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**ALLOCATION OF ENVIRONMENTAL COSTS  
IN ENTERPRISES OF CHEMICAL INDUSTRY**

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*Allocation of environmental costs to appropriate product, department (production centre), or activity (process) is highly significant for managerial decision making. The knowledge of environmental costs and their transparency represent starting data for a lasting evaluation of the efficiency of products, production centres and processes and for responsible planning of products and activities. The paper shows and compares different approaches to allocation of environmental costs in enterprises of chemical industry.*

**Introduction**

Enterprises of chemical industry are aware of a need to manage impacts of their activities, product and services on the environment. Environmental costs management has definitely its significant role within environmental management. Environmental costs comprise the costs of steps taken, or required to be taken, to manage the environmental impacts of an enterprise's activity in an environmentally responsible manner, as well as other costs driven by the

environmental objectives and requirements of the enterprise. Examples include costs of disposal and avoidance of waste, preserving or improving air quality, cleaning up oil spills, removing asbestos from buildings, searching for more environmentally-friendly products, carrying out environmental audits and inspections, etc. This paper is dealing with issues of allocation of environmental costs in enterprises of chemical industry. It shows changes in an approach to allocation of environmental costs in the 1990s, which were evoked by a distinct grow of environmental costs and an effort of enterprises to monitor, evaluate and improve environmental performance.

Environmental costs are often treated as overhead costs in accounting systems of chemical enterprises. Overhead costs can include, for example, these environmental costs: costs of monitoring and measuring of contamination, labour costs of internal auditors, costs of waste disposal, operating costs of end-of-the-pipe technologies, environmental pollution fees, etc. Environmental costs are mostly indirect costs. They are not, therefore, allocated to an appropriate object (product, department, activity) directly. They refer to several objects and so they are allocated by using cost-allocation bases (allocation keys).

When environmental costs are allocated correctly to the products, departments and/or activities that cause them, an enterprise can motivate managers and employees to search for alternatives for prevention of pollution or to suggest such actions that would lead to decreasing of environmental costs and increasing of profitability. Environmental costs management then leads to improving of environmental performance of an enterprise, to increasing of environmental quality, and to improving of enterprise's economic results.

### **The 1<sup>st</sup> Approach - Environmental Costs as a Part of Overhead Costs**

The 1<sup>st</sup> approach of environmental costs allocation was based on the following principle: a lot of environmental costs were treated as overhead costs (manufacturing overhead, administrative expenses). Overheads were allocated to products, departments and/or activities according to cost-allocation base chosen by an enterprise. Let us introduce a very simplified case of this environmental costs allocation. Figure 1 shows an accounting system in which environmental costs are together with other items (for example: management salaries, rent, other administrative expenses, etc.) a part of overhead costs. Let us assume that the enterprise produces two products — product A and product B. Overhead costs are allocated to products in a ratio that relates to consumption of direct labour and direct material for the production. Toxic waste is an output of production of the product B. Costs of toxic waste disposal are, however, a part of overhead costs. Then it is evident that in this case a part of toxic waste disposal costs is allocated to the product A, which does not cause them, and therefore should not be liable for

them. The result of such allocation procedure is a distortion of actual costs of products A and B.

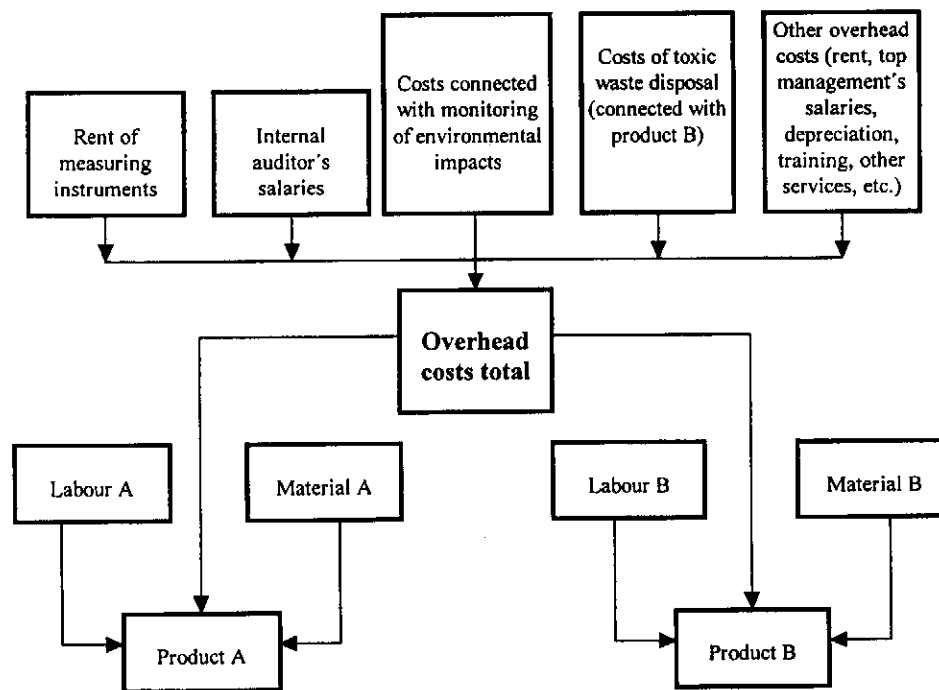


Fig. 1 Allocation of environmental costs (environmental costs are treated as overhead costs)

Considering the above mentioned case, it is clear that allocation of overhead costs to appropriate objects results from incorrect base. Costs of particular objects are determined inaccurately — some objects are charged more than it would be appropriate, whereas other objects bear lower costs than corresponds with reality. The result of such allocation procedure is an incorrect cost accounting of individual products, which projects in product's profitability. Also pieces of information about costs of a particular operating departments, plants and/or activities are incorrect. Information about a product's, plant's, or activities' contribution in environmental pollution is erroneous as well. In such cases, accounting system does not provide correct information for the decision making that would aid seeking after new ways to reduce enterprise's costs and to improve environmental performance.

Let us introduce an example of the above-mentioned approach (Fig. 2). Let us assume that the enterprise produces two products — product A and product B. Production process is realised in three production centres. There are 4000 kg of raw materials as an input of the production process. This amount of raw materials is used to produce 500 kg of the product A and 500 kg of the product B. Solid

waste substances and liquid wastes are formed during production. Solid waste (total amount of 800 kg) is disposed in end-of-the-pipe technology — incinerator of solid waste. Liquid waste is cleaned in a waste water treatment plant. Volume of waste water corresponding with the production is 2200 kg (2.2 m<sup>3</sup>). Table I shows waste flows connected with production of products A and B.

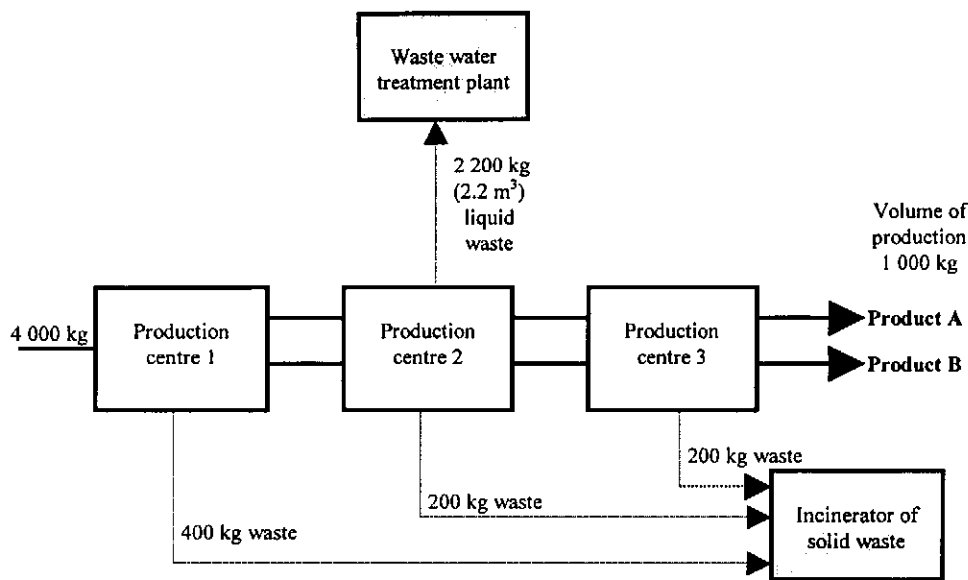


Fig. 2 Production process scheme

Table I Waste flows connected with production of products A and B

|           | Production centre 1 | Production centre 2   | Production centre 3 | Total                 |
|-----------|---------------------|-----------------------|---------------------|-----------------------|
| Product A | 200 kg solid waste  | 200 kg solid waste    | 100 kg solid waste  | 500 kg solid waste    |
|           |                     | 2 200 kg liquid waste |                     | 2 200 kg liquid waste |
| Product B | 200 kg solid waste  | -                     | 100 kg solid waste  | 300 kg solid waste    |

It is necessary to expend the following direct costs to produce 500 kg of the product A (it is the same for 500 kg of the product B):

- material 196 000 monetary units,
- labour costs 12 000 monetary units,
- other direct costs 4 200 monetary units.

Manufacturing overhead costs for 1 000 kg of products are 40 110 monetary units. Environmental costs of incinerating of solid waste and waste water treatment are included in manufacturing overhead costs. The total of all environmental costs is 20 110 monetary units. On the assumption that we will proceed according to previously used methods, and cost-allocation base to allocate manufacturing overhead costs to products A and B will be volume of labour costs, then calculation of total (direct and indirect) manufacturing costs (in monetary units) for the whole production volume will be following for products A and B:

| Product A                        | 500 kg         | Product B                        | 500 kg         |
|----------------------------------|----------------|----------------------------------|----------------|
| Material                         | 196 000        | Material                         | 196 000        |
| Labour costs                     | 12 000         | Labour costs                     | 12 000         |
| Other direct costs               | 4 200          | Other direct costs               | 4 200          |
| Manufacturing overhead costs     | 20 055         | Manufacturing overhead costs     | 20 055         |
| <i>Total manufacturing costs</i> | <i>232 255</i> | <i>Total manufacturing costs</i> | <i>232 255</i> |

### **The 2<sup>nd</sup> Approach — Differentiation of Environmental Costs and Their Twofold Allocation to the Production Centres and Cost Carriers (Products)**

Since the 1990s the environmental costs have increased significantly. Enterprises have appreciated the importance of information about environmental costs. In connection with implementation of upgraded information systems the enterprises have been interested in the problem of the environmental costs allocation.

At this stage, enterprises have paid attention primarily to allocation of environmental costs, which have reached considerably high values. In enterprises of chemical industry such costs are operating costs of end-of-the-pipe technologies (waste water treatment plants, incinerators) and environmental pollution fees. Significant environmental costs are separated from overhead costs and are allocated first to the responsible production centres and then to products. Separation of environmental costs from overhead costs and their corresponding allocation to production centres and products give the management a clearer and better overview of the centre's costs and of total costs of particular products.

Figure 3 demonstrates the allocation of operating costs of environmental cost centres (the example illustrates environmental costs allocation on the basis of the production process scheme — see Fig. 2). The 1<sup>st</sup> step shows allocation of the costs that are caused by operating of end-of-the-pipe technology (it is a cost centre), to production centres that created the waste flows. The 2<sup>nd</sup> step represents costs allocation from production centres to the cost carriers (i.e. products).

The incinerator of solid waste and the waste water treatment plant are the cost centres. Total costs of the incinerator, adequate to processing 800 kg of waste, are 20 000 monetary units. Costs of total amount of disposed liquid waste are 110 monetary units.

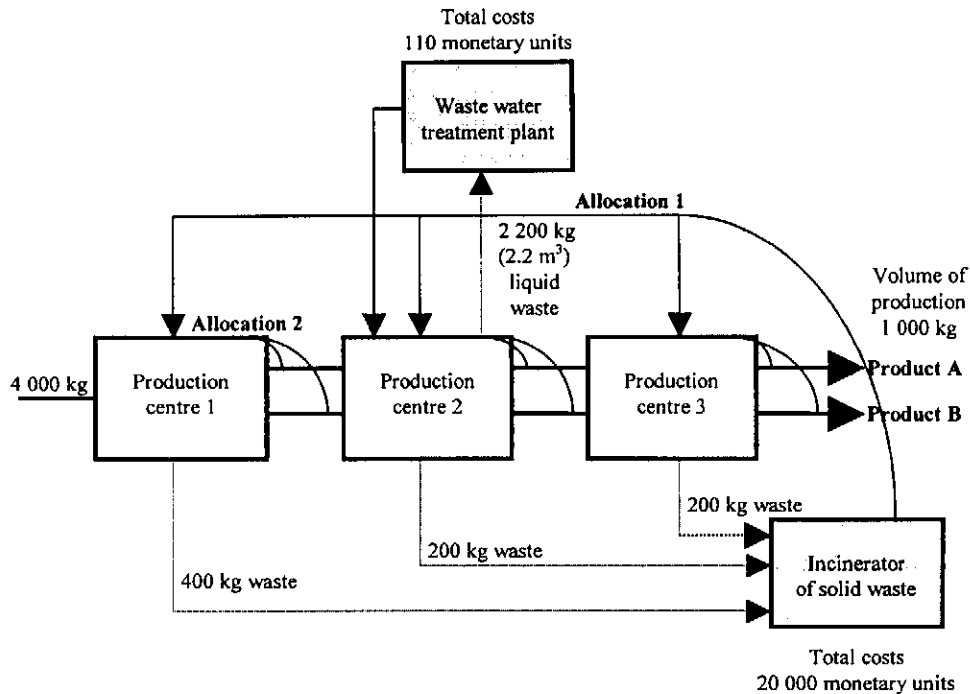


Fig. 3 Allocation of costs of the environmental cost centres

For the 1<sup>st</sup> step of allocation of costs related to disposal of solid waste, it is necessary to know not only total costs of incinerator but also to review if incinerated wastes of different kinds cause the same costs. In our example we assume that incinerating of 1 kg of waste of any kind causes same costs, i.e. incinerating of 1 kg of waste costs 25 monetary units. Therefore, after the 1<sup>st</sup> step of the costs allocation, considering the mentioned conditions costs of incinerating of solid waste are in particular centres following

- production centre 1            10 000 monetary units,
- production centre 2            5 000 monetary units,
- production centre 3            5 000 monetary units.

A different situation is encountered in allocation of costs caused by waste water treatment. Due to formation of liquid waste in the production centre 2, costs of waste water treatment plant are allocated only to this centre.

Environmental costs after the 1<sup>st</sup> step of allocation are, therefore, in

particular production centres following

- production centre 1 10 000 monetary units,
- production centre 2 5 110 monetary units,
- production centre 3 5 000 monetary units.

Allocation of environmental costs to products A and B comes in the 2<sup>nd</sup> step.

When allocating of environmental costs to products, a cost-allocation base should reflect costs of waste treatment (incineration and purification in our example). Waste was formed by production of products A and B in the particular production centres. It is clear that the amount of environmental costs related to particular products generally depends on the volume of waste formed during the production, on the type waste and on the way of waste disposal.

Let us assume that in our example production process of products A and B causes formation of solid and liquid waste streams in particular centres in the volume described in Table I.

If we allocate monetary units to waste streams based on the previously mentioned conditions (cost of incinerating of 1 kg of solid waste is 25 monetary units, cost of total waste water treatment is 110 monetary units), then environmental costs allocated to product A are 12 610 monetary units and to product B 7 500 monetary units (see Table II).

The above-mentioned environmental costs then appear in calculation of total manufacturing costs of products A and B in calculation items: costs of incinerating of solid waste and costs of waste water treatment. Calculation of total manufacturing costs (in monetary units) for the whole production volume of products A and B will be following

| Product A                              | 500 kg         | Product B                              | 500 kg         |
|--|----------------|--|----------------|
| Material                               | 196 000        | Material                               | 196 000        |
| Labour costs                           | 12 000         | Labour costs                           | 12 000         |
| Other direct costs                     | 4 200          | Other direct costs                     | 4 200          |
| Environmental costs:                   | 12 610         | Environmental costs:                   | 7 500          |
| ✓ Costs of incinerating of solid waste | 12 500         | ✓ Costs of incinerating of solid waste | 7 500          |
| ✓ Costs of waste water treatment       | 110            | ✓ Costs of waste water treatment       | -              |
| Other manufacturing overheads          | 10 000         | Other manufacturing overheads          | 10 000         |
| <i>Total manufacturing costs</i>       | <i>234 810</i> | <i>Total manufacturing costs</i>       | <i>229 700</i> |

## Comparison of Both Approaches to the Allocation of Environmental Costs

The examples given demonstrate inaccuracy of calculation of total manufacturing costs if operating costs of environmental cost centres are a part of manufacturing

Table II Environmental costs of products A and B (in monetary units)

|           | Production centre 1 | Production centre 2 | Production centre 3 | Total  |
|-----------|---------------------|---------------------|---------------------|--------|
| Product A | 5 000               | 5 110               | 2 500               | 12 610 |
| Product B | 5 000               | -                   | 2 500               | 7 500  |
| Total     | 10 000              | 5 110               | 5 000               | 20 110 |

overhead costs and direct labour is used as a cost-allocation base. A correct calculation expects that data, that are taken over and then processed are credible. However, credibility of calculation can never be absolute because complexity and large heterogeneity of real cost flows is an objective cause of implementing a large number of costing methods directly connected with accounting and cost planning. Actual costing has a significant importance in management. Rationality of producing a particular product is verified on the basis of calculation. And evaluation of final profitability and efficiency is based on comparison of particular types of calculations.

Now we can demonstrate the following points by this example:

- separating of environmental costs from overhead costs and their allocation to production centres and then to products give more accurate information for costs management — adding of items, which record data about significant environmental costs, into costing table and into intra-enterprise reporting provides important information for management by products line, departments line or activities,
- information about environmental costs included in calculations has an important role in management of impacts of products, activities and services on the environment; the information is used by management, costs analysts, technicians, design engineers, constructors, research workers and other interested parties,
- the information about environmental costs is a base for project assignment and actions to reduce costs and to improve environmental performance of an enterprise.

It is fundamental to choose a proper cost-allocation base (allocation keys) to acquire adequate information about environmental costs. It is also important that the allocation key should be closely connected to real environmental costs. In



practice, the choice of keys to allocate environmental costs is, from our experience, influenced by volume of emissions, solid waste and waste water treated, their toxicity and induced relative costs of treating different kinds of emission.

In order to be able to properly allocate operating costs of environmental cost centres, it is necessary to obtain information about flow of material, water, energy and the waste, that is created together with products. We have to know the volume and environmental impact of waste flows in accordance with reference to usage of facilities for waste disposal, regulation of contamination, and the level of difficulty to their decomposition. The detailed and accurate information about waste flows in all states can be obtained by monitoring with the use of measuring instruments. This solution is, however, a very expensive business in many cases and also in a large number of cases the measuring instruments are not available.

When allocating environmental costs, we must consider whether any exceptional event happened in a period for which allocation is made, for example, an accident in any facility. Consequences of an accident should be definitely assigned to the department that caused such accident, and should not be redistributed to all departments.

The second step of an allocation can be questionable in some chemical enterprises. From our experience, costs are allocated to products, for example, according to proportion of gross sales of a particular product in gross sales of whole production centre. Cost-allocation base should, however, reflect costs of disposal of the waste that was caused by products. The amount of environmental costs assigned to particular products generally depends on the volume of waste created, its type and the way of its disposal.

To conclude, we can say that the cooperation of economists, technologists and environmentalists is necessary to correctly allocate environmental costs. Environmental costs associated with several objects should be allocated only after realising a comprehensive analysis. Its output should be a base according to which appropriate objects are assigned the costs that correspond with their contribution. In enterprises of chemical industry environmental costs certainly belong among those items that significantly influence economic result of an enterprise and its financial situation, therefore; it is necessary to pay enhanced attention to them.

## References

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