Strategies in industrial chemical waste management

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According to the commonly accepted definition, the term waste is attributed to any material or object unusable in a given place and time. This in turn means, that the concept of waste is a subject of evaluation by a specific user in a given place and time.

Any material or object possessing utilisable qualities is not considered waste.

Activities aimed at granting utilisable qualities to waste, described as recovery or recycling, from the standpoint of the importance of aims for waste management are placed as secondary. The primary aim is to prevent waste production, and the third and last aim is neutralisation. Land-filling falls within the third category, but concerns only solid waste – liquid and gaseous waste, after being deprived of substances harmful to people or the environment, are released to the environment. Therefore waste management concerns solid waste, including solid waste produced in the purification of liquid and gaseous waste.

Resource application analysis has been carried out in the USA [1] – products are made from 6% of resource mass, lasting products – 1%. The rest consists of waste in various forms. Waste management requires adopting common procedures. Such an adoption should be undertaken due to risk for human life and well-being and supporting current environmental state, due to waste's quality, in case of direct release to the environment, of being a reason of dire losses and dangers to people, plant and animal life. An appropriate example would be the pollution of water and air. At the same time, due to the costs of safe waste storage and the need to ensure it's even decomposition, it is necessary to sign international agreements on the subject.

The most important among such agreements is the international Basel Convention pertaining to trans-boundary movement and disposal of hazardous waste[2]. Also worthy of note, are actions taken by the OECD, including control over waste transport and creation of internationally agreed upon standards, for economically reasonable waste management. One, among many, aim of such actions is the reinforcement of institutional and extra-institutional capabilities of controlling waste management in developing countries. The European Union contributes to the creation of an international-level control system through it's policies and especially through it's regulations concerning waste transport. The aim of both is to ensure a high level of environmental protection.

European Union Strategy[3] describes a coordinated approach to matters related to preventing waste production, due to which policies concerned with prevention will concentrate on reducing environmental impact, and will also set boundaries for detailed national policies. Actions in the matter of preventing waste production must be undertaken on all administrative levels.

On the European level, a directive concerning integrated pollution prevention and control (IPPC) and integrated product policy may substantially contribute to preventing waste production.

Referential documents detailing the best available techniques (BREF) developed within IPPC provide useful information on the subject of waste production prevention. These aspects of BREF should be reinforced, while Member States, the industry and other concerned parties should exchange information on optimal techniques on a more regular basis. Finally, the European Commission plans on a reevaluation of designing boundaries for ecological design initiatives within the boundaries of an integrated product policy.

However, most of the preventive measures will have to be undertaken on the national, regional or local level. This may include aims concerned with the matter of waste production prevention. The boundary directive concerning waste will be subject to changes- specifically to explain the duties of Member States in matters of evaluating waste production prevention programs available to the public, in the context of balanced production and consumption.

Within the states of the European Community the main tool for estimating the impact of technical procedures and installations on the environment is the IPPC directive[4], the aim of which is to obtain an integrated method of proceedings for control and prevention of environmental pollution. The directive introduces a term of environmental quality norm, which includes a set of conditions, which must be fulfilled in a given time by the environment or part thereof. On the fulfillment of these conditions depends whether permission is granted for technical installation operations. The directive details types of installations, for which such permission is required. In terms of chemical industry installations, the list contains almost every aspect of the industry. Relevant requirements for installations and processes can be found within document of the European Commission [5] abbreviated as BREF. These documents are published online at: http://eipcb.jrc.europa.eu/reference/sic/htm.

When attempting to evaluate an installation or technical process, from the environmental or economical standpoint the ECM [6] document may be used, which concerns economical issues and installation impact evaluation methodology – the level of environmental protection in general, or any of it's constituents – air, water and ground surface. This document was written while taking into account the possibilities of introducing technical solutions ensuring the improvement of installation performance within the environment, including the use of BAT (*Best Available Techniques*) recommended in BREF. Proceedings recommended by this document may help in assessing the degree of IPPC directive conditions' fulfillment, but are not binding at law. A schematic procedure for evaluating the possibility of BAT use is shown at Fig.1.

Proceeding according to ECM (*cross-media methodology)* may be broken down into four stages:

1. Determining the range and identification of possible alternative solutions for the process, which are available and may be introduced under the existing conditions. These solutions pertain to elements concerned with the IPPC directive.
2. Accounting for waste release (sewage, gases), waste, resource consumption, energy, sewage.
3. Potential harm to people and the environment (*cross-media effects*): toxicity to people, global warming effect, toxicity to water ecosystems, acidifying of soil, eutrophication, ozone depletion, photochemical ozone formation.
4. Interpreting contraindications for each alternative.

Each possible alternate route requires similar proceedings including the cost estimation of modifying the installation- both pertaining to investments and operation.

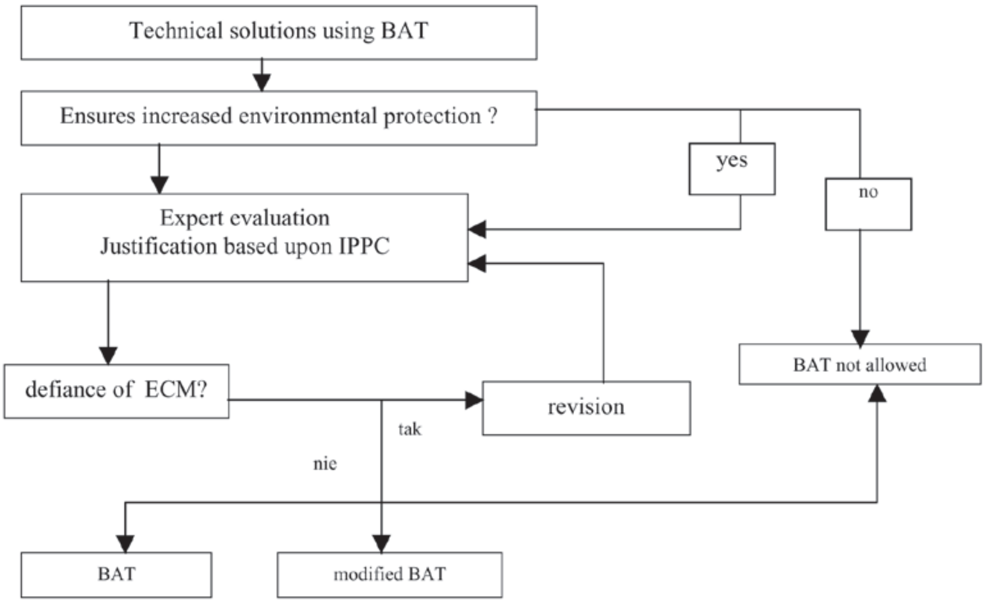

Fig 1. Evaluation progress for possible BAT introduction

The inorganic chemical industry wastes are created in significant quantities in the production processes of inorganic compounds which involves the use of mineral resources. Some examples are the production of phosphoric acid from apatite, or sodium industry. In the first case - with the most common technology - using sulfuric acid to decompose of calcium phosphate into phosphoric acid and gypsum – the amount of gypsum per 1 ton of P_2O_5 is 4 to 5 ton [7]. Gypsum production in the European Community countries is 3080 thousand t/y in 17 plants. In 14 of these plants have the technology using sulfuric acid is deployed. Only two of these plants (Belgium) have recipients for some waste phosphor-gypsum, other plants store phosphor-gypsum waste in landfills. According to BREF [7] two plants in the Netherlands discard of phosphor-gypsum waste to sea, which is currently the subject of an international ban.

Production of phosphoric acid in Poland is 600 thousand t/y, including 560 thousand t/y with application of sulfuric acid (Police, Gdańsk, Wizów). The significant market share of Polish procedure indicate that the cost of handling phosphor-gypsum waste in Poland is particularly favorable. It seems appropriate to examine the role of the individual components of cost of production of phosphoric acid in Poland, with particular attention to environmental protection costs - in this case the long-term costs arising from the impact of phosphor-gypsum landfills on the environment and costs of irreversible land use. In many cases, the organization of the production of phosphoric acid in the vicinity of the extraction of raw materials is observed (Mauritania, Syria, Israel). It is important, although difficult for economic reasons, to take steps towards the use of this material.

The second case, which can be mentioned, is the production of sodium industry. The production process of sodium carbonate, due to the persistent imbalance demand for sodium and chlorine compounds, and the use of sodium chloride as the cheapest raw material, is still dominated, by various variants of the Solvay process. Waste in this process is calcium chloride, which is the subject of storage. Production of 1ton of sodium carbonate creates 1.5 - 1.7 ton of calcium chloride. Well soluble in water $CaCl_2$ is stored in the vicinity of Soda Plant in landfills in the form of pools in the depressions of land, where it is supplied in the form of sludge. These are the so-called “white mud” characterized by the typical total lack of vegetation and animal habitats. The high solubility of these wastes in water requires the special handling with regard to precipitation water and groundwater, which raises the costs of landfills maintenance. In a few cases the waste can be stored in underground storage, but because of the requirements of integrity and immutability of the geological conditions, they may be only the residue after extraction of the salt by leaching method. Despite this, there are no changes of the technological process preliminary because of the lack of demand for chlorine. In this situation, the question arises whether to seek solutions to increase the demand for chlorine or as a last resort, to find a different type of waste that contains chlorine, but is less dangerous for the environment. Here illustrative is the example in Germany during the Second World War-the growing demand for sodium hydroxide and restricted imports, forced German industry to expand production of NaOH by electrolytic method, but to get rid of chlorine winidur (PVC) was created.

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