WASTES AND PROBLEMS OF SUSTAINABLE DEVELOPMENT

M.G. Berengarten
Department of Industrial Ecology, Moscow State University of Environmental Engineering, Moscow, Russia

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Summary

Problems of sustainable development are connected with problems of industrial and domestic waste formation. Processes of resource consumption and waste formation lie in inevitable connection with the state of the environment because consumption depletes natural resources and waste formation furthers pollution of the environment. The general approach to the problem is here analyzed in line with the concept of sustainability. The consumption of natural resources -- soil, water and air -- is to be realized under conditions that provide their preservation for future generations. Wastes are the leavings of raw materials, intermediate products and other products that, not being end results of the production process, have been formed as by-products or have lost their consumption value partly or fully. Various features of wastes may be used to classify them: aggregative state, cause of waste formation, stages of production cycle,

chemical composition, classes of danger, methods of waste application and various others. The author points out possible methods for the recycling of typical wastes: paper rubbish, waste wood, textile wastes, used automobile tires, exhaust oil products and oily wastes, polymeric wastes, mercury-containing lamps, ash-cindery wastes, and solid domestic wastes.

1. Introduction

Problems of sustainable world development are in close connection with problems of industrial and domestic waste formation. The functioning of any industrial, agricultural or service enterprise such as a plant, restaurant, hotel, workshop, or supermarket sees everyday consumption of a serious volume of raw materials and energy followed by the formation of material and energy wastes. The same situation is the case in a private house or apartment, when the consumption of energy and material resources is inevitable and also followed by the formation of wastes. Human and animal living functions are also the cause of waste formation.

Processes of resource consumption and waste formation lie in inevitable connection with environmental conditions. Consumption depletes natural resources, and waste formation causes further pollution of the environment. Of course, nature can provide the Earth's population with material and energy resources and anthropogenic waste neutralization, but these capabilities are limited. Attempts are being made to solve the problem of waste and its uncontrolled, unsystematic storage by serious forces of nature renovation.

It is reasonably well known that in 1847 in England a law was passed about the improvement of urban conditions: it commanded the discharge of solid wastes into the rivers to avoid the pollution of the cities. When this happened, insoluble wastes formed diluted solutions that were transported by water flows to seas and oceans. Wet-waste nutrient biogenic elements hit the circulation system. Fortunately, some of the wastes, including potentially dangerous ones, were neutralized by various microorganisms of water ecosystems.

However, if one compares the levels of economical development and urban population in the middle of the nineteenth century with those of today, one understands the absurdity of such a practice under contemporary conditions. Even at the beginning of the twentieth century such an approach was to be followed by a catastrophe in river ecosystems. Consequently the problem of waste must be solved by other methods.

Various countries have their own legal base dealing with the problem of waste storage. There is also experience in the sphere of waste recycling, storage and disposal. General approaches to the problem need to be analyzed in line with the concept of human progress. Consumption of natural resources, soils, water and air needs to be realized under conditions that provide their preservation for future generations.

Volumes of waste formation are very significant. For example, in 1998 the volume of industrial production waste formation in Russia was estimated at 2.8 tons annually. More than 90 percent is waste from the processes and recycling of mineral products.

Among other types of large waste one should mention the following: ash wastes of heat power plants, metal scrap and black metal wastes, metallurgy ash, wood waste, phosphorous-gypsum, paper and oil garbage, pyrite slimes, sulphite alkalis, polymer wastes, broken glass, and textile wastes. The volume of such wastes in Russia is over 35 million tons annually.

Practically all the megalopolises are large-scale waste "producers". For example, Moscow – the capital of the Russian Federation -- forms more than 3 million tons of industrial wastes and 2.5 million tons of sanitary wastes annually. The population of Moscow (including visitors) doesn't exceed 10 million, so that means that every tenant of the city "produces" more than 500 kg of various wastes each year.

The example sited above indicates that the volume of waste formation is comparable to the output volume of some mineral products that often exceed several million tons annually.
Many types of wastes are very dangerous for the environment, and urban and country population because of high toxicity. Even the storage or entombment of such wastes without appropriate safety measures may be followed by serious problems for nature and people, with ecological damage. This is particularly important in the case of radioactive and explosive wastes, highly volatile toxic agents. At the same time some of the wastes are neutral in their chemical and physical composition and may be buried or channeled into seas and oceans.

The problems of waste formation and use are urgent. It's necessary to remember that in the rational use of raw materials and energy production and consumption wastes may be considered as really valuable sorts of material or energy-recoverable resources. The "output" of such resources is not accompanied by special geological investigations, establishment of mineral industry plants, or the transportation of technological and energy resources across large distances. Wastes as recoverable material and energy resources are formed mostly in large industrial centers, precisely where there are principal possibilities of their reapplication as raw or energy materials.

Wide use of the wastes as recoverable materials could not only solve the problems of environmental pollution but also provide the material base with necessary resources. For example, in Russia in the 1990s under the conditions of transition economy, the volume of investigations in the sphere of searching for various types of deficit mineral deposits was reduced. The input of mineral reserves was lower than that necessary to compensate the reserve output. The fact that wastes include practically all the substances, all the known chemical elements, allows us to regard these wastes as a real or (in some cases) potential base from which to obtain necessary material resources.

Waste chemistry is, of course, different from the chemistry of natural mineral resources. In some cases the concentration of the components that it is necessary to extract from waste is lower than in natural materials but in some cases it is higher. The chemical compositions which contain various valuable components may also differ from the analogous states of natural materials.

Under a formal approach, all the types of waste are an assemblage of one or several

chemical compositions which by various technological means, particularly by chemical transformations, may be converted to necessary desired products. Many types of waste may be applied to energy production without environmental pollution instead of traditional fuels such as gas, oil or coal. In European countries the deposits of waste make it possible to provide villages and towns with energy and heat due to biogas escape.

In some cases, production of several types of marketable products from recoverable raw materials (wastes) is relatively simple and cheaper than from natural raw materials. For example, energy consumption of aluminum production from recoverable raw materials is 20 times lower than that from natural raw materials. For steel the analogues figure is 10 times lower. In addition, often the investments into the recycling of recoverable raw materials are 3–4 times lower than those into the production of natural ones.

2. Classification of Wastes

Contemporary knowledge about wastes makes it possible to define them in the following way:

Wastes are the leavings of raw materials, intermediate products, and other products that, being not end results of production process, have been formed as by-products or have lost their consumption value partly or fully.

The production or consumption wastes line is identical to that for a multiplicity of various industrial or agricultural products. For the better analyzing of wastes it is pertinent to divide them into various groups. Depending on their basic features one can distinguish several various approaches to the classification of wastes. Application of these said approaches can offer solutions concerning the management of wastes under urban conditions.

The features best suited to classifications of wastes are the following:

- by aggregative state
- by cause of wastes formation
- by the stages of production cycles
- by chemical composition
- by classes of danger
- by the methods of waste application.

2.1. Classification by Aggregative State

Like all the other chemical agents, wastes may be divided into gaseous, fluid and solid (or solid agents-bearing) ones. Many types of waste are multiphase systems -- slimes and pulps, for instance

Gaseous wastes are either collected by cleaning systems (in which case they are most commonly transformed into fluid [solute] or solid [adsorbed] condition) or are injected into the atmosphere. In the latter case a problem of gaseous waste is transformed into a

problem of environmental protection from dangerous gaseous emission.

Wastes in fluid state may get caught up in features of canalization or storm discharge. In this case these problematic wastes are followed by the problem of drainage cleaning.

In all other cases the solution of the problem lies in recycling, utilization or neutralization of industrial, agricultural and sanitary wastes or in their burning.

2.2. Classification by Cause of Waste Formation

According to how they are formed, wastes are divided into two big groups: production and consumption wastes.

Various flow processes are practically always followed with the formation of production wastes. In the said situation several types of waste may be formed. First and foremost these are the butt of raw materials that have lost their consumption value and aren't in line with technical standards, and also the butt of sources, materials, and semi-manufactured goods concerning production or service processes. In some cases such wastes may be returned to the production process (or applied to another production process) after extraction from mixtures.

Wastes are also by-products that are formed under the application of technological processes, and not themselves relevant to those particular end results. Production wastes include enclosing and access-way rocks that are formed under the process of natural mineral extraction, and agricultural wastes. Many by-products may, however, be used as end-products themselves elsewhere.

Consumption wastes are various used products and materials that have lost their consumption value because of physical attrition or obsolescence. There is a difference between the wastes of industrial production and domestic consumption. *Wastes of industrial production* are failed machines and equipment, industrial units made of metal, wood, glass, rubber, plastic and used oil products, reagents, catalysts, etc. *Wastes of domestic consumption* are cast-off domestic units or units of private consumption. Consumption wastes also include solid wastes that are formed as a result of human life activity.

The assortment of various technical units for domestic use is permanently growing. These are refrigerators, washing machines, TV sets, tape recorders, computers, various lighting and heating units, etc. But none of these technical units operate for ever. In due course all units or their components deteriorate. In these times of technical progress many units soon become obsolete because of the appearance of new, better models.

Every day, through food consumption and other activities, solid garbage is formed. This includes, for example, polymer packaging of food products, glass, metal and paper. Cooking is always accompanied by the formation of food wastes. The reconstruction of apartments, houses, industrial enterprises, city streets or other urban territories form garbage to be collected by municipal services.

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Biographical Sketch

Michail G. Berengarten was born in Izhevsk, Russia in 1946. From 1964 to 1975 he was a student, post graduate, and then research engineer at the Moscow Institute of Chemical Technology after D.I. Mendeleyev. He investigated the mechanism of ammonia synthesis catalysts promoting action. In 1973 he was awarded the degree of candidate of science.

From 1975 he has worked at the Moscow Institute of Chemical Engineering – MIChM (now called the Moscow State University of Environmental Engineering) -- as assistant, senior lecturer, and professor. He has investigated the sphere of industrial chemistry, environment protection, industrial ecology, and methodical problems of learning in technical universities.

He is the author of the textbook *Basic Chemical Engineering with Practical Application* (Mir Publishers, Moscow, 1988), and over 80 other books, papers and patents.

From 1994 to 1999 he worked as the International UNESCO Chair in Ecological Clean Engineering. From 1999 he has been the Vice-Rector of Moscow State University of Environmental Engineering and Head of the Industrial Ecology Department.