials going into a process equals that which comes out. However to reach such a level of detail is seldom feasible under limited timescales, apart from for very simple processes. Despite this, the mass balance approach still provides the basis for a better understanding of the production process. This in itself is the key to identifying areas of unnecessary wastage and where production processes and their management can improve with real cost benefits.

2.4 STEP 4 - EVALUATING THE OPTIONS

If undertaken systematically, the first two steps of the assessment will

reveal a range of areas in which eco-efficiency can be improved, through both better management and process technology. In order to select the most appropriate option for your business, it is also important to take a systematic approach to their evaluation. Three factors need to be taken into account:

- the environmental performance of the option;
- the nature of the option and its implementation potential; and
- the cost of the option and its payback period.

Such an evaluation will of course include subjective considerations. The following technique, however, can be used to apply a score to each factor.

Environmental Performance

Assessing the environmental performance can be complicated, particularly where different types of environmental effects have to be compared. As a starting point, it may be most practical to consider reductions in waste and the use of toxic substances as below:

- Reduction at source (raw materials, toxins, and energy) - 5 points.
- Resource recovery and in-process - 4 points.
- End-of-pipe recycling - 3 points.
- In-process treatment - 2 points.
- End-of-pipe treatment - 1 point.

Implementation Potential

More than one eco-efficiency option may address the same problem (such as excess water use), however their implementation may involve different levels of complexity. For example, one measure may require substantial changes to existing plant and therefore result in unacceptable delays, where the other (perhaps more costly) option may provide an instant solution. Implementation potential can also be assessed using a scoring system:

- Highly likely - 4 points.
- Medium probability - 3 points.
- Low probability - 2 points.
- Highly unlikely but still worth considering - 1 point.

Cost of the option and payback

Certain eco-efficiency options are high in capital cost and may seem unattractive. However, the savings which arise from the option must also be taken into account when assessing its cost.

Calculating the simple payback period is one useful tool for assessing the cost benefit. The simple payback period shows how soon the option will pay for itself in savings (perhaps two weeks or four years), and is calculated by dividing the total capital investment (equipment and installation costs) by the expected operating cost savings per year (from reduced material, energy, water, labor and waste disposal costs). In the scoring system below, options with a high capital cost but rapid payback should therefore be considered as a *low cost* option:

- No or Minimal Cost - 4 points.
- Low Cost - 3 points.
- Medium Cost - 2 points.
- High Cost - 1 point.

Comparing the Options

Once scores have been attributed to the environmental performance,

implementation potential and costs of each option, they can be more directly compared, as shown below. Those options awarded the highest scores are more likely to be successful.

Modification	Environmental Performance	Implementation Potential	Cost of Option	Total Score
Option A	5	4	4	13
Option B	4	2	1	7

CONDUCTING AN ASSESSMENT – A SUMMARY

- Obtain the commitment and support of top management, to establish a strategy and clear objectives.
- Formulate an *Action Plan* which identifies the focus of the assessment and allocate responsibility.
- Collect documentation, flow diagrams of processes, and relevant data .
- Establish the baseline using a mass balance to measure inputs and outputs.
- Identify opportunities for eco-efficiency through improved management and process technology.
- Evaluate options for using a systematic assessment of environmental performance, implementation potential, and option cost.

3 DEVELOPING PRACTICAL SOLUTIONS

The methodology in the previous section shows how opportunities for eco-efficiency measures can be identified, quantified, and compared to each other for appraisal.

This section describes some of the areas where eco-efficiency measures have been adopted in the paper and printing industry in the past. Basic guidelines are given for the three key areas in which these opportunities are commonly found:

3.1 HOW GOOD IS YOUR HOUSEKEEPING?

Housekeeping is a general term which is used to describe how well the day-to-day activities of a facility are managed. Housekeeping measures are not necessarily technical in nature; they include basic functions such as storage, stock control, record keeping, cleaning and maintenance.

Good housekeeping is essential for making sure that a business is run efficiently. In the same way, good housekeeping is also the first and most essential step to improving eco-efficiency. Housekeeping is therefore the first place a manager should look for opportunities to save resources, reduce waste and prevent pollution. Good housekeeping provides low-cost, low-risk and low-technology solutions for improving eco-efficiency and saving money. Areas where efficiency can be improved, regardless of type of facility, include :

- material handling;
- water and energy conservation;
- equipment inspection and maintenance;
- purchasing and storage; and
- process monitoring.

Improving eco-efficiency through good housekeeping requires involvement from everyone working in the facility. This ensures that all employees understand the role they play, and may require some basic training to raise their awareness. The key messages to promote are that *wherever there is waste there is wasted money*, and that *their actions bear directly on the environment*.

Material Handling

Eco-efficient housekeeping measures for material handling in the pulp and paper manufacturing and printing processes are highlighted below. Such measures not only increase production efficiency, but also reduce energy, water and chemical use and minimize the generation of waste.

MATERIAL HANDLING IN PULP AND PAPER MANUFACTURE

Fiber handling - Keep materials clean and avoid contamination from soil and stones, etc, to minimize silica content. High silica contents in straw and bamboo fibers increase surface hardness and can produce uneven chip quality and inefficient cooking.

Fiber storage - Protect fibers from rain and dust. Pack straw fibers in bales which can be stacked on hard platforms to prevent microbial attack. Always store fibers at suitable moisture levels (eg 8-15% for straw) to avoid self combustion.

Washing and de-dusting - Undertake wet de-dusting and washing prior to pulping. Wherever possible, wash water should be screened and circulated for re-use and passed through a stone trap prior to discharge.

Bagasse fibers - Remove pith to reduce the need for chemical use during pulping and disturbances during washing and papermaking.

De-barking wood fibers - De-barking provides clean and uniform raw material for processing. Where possible use dry de-barking, reducing effluent generation and avoiding the need for bark drying.

Fiber Separation - material sent for defibration or cooking should be of similar moisture content, size, and species, and free from contaminants.

MATERIAL HANDLING IN PRINTING PROCESSES

Drum pressing - Collect and re-use ink from the ink drum presses.

Press cleaning - Extract solvents by wringing or the centrifuge of rags for re-use.

Solvent use - Losses in solvent due to poor use and evaporation can range

from 25-40%. Minimize losses by covering cleaning tanks, closing drain plugs, and avoiding unnecessary solvent use (eg for floors). Increase cleaning efficiency through brushing, ultrasonic, or mechanical agitation.

Color changes - Mix inks according to need, and print batch colors in one sequence to avoid clean-out wastes.

Water and Energy Conservation

The use of water and energy is one of the main environmental impacts associated with the pulp and paper manufacturing and printing processes, and also forms a substantial proportion of production costs.

Opportunities to reduce water and energy consumption include:

- the use of high-pressure and low-volume hoses for equipment cleaning;
- avoiding washing processes, such as wet debarking, where possible;
- the re-use of washing and cooling waters in other processes, using primary and secondary treatment before effluent discharge;
- the dry cleaning of equipment and production areas prior to washing;
- insulating hot surfaces, such as water and liquor tanks, to reduce heat loss; and
- optimized scheduling and control, to minimize the switching of furnaces and ovens and avoiding warm-up times.

Equipment inspection and maintenance

The periodic checking of components (pumps, valves, filters, switches and regulators) will avoid inaccurate dispensing, leaks, filter clogging and off-quality production. Close attention should be paid to common defects such as missing guards, loose electrical cords, and leaks of water, steam and compressed air.

Chemical purchasing and storage

Badly managed purchasing and storage can lead to over-stocking and poor storage, with material lost through aging, spillage and contamination. Proper chemical and ink handling begins with procedures for ordering, purchasing, and storing:

- obtain details about proper packaging, handling, chemical constitution, and control of impurities from the suppliers;
- use packaging designed to minimize spills (most bulk containers are effective);
- registering dates and quantities of all purchases on receipt to minimize surplus and spoilt orders;
- segregate chemicals (eg acidic, flammable, alkali, oxidizer) to prevent contamination;

- use proper racks, storage bins and bulk tanks with dikes or berms to contain leaks;
- store goods away from heavily trafficked areas to avoid container damage; and
- use a vacuum to clean-up powder spills, which under no circumstances should be washed down the drain.

Process monitoring

Product losses in the pulp and paper manufacturing and printing industries can be reduced through better production control, with continuous sampling, measuring, scheduling and calibration. All measuring instrumentation (eg temperature and pressure gauges) should be routinely calibrated.

3.2 TECHNOLOGICAL MODIFICATIONS AND SUBSTITUTIONS

Once the first step of improving housekeeping has been taken, the eco-efficiency assessment can move on to technology modifications and material substitutions. On the whole such changes do require some capital investment, however savings in energy, water and material use can result in attractive payback periods, perhaps within a few months.

For example, newly developed small-scale boilers can burn gas rather than coal, providing more efficient energy generation and reducing emissions of carbon monoxide, nitrogen oxide, sulfur dioxide and particulates, eliminating the need for ash disposal to landfill.

The easiest technologies to implement in the food and beverage industry are often those proven in other industries.

In each case, the design stage (of a product, the process and particularly a new facility) offers the unique and optimum opportunity for making change.

TECHNOLOGICAL MODIFICATIONS IN PULP MANUFACTURE

Spent cooking liquor disposal - There are substantial opportunities for the recovery of both chemicals and waste heat from spent liquor in the chemical pulping process is the implementation of efficient recovery systems for chemical and energy from spent liquor, either by:

- evaporation and concentration of cooking and washing liquors;
- combustion of concentrated liquor in a recovery furnace; and
- conversion of recovered materials into active cooking chemicals.

Spent liquor (particularly from small non-wood mills) may also be used for unconventional energy production; separated into black liquor lignin; used for lignin compounds; or other black lignin compounds.

Bleaching - Limit the emission of chlorinated compounds by reducing lignin content in pulp prior to bleaching, by

- extending the delignification process in cooking;
- pre-bleaching with oxygen under elevated pressure; or
- combining both methods.

TECHNOLOGICAL MODIFICATIONS IN PULP MANUFACTURE

For chlorine-based bleaching systems, use total chlorine free or elemental chlorine free bleaching systems wherever feasible. For example, use oxygen, ozone, peroxides (hydrogen peroxide), or enzymes.

Energy conservation - Reduce energy use by recovering waste heat from effluents and discharges, such as:

- moist air from dryers and hot effluent waters;
- flash steam of digester plants; and
- mechanical pulping processes.

Reduce process heat losses by minimizing transport distances in piping, and monitoring pulp consistency to optimize pumping. Use high efficiency and variable speed drives motors for pumps and fans, belt transport instead of blowing, and low friction suction devices.

TECHNOLOGICAL MODIFICATIONS IN PAPER MANUFACTURE

Closed-system milling - closed system milling uses considerably less water and energy than open systems, and should be adopted where possible. For example, contaminated and uncontaminated flows should be kept separate to allow re-use or proper treatment for disposal.

Sealing water supply - Flowmeters should be installed to monitor the supply of sealing water to pump glands to reduce over supply.

Forming wire and press felt cleaning - Adopt headbox showers, wire return roll showers, and web knock-off showers in place of fresh water

needle jets. Install spray pipes with rinsing devices or self-cleaning systems to avoid fiber clogging.

Dry-end cooling waters - Recover condensates from drying cylinders for re-use as felt cleaning sprays during pressing.

TECHNOLOGICAL MODIFICATIONS IN PRINTING

Offset printing ink - Some inks now use pigments with no heavy metal content, and therefore avoid the generation of hazardous waste which can enter landfill or sludge effluent in paper recycling projects.

TECHNOLOGICAL MODIFICATIONS IN PRINTING

Ink mixing - Automated mixing systems can increase efficiency by reducing over mixing and evaporation losses.

Waste ink recovery - Solvents from waste inks can be recovered through vacuum distillation (at 140°C), filtration, and blending. Recovered solvents can be used for press cleaning, etc.

Equipment cleaning - Reduce consumption of cleaning materials by installing triple counter current systems for mixing vessels, blades, and spatulas. Install ultra-filtration systems to process spent wash water for cleaning around machinery.

Fountain solutions - Some new fountain solutions do not contain harmful isopropyl alcohol or mineral acids, and substitute ethylene glycol by substitution with propylene-based glycol. Harmful vapor emissions are reduced significantly.

3.3 WASTE MANAGEMENT

A cornerstone of good waste management is the segregation (the capture, separation and storage) of different waste streams to allow

material recovery, recycling and re-use. Without segregation, the efficient re-use, recycling and recovery of materials is impossible. It is particularly important where waste streams of one industry can provide the raw material input for another.

In many cases throughout industry two or more companies have developed mutually beneficial programs for using each other's waste materials. Benefits include reduced waste disposal costs, savings in material and supply costs, and revenue generation through marketing reusable materials.

Paper production, for example, can exploit numerous in-process recovery mechanisms. In addition there are opportunities for material exchange with other industries, particularly where bagasse fiber base is used (bagasse pith constitutes a valuable fuel for sugar production).

In the printing industry, reclamation facilities have been established to recycle waste lithographic inks into high quality ink. Similarly, valuable metals can be recovered from metal based pigments. Additional opportunities exist for the direct transfer (without processing) of waste solvents from industries requiring ultra-high-purity solvents (eg the electronics industry) to industries that do not have stringent purity requirements (like the machinery and painting industries). In addition, waste solvents are available through waste exchanges, which could potentially be used as a substitute for print machine cleaners.

The first step in introducing a program to market your by-products is to conduct a facility wide inventory of all potentially reusable products and supplies. Most economies house State Houses for waste reduction who can supply you with information pertaining to recyclers who will buy products, together with information and guidance on existing waste exchanges.

4 MONITORING YOUR PROGRESS

Once measures for eco-efficiency have been implemented, it is critical that progress is continually monitored. This is the key to identifying whether the initiatives are in fact producing the cost savings that were anticipated, and hence whether the objectives of the eco-efficiency program have been met.

In addition, monitoring is the only way to establish whether the performance targets which you have established are being achieved. This information provides the basis for setting targets in the future, and also helps identify where the implementation of subsequent eco-efficiency measures can be improved.

The following gives a simple checklist which can be used to assess the overall benefits of the eco-efficiency program. As mentioned above, this should be supported with more detailed records of material, water and energy consumption, and waste disposal charges.

THE ECO-EFFICIENCY EVALUATION CHECKLIST

Taking all costs into account, have unit costs of production fallen?

Are you still ordering the same quantity of raw materials?

Has there been a reduction in energy costs?

Has unit output remained static?

Have you received the same amount of violation notices?

Are you selling any new products?

Are you selling more of the same products?

Have waste handling and/or shipping costs remained static?

Have waste disposal charges decreased?

Are you discharging less effluent and air emissions?

Is there any reduction in the number or work-related accidents?

Has your program had any effect on the number of worker absentee days?

Is there a lower turn over of staff, perhaps through improved working environment, conditions, and moral?

Overcoming Obstacles and Maintaining Your Program

HELP!!

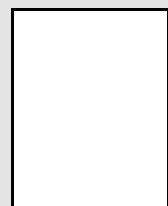
- Contact local government and ask about pollution prevention
- Find out what local and international Trade Associations are doing.
- Local universities and colleges are often eager to participate.

Nearly all eco-efficiency programs depend upon the commitment of you and your staff for their success, continuation and advancement. You must therefore disseminate and publicize stories of success and acknowledge your efforts and their efforts in its contribution. You should also allow for the development and implementation of new ideas and techniques.

GOOD LUCKand avoid conclusions, such as "there are no cost saving or environmental opportunities at my facility".

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