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Valery NESTERENKO,
Belarussian State Politechnical Academia, Belarus

ENVIRONMENTAL EDUCATION AND TRAINING OF ENGINEERS IN THE FIELD OF INTEGRATED WASTE MANAGEMENT

1. Introduction

At present as a result of industrial processes and the expansion of human activity, an increasing accumulation of waste is taking place all over the world. At the same time the amount of non-renewable natural resources is decreasing at a rapid rate. However, a considerable proportion of waste can be recycled and re-used. In connection with this, the problems of dealing with production and consumption waste have gained major economic and socio-political value over the past few years. The improvement of the ecological situation, as well as an increase in the efficacy of economic development and social stability of society, depends on the solution of these problems.

It is commonly known that the realisation of the concept of waste free production is the basic way of solving a problem of global importance – the rational use of natural resources and environmental protection against pollution from industrial and agricultural waste. The constantly increasing problem of solid domestic waste (SDW) needs a solution now in the majority of countries.

These problems are also relevant to the Republic of Belarus [Conditions of the Envionment in Belarus, 2000; Nesterenko et al., 1998]. The Republic of Belarus is one of the 14 countries situated in the drainage basin of the Baltic sea. So solving the problems of environmental protection of Belarus is also very important for the Baltic region.

2. Method of approach

In 1999 24.4 mln tons of solid industrial waste (IW) was created on the territory of Belarus. This was 5.6% more than in 1997. The level of waste utilisation was only 16.7%. The majority of non-utilised IW was removed from factories to dump polygons (77.9%), while the rest was taken to SDW dumps (21.6%) or left of the factory territory (0.5%). The annual formation of SDW is about 20 mln tons [Conditions of the Envionment in Belarus, 2000].

The differences in the volumes of formation, utilisation and discharge from different regions in the Republic of Belarus are presented in Table 1.

The Minsk region has the greatest volume of waste (87.1%). This is due to the operation of the "Belaruskalij" PO plant. In 1999 the percentages of total industrial waste produced in the other regions were as follows: Gromel 5.0, Grodno 2.6, Mogilyov 1.3, Vitebsk 0.8, Brest 0.7. In the Minsk and Gromel regions unutilised industrial waste was in general removed to SDW polygons. The amount of waste stored and accumulated by firms and on state terrains increased in 1999 by 2.2% to 684.6 mln tons from about 660 mln tons. 660 mln tons was stored in Minsk, 16.9 in Gromel, 2.1 in Rechiza and 1.4 in Grodno. The structure of waste in Belarus is given in Tables 2–5.

About 800 types of industrial waste are defined. Figure 1 presents the total amounts of waste produced in 1999. Halite waste and clay-saline waste form the majority of such waste (79.8%). Other wastes of mineral parantage also form a significant proportion of waste, together with waste products from the food-processing industry, hydrolysing lignin and industrial garbage. The level of utilisation of waste remains low and accounts for 5.1% of halite waste, 0.0% of clay-saline slimes, 3.1% of phospogypsum and 29.1% of hydrolysed lignin.

Industrial garbage is removed to storage places. Products from the food-processing industry is characterised by a high level of utilisation (81.8%), as is waste from animal breeding (99.8%) and burnt soil (96.2%).

The dynamics of the formation and removal of industrial waste in the Republic of Belarus as a whole is shown in Figure 2. The amount of waste produced fell significantly in 1993, but since then there has been an upward trend. The percentage of waste utilised over this period was almost constant.

As mentioned before, in 1999 the annual formation of IW was about 2.4 mln tons and SDW 2.0 mln tons. The amount of class 1–4 toxic waste in was about 1.5 mln tons. Non-utilised waste from production and consumption are routed to 80 IW dumps and more than 180 SDW dumps. They occupy a total area of 2950 ha. SDW dumps occupy an area of

Table 1. Formation, usage and waste discharge in the Republic of Belarus [th. tons]

Region	Volume of waste produced		Volume of waste utilised		Waste discharged		Volume of waste at the end of the year	
	1995	2000	1995	2000	1995	2000	1995	2000
Brest	110.0	209.0	59.8	142.0	117.0	70.0	98.5	406.0
Vitebsk	208.3	193.0	76.2	117.0	144.8	94.0	585.5	257.0
Gomel	756.8	1174.0	320.9	466.0	465.2	708.0	17509.9	20739.0
Grodno	445.7	614.0	104.8	439.0	424.0	217.0	1688.8	1475.0
Minsk	17543.3	20762.0	2773.8	2169.0	15081.4	18612.0	594421.6	680357.0
Mogilew	285.4	309.0	149.2	238.0	140.5	75.0	4671.9	357.0
Total	**19349.5**	**23261.0**	**3484.7**	**3571.0**	**16372.9**	**19776.0**	**618976.2**	**703591.0**

Source: *Information and statistic about environmental and ecological protection in the Republic of Belarus*, 2001.

Table 2. Waste from vegetable and animal parentage

Type of waste	Volume of waste [th. tons]		
	1995	1999	2000
Food production waste	—	291.0	372.0
Food product waste	—	220.3	375.2
Timber waste	282.8	306.5	456.0
Hydrolysed lignin, hydrolysed slime	175.0	301.7	274.2
Waste from production of paper and cardboard	—	15.9	12.9
Total	**457.8**	**1135.4**	**1562.0**

Source: *Information and statistic about environmental and ecological protection in the Republic of Belarus*, 2001.

Table 3. Waste from inorganic mineral sources and waste from their recycling products

Type of waste	Volume of waste [th. tons]		
	1995	1999	2000
Waste from metallic ores and furnaces	—	249.3	461.7
Overburden	—	1466.2	1309.9
Burnt ground and waste from core moulding sand	—	496.6	127.4
Waste from concrete, flint gravel, calcareous waste and buffing materials	—	83.4	60.1
Phosphogypsum	56.5	450.6	312.2
Mineral slimes	—	125.0	96.9
Ferriferous dust	—	22.7	25.6
Total	**56.5**	**2893.8**	**23993.8**

Source: *Information and statistic about environmental and ecological protection in the Republic of Belarus*, 2001.

Table 4. Waste from chemical production

Type of waste	Volume of waste [th. tons]		
	1995	1999	2000
Galvanic slimes and waste from halite	13969.9	17459.8	16656.2
Slimes of halite clay-saline	302.0	2017.4	1975.3
Waste from mineral acids and alkalis	—	12.1	10.5
Waste liquors	62.3	73.7	78.8
Waste from crude oil production	—	25.0	25.3
Waste from organic solvents and paintwork materials	—	3.7	3.3
Total	**14334.2**	**19591.7**	**18749.4**

Source: *Information and statistic about environmental and ecological protection in the Republic of Belarus*, 2001.

Table 5. Waste from industry, similar to solid domestic waste

Type of waste	Volume of waste [th. tons]		
	1995	1999	2000
Industrial waste, similar to domestic garbage	304.6	433.7	494.6
Slimes from water preparation	—	13.8	13.9
Slimes from waste water treatment	591.9	165.2	158.5
Plastic waste	—	3.6	7.8
Plastic and textile waste	14.0	34.2	29.0
Total	**910.5**	**650.5**	**703.8**

Source: *Information and statistic about environmental and ecological protection in the Republic of Belarus*, 2001.

815 ha. More than half of them are already full. The location, construction and conditions of the exploitation of the majority of dumps do not comply with norms and this aggravates the ecological danger of these objects.

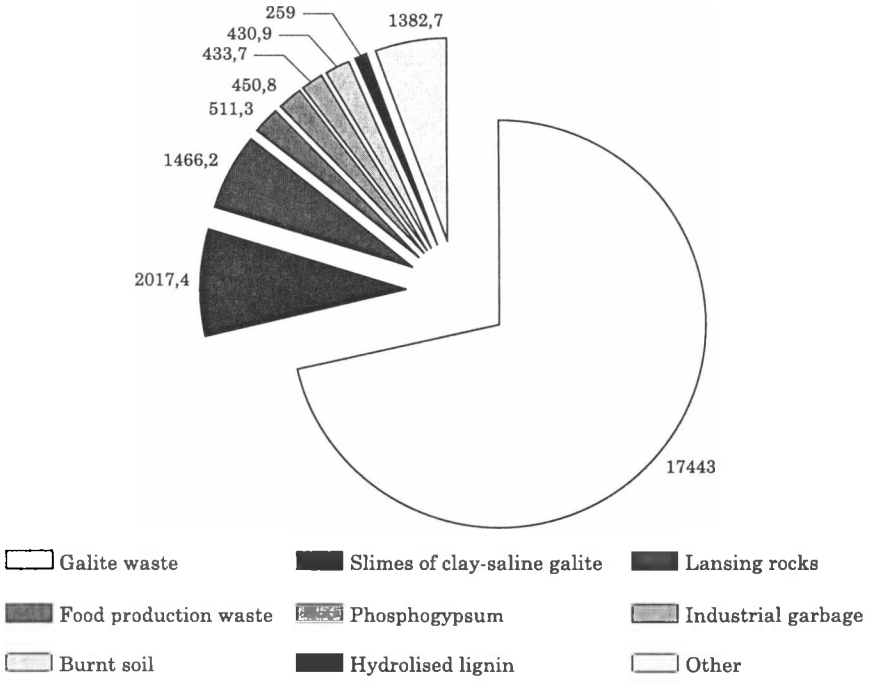

Fig. 1. Pie diagram for the formation of industrial waste in the Republic of Belarus in 1999 (th. tons/per year)

Source: *Condition of the Environment of Belarus*, 2000.

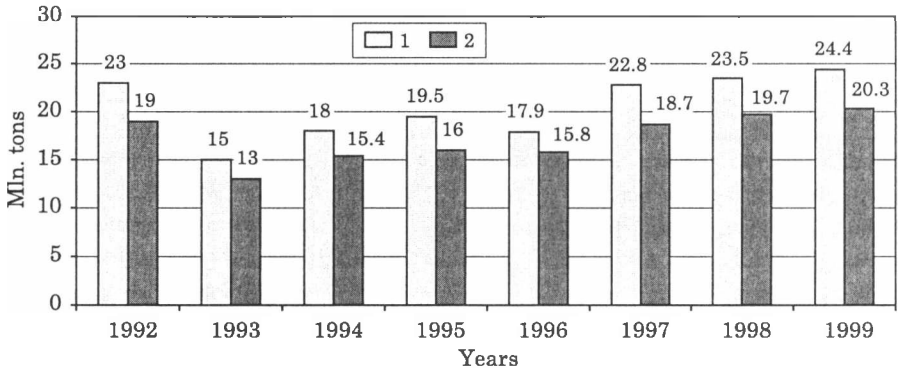

Fig. 2. The dynamics of formation (1) and accumulation (2) in storage of industrial waste in 1992–1999 for Belarus in general

Source: *Condition of the Environment of Belarus*, 2000.

Since the field of production and consumption waste encompasses a wide range of problems, addressing such problems requires professional training. The Belarussian State Politechnic has started a new course "Integrated Waste Management". This course includes the following subjects: sources and classification of waste; large scale waste creation; utilisation of waste and secondary materials; the concept of hazardous waste; taxation of hazardous waste; threats to the environment and human health from waste; principles of integrated waste management (IWM); a hierarchy of priorities in IWM and integration of approaches; systems of collection, transportation and intermediate storage; strategies of IWM; mechanical processing of solid waste; utilising and neutralising waste; engineering and technology in waste management; planning and construction of dumps for the burial of industrial and solid domestic waste; global implications of burying waste; working with hazardous, toxic and radioactive waste; the Basle Convention on the Control of International Transportation of Hazardous Waste; systems of monitoring waste and public information on environmental protection; features of IWM in different fields of economics; legal aspects of the conversion and utilisation of waste; waste prevention [Nesterenko and Dorozhko, 2001, 471].

The teaching of this discipline pursues goals of both methodological and special nature, namely: to teach future engineers in the field the most rational solutions to the various problems of waste management, to provoke an analytical and professional approach to waste management, as well as providing indispensable practical knowledge in this field. The special nature of the course consists in forming engineer-ecologists with

a comprehensive outlook on the field of waste management. This outlook is based on the fact that the optimal method of waste management involves waste utilisation and minimisation of waste creation.

The problems considered in the field of waste management are directly connected with industrial and educational practices, together with the availability of information. The implementation of the course takes these facts into account. The course will be updated to keep up with the latest developments in technology.

3. Conclusions

As confirmed by experience, a modern approach to the problem of waste management has to be based on the following concepts. Firstly, there is no technology capable, by itself, of dealing with the amount of waste produced. Secondly, technology can reduce the amount of waste created only in conjunction with a set of economical and social instruments. Thus, the problem of waste management is not just a technical problem, but an organisational and economic problem as well. The principle of Integrated Waste Management is to encompass these aspects into one program. Only then will it lead to a considerable decrease in environmental pollution and thus contribute to the solution of ecological problems at local and national level.

Literature

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