EMP/ENV/MOD. 5

INTERNATIONAL LABOUR ORGANISATION
UNITED NATIONS ENVIRONMENT PROGRAMME

EMPLOYERS' ACTIVITIES

Environmental Training Course for
Employers' Organisations

Module 5
Pollution Prevention Pays

International Labour Office
Geneva

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1. Introduction to the PPP concept

Environmental protection often involves costs to the enterprise. In the first four units, we have analysed the reasons why these costs must be accepted, how to minimize them, how to anticipate and plan for effective environmental protection, how to weigh costs against benefits. In this unit we shall show that, far from entailing costs, in many cases sound environmental management can be a source of profits for the enterprise. The experience of many enterprises is there to prove this (Exhibits 1 to 3). How can this be explained? Are these cases exceptions? Can your enterprise do as well? How is it done?

The key to the apparent paradox

A pollutant is a resource in the wrong place

Example: Most heavy fuel oils contain 2-4 per cent sulphur. Fuel combustion produces, among other pollutants, sulphur oxides (SOx), which cause harmful health impacts, the corrosion of buildings and historical monuments and, through the phenomenon known as "acid rain", major damage to natural ecosystems, such as lakes and forests. Since millions of tons of heavy fuel oil are burnt daily in industry and power stations, tens of thousands of tons of waste sulphur are discharged into the global atmosphere. However, sulphur is also an essential raw material used in many chemical processes. Therefore, if this waste sulphur could be economically converted into elemental sulphur or sulphuric acid, a pollutant would become a resource. This precisely is the objective of EST (environmentally sound technology), also called no-waste or clean technology, briefly described in Module 1. In the present example, how could this be done? Either by extracting the sulphur from the fuel oil before it is burnt ("desulphurisation" process) or by recovering sulphur dioxide (SO_2) from the stack gases after combustion ("scrubbing"). Both processes are used in industry and have their costs and benefits, which need to be evaluated in each case before the investment is decided upon. The present example illustrates the working of PPP by turning the wastes of one process into a raw material of another process.

But the PPP concept is much broader. If a pollutant is indeed a resource in the wrong place, polluting industries must be inefficient, because they use wasteful technology. In fact, this is often the case. Many of today's "problem industries", such as iron and steel, heavy chemicals, non-ferrous metals, etc. are also polluting industries. They are in trouble not because of a depressed demand for their products, but because of more efficient competition, using better and less polluting technology. The reverse is also true: a study of 2,000 enterprises in the United States by the Strategic Planning Institute of Cambridge, Mass. shows that the most profitable enterprises are those which produce specialised products, requiring only a low capital and resource input, but having a high technology and quality ("science") content. We may therefore conclude that pollution prevention and resource conservation can make processes more profitable by making them more efficient.

2. Planning for PPP in the enterprise

On the basis of the successful experience of many enterprises, both in industrialised and developing countries, it is possible to formulate some general criteria and methods on how to set up a successful PPP programme at the enterprise level:

2.1 Objectives of a PPP programme

(a) Reduce wastes and pollutant emissions;

(b) conserve energy and make more efficient use of raw materials and other resources;

(c) promote technological innovation;

(d) reduce pollution abatement and production costs.

2.2 PPP strategies

(a) Product change or redesign;

Example: water-based paints;

(b) modification of the production process and raw materials;

Example: continuous instead of batch process;

(c) redesign equipment and plant layout;

Example: hi-temperature incinerators;

(d) recovery of waste materials for re-use;

Example: solvent recovery.

2.3 Profit opportunities

Increased profits result from:

(a) cutting costs through improved materials efficiency;

(b) using your own manpower and know-how to make improvements, possibly in association with research institutions;

(c) selling by-products or residues (waste exchanges);

(d) selling the acquired know-how to others.

Note: The market for know-how is big and growing. According to the US Survey of Current Business (June 1981) the investment in clean technology in 1981 is estimated at $1,630 million.

3. Implementation of PPP at the plant level - A three-step approach (sponsored by the Dow Chemical Co.)

Step 1. Analysis of current situation

- Process analysis
- Flow sheets, operating conditions and flexibility
- Pipe runs and drains
- Materials balance
- Energy balance

- Water balance
- Legislative trends
- Waste treatment costs (actual and potential)

Step 2. Search for alternatives

(a) For reduced water consumption take measures to:

- Reduce wastage
- Re-use waste waters
- Treat and recycle water in the plant
- Use separate drains
- Substitute recoverable solvents, etc.

(b) For reduced raw material use take measures to:

- Increase conversion rates
- Increase yields
- Recycle materials
- Avoid spillage
- Recycle wastes from other processes
- Reduce wastes, etc.

(c) For reduced energy use take measures to:

- Re-use waste heat
- Couple endothermic and exothermic processes
- Integrate heat and power production
- Reduce temperatures
- Reduce pump and compressor loads
- Reduce heat losses, insulate, etc.

Step 3. Investment decisions

- Examine the effect of the proposed alternatives on the capital and operating costs of the plant (process plants and waste treatment plants), taking into account other benefits.

4. The role of top management

Top management of the enterprise can play a key role in promoting PPP within the enterprise through:

(a) a constructive policy on relations between the enterprise and the community in which it operates and observance of environmental law;

(b) evaluate staff on performance by environmental, as well as economic, criteria and establish an information system to support this evaluation;

(c) plan for emergencies and accidents;

(d) encourage environmental awareness and involve staff at all levels in the PPP programme.

5. The role of production/project managers

(a) Train personnel in the skills needed to apply safety regulations, protection against health hazards and pollution control and prevention.

(b) Assign responsibilities and train in applying hazard management and emergency procedures.

(c) Re-examine existing processes with a view to introducing low-waste technologies to minimise consumption of energy, raw materials and water.

(d) Sell wastes as raw materials and buy wastes as raw materials (look for waste exchanges or markets).

(e) Look for ways to conserve energy (insulation, heat recovery, fuel substitution).

(f) Establish maintenance and good housekeeping procedures and check on their implementation.

(g) Review all stages in a new project, or changes in products, processes, packaging or transportation, for their impacts on health, safety, and the total environment.

(h) Associate the personnel in a consultative process (joint committees): install a suggestions system; establish a regular information system; reward outstanding contributions.

6. Exhibits

Exhibit 1

PPP IN FRENCH ENTERPRISES

Process	Company	Annual savings in French francs (1980)
Recovery of hydro-carbon in an oil refinery	Raffinerie Elf Feyzin (Rhône)	5 356 000
Recovery of methionine mother liquor by evaporation	Soc. Alimentaire Equlibrée de Commentry (Allier)	2 500 000
Recovery of plum juice	Etablissements Laparre Castelnaud de Gratecombe (Lot-et-Garonne)	107 500
Recovery of glycerine in a soap factory	Savonnerie de Lutterbach (Haut-Rhin)	173 300
Water recycling in fibre-board plant	Isorel, Casteljaloux (Tarn-et-Garonne)	250 000
Recovery of iron dust in steel works	Sacilor, Gandrange (Moselle)	800 000
Recovery of whey	Soc. Lacto-Centre Bas-en-Basset (Haute Loire)	726 000
Recovery of protein and potassium from a yeast factory	Soc. Industrielle de la Levure Fala (Silf), Usine de Strasbourg (Bas-Rhin)	155 500
Conversion of phosphoric acid waste	Rhone Progil, Les Roches de Condrieu (Isère)	500 000

Exhibit 2

PPP IN INDUSTRIALISING COUNTRIES

Enterprise	Process	Technology
1. Guangzhou Chemical Works, China	Chlor-alkali cells	(a) Diaphragm cell prevents mercury pollution (b) Waste chlorine is converted to bleach (c) Cell sludge is recycled as rubber filler
2. Kamchai Iamsuri, Thailand	Agricultural complex including 200 t.p.d. rice mill, 10,000 head pig farm, bran oil, 3 million fish farm, poultry, brick works, animal feed plant	(a) Wastes from pig farm converted to biogas (b) Poultry wastes for fish feed (c) Rice husks fuel brick kiln
3. Palm oil industry, Malaysia	Vegetal oil extraction and refining	Fermentation of oily effluent produces high-protein animal feed
4. Rourelka Steel Mill, India	Steel blast furnace	Slag granulation converts solid waste into raw material for cement production

Exhibit 3

RECYCLING TECHNOLOGIES IN AGRICULTURE

Technologies	Residues used with technologies
1. Energy	
Methane fermentation (biogas)	Animal manures, food processing, liquids and solids, crop residues, palm oil sludge, fish wastes, meat slaughtering and processing residues
Pyrolysis	Animal manures, wood-processing residue
Burning	Dried animal manures, wood, forestry residues, bagasse, nut husks, rubber fibre, rice husk, cotton stalks, coconut leaf
Ethanol fermentation	Molasses, sugar cane, cassava
Charcoal	Coconut shell, coconut stem and husk, rice husk
2. Human food	
Mushrooms	Rice straw compost, manure compost
3. Animal feed	
Direct feeding, single cell protein production by microbial or chemical processing	Maize stalk, cobs and husk, coconut meal, cassava residues, molasses, treated straw, rubber seed meal, fish silage, edible oil refining residues, separated fruit and vegetable-processing solids, ensiled manure, blood, feather meal, animal manures
4. Fertilisers	
Nutrients and soil conditioners	Sugar cane filter mud, distillery stillage, manure, rice straw ash, coconut coir
5. Construction material and paper	Bagasse, rice straw, coconut stem
6. Handicrafts	Coconut tree parts
7. Chemicals	
Vinegar, glycerine, furfural, silica, organic acids, activated carbon, glue, by microbial processes	Coconut shell, whey, rubber seed, lignocellulosic residues, molasses, cassava pulp, palm oil refining residues
8. Water	
For irrigation re-use through mechanical, chemical and biological treatment	Agro-industrial wastewaters

Adapted from: F. Walker, UNEP Industry and environment, Jan./Feb./Mar. 1980.

7. Cases

7.1 The Dow Chemical Company[1]

The Dow Chemical Company has found that many of its items of expenditure on pollution control ended up as very good investments in that they have resulted in net savings to the company. Much of this expenditure was for process changes which resulted in the saving of resources formerly lost to the air or water. Among the examples quoted by the Chairman of the Board of Directors of Dow, at Dow's Midland plant, were 28 cooling towers installed at a cost of $7.2 million to re-use cooling water. These gave better operating efficiency and lower water costs and resulted in a 10 per cent return on investment and, of course, reduced thermal pollution of the river. The Dow Corning Corporation, Hemlock, Michigan invested $2.7 million to recover chlorine and hydrogen previously lost to the atmosphere, and achieved savings in operating costs of $900,000 a year. Hercules spent $750,000 on reducing the solids discharged into the Mississippi river and is now saving $250,000 yearly in material and water costs as a result. Dow's Midland Division saved $6 million in the last three years alone on materials which were previously lost to the sewers. Seven pollution-control projects have been installed in Dow's 14 latex plants around the world at a capital cost of about $2 million and are expected to cut operating costs by almost $2 million per year. Through a project to save chlorinated solvents now being developed, Dow's Freeport, Texas, plant expects to save $100,000 per year with an initial capital investment of only $125,000.

Some results achieved at the Dow Corning plant at Midland, Michigan:

Acid reclamation

Two of Dow Corning's plants reclaim major sulfuric acid streams that were previously disposed. This action has eliminated the need to treat between 1-2 million gallons of acid annually. Additionally, the acid reclamation has eliminated the following items each year:

- purchase of about 7.5-15 million pounds of waste water treatment chemicals;
- hauling of about 40 million cubic yards of sludge; and
- burial of about 10 million cubic yards of salt.

Reduced acid usage

One Dow Corning plant recently reduced the amount of acid required in a major processing unit by nearly 1 million pounds annually. This was accomplished by installing on-line process analysers and has resulted in annual savings of about $250 million. An added benefit has been the elimination of subsequent waste water treatment and a major salt discharge to the environment.

Acid reclamation

Another major unit at one Dow Corning plant reprocesses waste acid into a usable material. This process has eliminated about 5 million pounds of acid from the plant sewer annually.

By-product recovery

Two major chlorosilane waste streams present at several Dow Corning plants are now processed into usable materials. This process reduced the previous waste streams by more than 75 per cent and provides a net benefit of about $3 million annually.

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[1] Abstracted from M. Royston: Pollution prevention pays, op. cit., and D. Meyer, Manager, Environmental Control Dept., Dow Corning Corporation, Midland, paper presented at a symposium in Winston Salem, N.C. in 1982.

Catalyst recovery

Essentially all catalyst used in chlorosilane manufacture is now recovered and ultimately re-used.

Brine production and sales

Two significant hydrocholoric acid waste streams at one Dow Corning plant are now converted to a calcium chloride brine and sold for snow removal and dust control. Nearly 1 million gallons of brine are sold annually.

Spent solvent reclamation

Nearly two-thirds of all solvent used by Dow Corning is now collected and reclaimed - either internally or externally. The external sales from one plant alone generate more than $250 million annually.

Baghouse dust

One air pollution control baghouse collector captures more than 15 million pounds of fine particles annually. Whereas this material was once totally landfilled, uses for the material have been developed, and a substantial portion of the dust is pelletised, bagged, and sold. Landfill costs have essentially been eliminated and sales revenues more than offset incremental handling costs.

Vent recovery system

The installation of a central vent recovery system at one plant reduced the emission of corrosive gases by more than 90 per cent from a major process. The recovery system works by cooling and condensing the vapours and recycles usable material back into the process.

Process modification

A single process waste stream at one plant was responsible for about 33 per cent of the plant's total oxygen demand in the treatment plant. Restructuring the process essentially eliminated this waste from the effluent and saved the plant in excess of $300 million annually by avoiding treatment costs.

Vent recovery system

Dow Corning's Hemlock, Michigan plant invested $2.7 million to recover chlorine and hydrogen and achieved savings in operating costs of $900 million a year.

By-product sales

The total waste stream from one major process is now purchased and used beneficially by an unrelated company. The material is generated at a rate in excess of 2 million pounds per year, and the net savings, considering the sales and waste treatment and disposal avoidance costs, approaches $100 million annually.

Wood-fired boiler

Dow Corning will start up a new power plant at its main plant in Midland this summer burning waste wood as its primary fuel. The system will also maximise thermal efficiency by cogenerating both steam and electricity. Rated at 275,000 pounds of steam per hour and 22.4MW electricity, the unit will cost about $30 million and has an attractive payback.

The boiler will burn in excess of 150 million tons of wood chips (dry basis) each year, which is equivalent to 600,000 barrels of oil. One of the unique features of the new system is that at least 75 per cent of its wood fuel will be obtained from scrap or waste sources such as landfills and sawmills. The new boiler will use a substantial resource that would otherwise be wasted.

PCBs

The 1979 ban on the manufacture, distribution, and use of PCBs enhanced an existing product opportunity for Dow Corning. A silicone-based fluid has become a widely accepted and environmentally safe alternative to PCB or askarel fluids in the electrical equipment industry.

Major activity in the past has centered on the new equipment market. But Dow Corning has just developed a new technology to decontaminate existing electrical transformers and will commercialise this breakthrough on 1 July 1982. The new system, in combination with a silicone fluid retrofill, will lower the PCB content in a transformer below the mandated 50 ppm limit.

Dow Corning's approach to handling the waste from the transformer retrofill programme speaks strongly to its commitment to product stewardship and pollution prevention. First, Dow Corning will provide cradle-to-grave tracking on all system components and silicone fluid even though not legally required to do so. Second, the wastes from the system will be incinerated notwithstanding the fact that current regulations allow landfilling. Incineration clearly offers a walk-away solution when compared with burial. Third, Dow Corning is now assessing the feasibility of recovering and re-using as much of the silicone fluid as possible. The destruction of any re-usable fluid represents, in the eyes of executive management, an unacceptable waste of natural resources and energy.

The retrofill programme, in short, provides a solution to a major part of the PCB problem by using a much safer product, extending the useful life of transformers, minimising long-term liability through incineration, and maximising re-use of available material.

Procedure

One effective method used to assess and control waste is through a capital authorisation process. Any new or significantly modified process must, of course, receive capital funds for construction. But before capital funds are authorised, the approval of the Environmental Control Department is needed. In addition to Environmental Control, Safety and Industrial Hygiene Department signatures are also required before executive management will consider the authorisation request.

An equally effective procedural concept has been the establishment of an Environmental Control Technology Center composed of individuals skilled in process technology, operations, research, environmental studies, and regulations. This group systematically examines our manufacturing technology and process development efforts from an environmental perspective to determine ways of eliminating waste generation, identifying waste recycling opportunities, or altering wastes to make them suitable for re-use. Each year opportunities are identified and projects initiated in co-operation with plant personnel to achieve improvements at various manufacturing locations.

Summary

The effects of Dow Corning's programme of pollution prevention at the source, and recovery and re-use have been substantial. At the Midland, Michigan plant alone, which is the most diverse of all of Dow Corning's 24 world-wide manufacturing sites, the value of recovered products, including disposal avoidance charges, exceeded $8 million in 1981. Further, pollutant levels in the chemical process sewer have been reduced over the past decade about 50 per cent and 80 per cent, respectively, for total dissolved solids and total oxygen demand. It is significant that these reductions have occurred at the same time that production has increased.

Pollution prevention does pay. It is a programme that is technically stimulating and very rewarding. Moreover, it offers a unique opportunity for the environmental professional to enhance the environment and contribute positively to the company's bottom line. The above examples should act as a challenge to industrial participants to examine their own processes and develop new technologies which are both clean and profitable.

7.2 North British Distilleries Ltd., Edinburgh, UK[1]

Another interesting case relates to Scottish whisky distilleries. In the late 1950s it became clear that the quality of many Scottish rivers and the salmon fishing which depended on it were being adversely affected by the discharge of effluents high in suspended solids and BOD[2] from the many whisky distilleries situated on their banks. Given an ultimatum to stop polluting or to close down, the distilleries began to examine various ways of treating their effluents. Given the high suspended solids derived from malt husks and protein and the high BOD derived from sugar, starches and soluble protein, the cost of treatment threatened to be prohibitive. On further examination, however, it appeared that the various components of the wastes - husk, sugar, starch, protein, fat, yeast vitamins - would, if dried, make a high-quality cattle feed. It was decided, therefore, to invest in evaporating and drying plant to convert the effluent into animal feed. The operation proved successful and, much to everyone's surprise, the benefits not only covered the treatment costs but the process actually made a profit.

One of the most recent installations is at the North British Distilleries Co., Ltd. in Edinburgh. This plant takes the distillers' spent wash at 2 per cent total solids and evaporates it to 40 per cent total solids, the evaporation rate is 280,000 lb/hour of water, and the plant uses mechanical vapour recompression to achieve high thermal efficiency. The plant consumes 1900 kW at 33 kV, 400 kW at 440 V and 15,500 lb/hour of steam at 120 psig. Processing costs in an analogous case, using more electricity and less steam, are as follows:

Evaporation 275,000 lb/hour.

Utilities consumption

Steam	7 900 lb/hour at £1.25 per 1 000 lb.
Water	7 000 gal/hour at £0.08 per 1 000 gal.
Electricity	2 575 kW/hour at £12.50 per MWh.

Utilities cost

Steam	£9.97 per hour
Water	£0.56 per hour
Electricity	£32.17 per hour

Total utility cost per 7,500-hour year is £312,000.

Approximate plant capital cost is £602,000.

Capital charges at 20 per cent depreciation and 15 per cent interest are £211,000 per annum.

Hence processing cost per annum is £513,000.

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[1] M. Royston, Pollution prevention pays, op. cit.

[2] Biochemical oxygen demand.

Revenue from sale of £20,000 tons per annum of dark grains (dry weight) at £60 per ton is £1,200,000 per year, i.e. a profit of £687,000 per year or a return on investment of over 100 per cent per year. It has been reported that by-product recovery operations reduce the pollution potential of the wastes by 50 per cent.

Considering how profitable this waste treatment has turned out to be, it is surprising that the distilleries did not adopt it of their own initiative long ago.

7.3 3M Corporation, St. Paul, Minnesota, USA[1]

Perhaps the most outstanding example of the successful application of non-waste technology or a resource conservation programme which tackles pollution at its source and hence provides both ecological and economic pay-offs, is that of the 3M Company and its so-called 3P programme, "Pollution Prevention Pays". The programme was initiated as a result of an inquiry by Raymond H. Herzog, the 3M Board's Chairman and Chief Executive Officer, on trimming the costs associated with environmental protection. The environmental engineering and pollution-control department responded by suggesting that certain cost savings could be made by the promotion of resource-conservation technology. This was accepted and then sponsored throughout the 3M organisation. The 3P programme has four basic aspects: the reduction of pollution through product reformulation, through process modification, through the redesigning of equipment and through recovery of waste material for re-use. The pay-off associated with the programme was considered to be a better environment, conserved resources, improved technologies and reduced cost. The four criteria which were used for judging whether a given project could become part of the 3P programme were: firstly, that it should eliminate or reduce a pollutant; secondly, that this reduction should bring about reduced energy consumption, more efficient use of raw materials and/or of other natural resources; thirdly, that it should include some innovative feature; and fourthly, that it should bring about monetary benefit to the 3M Company, through reduced or deferred pollution control or manufacturing costs, increased sales of existing or new products or by reduction in capital or expenses.

Projects in the US plants of the 3M Company which have brought about major savings include the following: the elimination of hydrocarbon wastes from a reactive coating process resulting in a saving of $2 million, the reduction of odour in a high conversion polymer process resulting in a benefit of $1 million, elimination of hydrocarbon pollution from a 100 per cent solid coating process resulting in benefits of $3 million, reduction of chromium pollution from a chromium six process resulting in the benefit of $80,000, reduction of water pollution from a cooling-water recycle system resulting in a benefit of $200,000, reduction of dissolved solids and hydrocarbons through the reformulation of a chemical process resulting in benefits of $1.15 million, reduction of sulphur dioxide and particulates by improvement of an incinerator design resulting in benefits of $175,000, reduction of zinc salt effluent through a re-use system resulting in benefits of $55,000, reduction of hydrocarbon effluents from a polymerised coating process resulting in benefits of $100,000, reduction of wet scrap through the redesigning of a spray booth resulting in benefits of $125,000, reduction of alcohol in an effluent as a result of process modification bringing benefits of $35,000, elimination of the heat needed to incinerate scrap through re-use of the product, resulting in benefits of $500,000, the production of waste water and sludge by recycling white water, resulting in benefits of $56,000, the reduction of a photo-reactive hydrocarbon by changing the solvent in a degreaser, resulting in benefits of $24,000, elimination of the loss of Freon propellants through their replacement with other materials, resulting in benefits of $100,000, avoidance of various hydrocarbon effluents in such different processes as mixer reflux systems, high solid coating and modified polymer coating, resulting in savings of over $1 million and the elimination of pollution by mercury through reformulation of a resin, resulting in benefits of $330,000. In the 3M Company's Australian operations, the reduction of formaldehyde fumes achieved by modifying a process brought about a saving of $350,000, the reduction of solvent pollution by going to a water-based system resulted in savings of $45,000 and in another case the replacing of solvents by water resulted in a saving of $27,000 as a result of cheaper adhesives and cheaper production wastes. In the United Kingdom, 3M operations are also submitted to the 3P approach and have resulted in savings of £98,000 due to the elimination of organic solvent vapours in one instance. Other projects involving lower adhesive usage saved £45,000. In another instance

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[1] Abstracted from M. Royston: Pollution prevention pays, op. cit., and R.H. Susag, Director of 3M Environmental Operations, paper presented at a symposium in Winston Salem, N.C. in 1982.

the substitution of a water-based adhesive for a solvent-based adhesive brought about a reduction in expenditure of £36,000 per annum. A reformulation brought about reduced material costs of £45,800 per annum plus reduced steam consumption of £40,000 per annum. In another instance the reduction of formaldehyde losses enabled the process cost to be reduced by £21,200 per annum. In another case by a modification of curing ovens to improve their thermal efficiency, sulphur dioxide emissions were reduced and the fuel bill was reduced by £79,000 per annum. Other instances in the UK involve the reduction of waste water with a saving of £10,540, and the changing of a material which had previously been causing pollution resulting in a raw material saving of £18,000 per annum. The replacement of zinc oxide by calcium carbonate reduced pollution from the land fill and also resulted in material cost savings of £25,000. The co-ordination of waste disposal and the establishment of market outlets for reject material resulted in credits against manufacturing costs of £63,000. Improving the capability to reclaim film material and re-using it resulted in material savings of £23,000 per year plus an unmeasured reduced disposal cost. There are many other instances not only from the 3M Company's UK operations but also from their operations all round the globe.

3P results

Let us look at the 3P results. Since the programme began in 1975, a total of 144 3P projects have been recognised in the United States. A total of 456 smaller 3P projects have been recognised by 3M companies in 20 countries outside the United States.

The combined total of 600 3P projects has resulted in eliminating the discharge of more than 125,000 tons of air pollutants, 4,000 tons of water pollutants and 12,000 tons of sludge - along with the prevention of over 900 million gallons of wastewater.

In addition, the 3P programme's annual energy savings are estimated at the equivalent of 228,000 barrels of oil. Cost savings to 3M total more than $100 million. These costs are for pollution control facilities that did not have to be constructed; for reduced pollution control operating costs and for retained sales of products that might have been taken off the market as environmentally unacceptable.

Each year, the results have been better. Last year in the United States, for example, there were 42 3P projects - the most yet.

These 42 projects, all demonstrating technical accomplishment, eliminated the discharge to the environment of approximately 28,500 tons of air pollutants; 1,300 tons of water pollutants, 6,900 tons of sludge and solid waste and 39 million gallons of wastewater. The energy savings equalled 56,000 barrels of oil.

The 42 projects resulted in a $30 million savings for 3M. Included in this figure are $7 million for unnecessary pollution control facilities; $21 million in raw material and operating costs; $1 million in additional energy savings and $1 million for retained sales of products that might otherwise have been taken off the market as environmentally unacceptable.

Last year's 3P projects included five increased solids coating modifications; five solventless coating improvements; two product curing changes; an incinerator efficiency improvement; five solvent recovery processes; the cross venting of a sand mill; two cleaning solvent recovery methods; two resin reformulations; three substitutions of toxic raw materials; three hazardous cleaner substitutions; an improved coating process that reduces two coatings to one; a product cleaning change and a resin application modification.

I also can report that our 3P programme is doing well so far this year. One of the very latest projects that has been submitted for consideration is a wastepaper recycling project that involves several of our facilities in Minnesota.

So far, over a five-year period, more than 11,000 tons of wastepaper have been recycled, saving the equivalent of nearly 200,000 trees - a small forest. We have saved $240,000 in landfill costs - not to mention valuable landfill space - and earned more than $1 million from sales of the used paper to paper mills.

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Module 5

Summary

The PPP concept (Pollution Prevention Pays, not to be confused with the other PPP - the Polluter Pays Principle), is based on an approach to pollution as an expression of inefficiency. The term pollution is used in the broad sense, i.e. not only the emission of pollutants and wastes, but also the waste of resources (raw materials, energy, water, etc.). Therefore pollution prevention equals waste prevention, greater efficiency, hence is economically profitable to the enterprise. To apply this concept to the management of the enterprise, its objectives, strategies and opportunities are defined. A PPP programme at the plant level is implemented by a three-step process, which involves management and staff at all levels. The respective roles of top and operational management are defined, and a policy of staff involvement is recommended. The exhibits illustrate the results achieved in enterprises from various sectors in an industrialised and in industrialising countries and the technologies applied to make profits from agricultural wastes. The case studies describe in some detail the PPP programmes of three large companies.

Lesson plan

(a) Introduction to the PPP concept - Section 1 of the module — 10 minutes

Stress the wasteful aspect of loosing materials and energy to the environment. Use Exhibits to raise interest - explain terms. Ask for participants' views and experiences of waste prevention.

(b) Planning for PPP in the enterprise - Section 2 — 15 minutes

In presenting the strategies (2.2), explain that PPP may require technological innovation in some cases, but often can be achieved by better housekeeping, maintenance and tighter control of resources, in brief by better management.

With regard to the sale of by-products and residues, explain the role of government in promoting recycled materials in substitution for imported or scarce raw materials.

(c) Implementation of PPP at the plant level - Section 3 — 15 minutes

Explain that the three-step approach is of general application, although the particular structure presented is characteristic of a chemical process plant. Explain the terms and give examples for each step.

(d) The role of top management - Section 4 — 10 minutes

At the policy-setting level, PPP requires a long-term commitment. At the executive level, a PPP focal point or programme co-ordinator of high rank may be required.

(e) The role of production/project managers - Section 5 — 10 minutes

Points 5(a), (b) and (f) are part of good management practice in general, but they are also a prerequisite to PPP.

5(c) and (e) involve some or all of the steps indicated in section 3, but the initiative is often taken by the operational manager, possibly in response to suggestions received from his staff (see point 5(h)).

Point 5(g) does not imply a full EIA (see Module 2), but some of its techniques could be usefully applied.

(f) Cases - Section 7 — 20 minutes for each case

Allow ten minutes for reading of each case, respond to questions of clarification. This is followed by a general discussion.