

WASTE MANAGEMENT IN R.MACEDONIA

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Abstract: *The fast development of industry and increase of consumption are the reason for the creation of large quantities of waste. Around 80% of the created waste is the result of agricultural, industrial and mining activities. The rest of the waste amounting to 20% comes from households. This waste can mostly be re-used or re-processed (plastic, metal, paper, glass, biodegradable organic matters). Efficient waste management enables avoiding the frightening future for the generations to come, i.e., their living in an environment overburdened with waste.*

The European Union has introduced strict regulations referring to waste management that R. Macedonia must effectuate as well. To that effect, our country started with removal of landfills in a number of towns without previous selection of those types of waste that can be reused or reprocessed. In future, only waste that can be re-processed, for example by recycling, will be allowed to be disposed on landfills. At the moment, in Skopje, there is the big "Drisla" landfill, which is planned to be closed by our government. The selected concessioner will build a new landfill according to all valid regulations and standards..

The existing landfill poses an ecological problem that will certainly have an effect upon the tourism in Skopje city. It is in the immediate vicinity of the city and, at the moment, it causes pollution of the underground water and thereby the flora and fauna in Markova Reka river.

Key words: *types of waste, waste emissions, principles of prevention of waste creation, environment*

1. Introduction

Macedonia covers an area of approximately 25 700 km². The annual precipitation ranges between 500 and 750 mm, while the average temperature ranges between 10 to 15⁰C. At the moment, Macedonia has 2,4 million inhabitants, with approximately 584000 households. The average household consists of 4,1 members. According to Macedonian sources, in 2012, Macedonia generated 713564298 tons of communal solid waste. On the average, 349 kg/per inhabitant are generated annually, out of which a certain amount is generated in rural areas with inadequate or no refuse collection. It has been estimated that between 300 000 and 400000 tons of solid waste per annum is generated in a number of urban areas where a system for collection, treatment and final depositing is necessary in the initial phase. As a result, approximately 300 kg/per inhabitant of solid waste is generated in the urban areas at an annual level. The composition of the communal solid waste in

Macedonia includes waste from households, waste from institutions, waste from restaurants/hotels, office/commercial waste and some lighter fractions of waste originating from the industry and the enterprises (Omura 2003). Approximately 50-70% of the quantity of waste originates from the households, while the remaining is commercial and other waste. In addition to the mentioned waste, most of the sources generate a certain amount of hazardous waste, as well.

2. Types of waste

Communal solid waste

The communal solid waste is the main type of waste within the total quantities of waste generated in Macedonia. It includes the waste from the households along with the waste from the maintenance of public hygiene and collected waste from the parks, the commercial-institutional waste and the waste created by the industry. A minor part of the waste originating from the households is dangerous: batteries that contain heavy metals and acids or paints and solvents based on oil. In densely populated areas, there are created larger quantities of communal waste than in the municipalities of a rural character. The total creation of communal waste and its composition is given in (Table 1).

Table 1. Generated total waste and composition

| Type of waste | Quantities (tons/per annum) | (%) |
|------------------------------|--------------------------------|------------|
| Waste from households | 417,838 | 73 |
| Commercial waste | 154,543 | 27 |
| Types of waste | | |
| Bio-degradable waste | 148,819 | 26 |
| Waste from wrapping material | 97,305 | 17 |
| Debris | 28,619 | 5 |
| Other types of waste | 297,638 | 52 |
| Total communal solid waste | 572,381 | 100 |

Waste from Wrapping Material

Most of this waste is deposited on landfills or on unlicensed landfills as part of the communal solid waste and similar types of commercial/industrial waste. At the moment, the capacity for recycling, re-use and return of wrapping material into the production cycle in Macedonia is very limited. There are certain capacities for recycling of metals, paper and cardboard, PET, PVC and HDPE. However, these are presently not functioning with a full capacity or to some considerable extent (Table 2).

Table 2. Recycled and re-used waste

| Wrapping material | Paper/cardboard | PET | Glass |
|-----------------------------|-----------------|------------|--------|
| Recycled (t) | 14,844 | 0,2 | 0 |
| Imported | n/a | 0 | 0 |
| Exported | 3,600 | 0 | 0 |
| Deposited in a landfill | 71,655 | 10,74 8 | 13,972 |
| Total amount (generated) | 86,499 | 10,74 8 | 13,972 |
| Extent of recycling | 21,1 % | 0,01 % | 0 % |

Communal Services

The refuse collection services are mainly provided by communal enterprises that also include other activities: cleaning of streets, public parks and green areas. Only a minor part of refuse collection enterprises represent private companies that usually provide services to rural areas.

Existing Waste Management Practices

Regular refuse collection services are mainly limited to urban media, while insufficient attention is paid to rural settlements. Seventy percent (70%) of the total population in Macedonia receives regular refuse collection services, while only about 10% of the total number of rural settlements are encompassed with the organized services. There is no standardization since the communal enterprises use vehicles and containers for collection and/or compacting of waste of different kinds and sizes. In larger cities, the waste management system is more organized. Refuse collection services are provided at least once a week, but most frequently, old vehicles of a small capacity are used. The limited refuse collection services in rural areas, if any, are usually carried out by a tractor-trailer or, sometimes, by small multi-purpose municipal vehicles.

Return of Waste in Production Cycles/Recycling

In Macedonia, there are two parallel systems for collection of paper/cardboard. One of them is organized by the paper factory “Komuna” that collects around 20% of the respective waste, while the other is organized by collectors of secondary raw materials (mainly paper and cardboard). A few larger collectors/brokers at the market procure paper and cardboard from the other subjects included in the system. In this way, the brokers provide “Komuna” factory with the collected quantities of waste paper or export the waste paper to neighbouring countries.

The recycling capacity of paper factory “Komuna” is not completely used due to market limitations and also due to payment conditions regarding the end users.

Waste metals represent most of the collected recycling material. These are processed by the steel factory “Makstil” from Skopje. There is a well established network of collectors and/or brokers as well as a strong and stable market for the waste metals that are returned to production cycles (Lettinga1999). It can be concluded that 80% of the generated scrap iron is collected and returned to processing. The collected and processed scrap includes cars, appliances, technological/industrial waste, waste machinery/equipment and other different steel products that belong to the category of waste scrap. About 50%-60% originates from industrial sources and thrown machinery.

The market for recycling of plastic in Macedonia is underdeveloped. Most of the “hard plastic” is collected, including HDPE, PVC, polypropylene and polystyrene. They originate from broken car batteries, tubes, boxes and containers. Due to high expenditures for collection, PET plastics is currently collected informally and to a limited extent.

Composting

Several existing composting capacities represent capacities for composting or anaerobic digestion (to a lesser extent) intended for degradation of agricultural waste, particularly fertilizers. Only a small capacity, a pilot project in Zrnovtsi used the organic fraction of the municipal solid waste (MSW) as the basic material for production of compost (Haandel 1994). The main barrier for development of the market for organic compost originating from waste in Macedonia is mainly the lack of information on the use of the compost and the associated benefits.

Industrial Solid Waste

The industrial solid waste consists of all kinds of solid waste created from industries and the very industrial processes as well as any other source within the frames of the industrial capacity. One should differentiate between industrial non-hazardous waste (all kinds of solid waste created within the frames of the industrial capacity that do not contain dangerous elements or contain hazardous waste below the minimal standards/norms) and industrial hazardous waste (Townsend 2005). The treated industrial waste waters (for example, silt) that contain constituents exceeding the minimal standards/norms are included in the total quantities of hazardous waste (Table 3).

Table 3. Creation of industrial non-hazardous and hazardous waste

| Type of waste | Total (tons/ per annum) | Non-hazardous waste (tons/per annum) | Hazardous waste (tons/ per annum) | (%) |
|--|-------------------------|--------------------------------------|-----------------------------------|-----------|
| Waste from mining | 17 246, 000 | 12 700, 000 | 4 546,000 | 26 |
| Waste from thermal processes | 2 090,726 | 2 015,379 | 75,347 | 3,6 |
| Waste from other processing industries | 108,877 | 106,830 | 2,047 | 1,9 |
| Total | 19 445,603 | 14 822,209 | 4 623,394 | 24 |

In Macedonia, the largest quantities of industrial waste and industrial hazardous waste are created in the mining sector. The biggest two generators in the sector of thermal processes are the MHK Zletovo smeltery with 70,000 tons/per annum of PB-Zn slag and dust from exhaustion gases from chimneys and the steel factory Makstil – Skopje that creates around 5,000 tons of dust from exhaustion gases from chimneys per annum. The remaining industrial waste and hazardous waste is created mainly by small and medium size processing industries or companies.

Existing Practices in Solid Waste Management (SWM)

Generally, the generators of hazardous waste do not separate their industrial non-hazardous waste. If any, such a separation is due to market demand – for example, only those kinds of hazardous waste that can be sold are separated. In the country, there are no officially licensed collectors and transporters of hazardous waste. The total quantity of industrial non-hazardous waste which is deposited on municipal landfills is estimated at 4.927 tons/per annum, while the amount of industrial hazardous waste is 487 tons/per annum.

Medical Waste

Medical waste (MW) is considered the solid waste generated by medical and health care institutions (outpatient departments, hospitals, polyclinics and health care stations, dental clinics, etc.). The waste consists of used objects and materials for diagnosis, medical treatment (Bittton 2005), prevention of diseases among people and animals (Law on Waste). According to EU, medical hazardous waste is classified as follows:

- Parts of body and organs, including blood bags and blood reserves (pathological waste);

- Waste whose collection and depositing is the subject of special demands for the purpose of prevention of infections (contagious waste);
- Chemicals consisting or containing dangerous substances;
- Other chemical materials;
- Cytotoxic and cytostatic medicines;
- Other medicines.

In Macedonia, a roughly estimated 900-1.000 tons of MW is created annually. It represents about 15% of the total waste created by health care institutions (Table 4).

Table 4. Creation of medical waste

| Medical waste | Quantities (tons/per annum) | % |
|------------------------|-----------------------------|------------|
| Skopje/Kumanovo region | 350 | 5 |
| Remaining part of RM | 650 | 10 |
| Total | 6 670 | 100 |

Limited quantities of dangerous MW – around 35% are selected, transported and incinerated at Drisla landfill in Skopje. The remaining 65% of the dangerous MW is deposited on municipal landfills or “unlicensed” landfills.

Waste from Agriculture-Stockbreeding

There are no exact/reliable statistic information about waste generation from agriculture. The estimations are based on field studies including large agricultural capacities and animal farms in Macedonia (Table 5).

Table 5. Waste from agriculture and stockbreeding

| Type of waste | Fertilizer (tons/per annum) | Animal corpses (tons/per annum) |
|--------------------------|-----------------------------|---------------------------------|
| Waste from stockbreeding | | |
| Poultry | 81,295 | 340 |
| Swine | 469,930 | 469,930 |
| Cattle | 3 000,000 | |
| Sheep | 1 300,000 | |
| Plants | Organic remains | |
| Crops | 500,000 | |
| Vineyards | 54,000 | |
| Vegetable | 13,000 | |
| Fruit | 6,000 | |

Animal excrement

The relatively large quantities of waste generated by breeding cattle and sheep are entirely used for fertilization of the land. However, this practice should be improved through corresponding training of framers related to composting and planned application of the compost for the soil (Burke 2001). There has not been any analysis so far as to definition whether the storing of this kind of a fertilizer in certain areas is risky or not.

Animal tissue waste

At the moment, there is no appropriate system for management or a legal frame for managing waste associated with animal tissues (Vandevivere 2002). The existing practice involves burial of animal tissues in holes dug in the earth on the farms, or their depositing on the rural “unlicensed” landfills. In both situations, this activity is carried out in a completely uncontrolled way which does not comply with the sanitary standards. There are only several, rare, organized regional places for burial of this type of waste.

Plastic waste

There is no system for collection and depositing of plastic originating from production in green houses. It is a general practice to burn the waste in an open fire on the same location along with the waste consisting of animal tissues. Local companies collect the plastic waste to a certain extent and perform its recycling.

Agrochemical waste containing dangerous substances

In Macedonia, there are no safe capacities for depositing agrochemical waste containing dangerous substances as are contaminated waste from wrappings of pesticides and consumables for maintenance of hygiene of sheep, etc. The contaminated waste from wrappings is usually burnt or deposited along with the communal waste.

Special types of solid waste

The following types of waste should be considered separately:

- Waste oils and oils containing PHB and PHT;
- Waste metalworks;
- Car batteries and accumulators;
- Waste tires.

At the moment, in Macedonia, there are no statistically accurate information on the creation of such wastes at annual level nor schemes of harmonization of collection and ecologically suitable return of the waste in the production cycles. The (Table 6) presented below shows

the assessments made for Macedonia in 2004/2005 based on the study on evaluation of the market of recyclable matters in Macedonia:

Table 6. Creation of special types of waste (tons/per annum)

| Type of waste | Quantity (ton/per annum) | Thrown units/per annum |
|--------------------------------|--------------------------|------------------------|
| Waste tires | 5,000 | |
| Waste oils | 8,000 | |
| Waste vehicles | | 17,500 |
| Car batteries and accumulators | 1,500 | |

Current practice

Waste tires

Although part of the annually created waste tires is collected and used as a fuel in production capacities for lime, most of the waste tires are being deposited at the moment. In addition to the locally created quantities, there is import of waste tires for different goals. There is no usage of energy from tire combustion despite the existence of processing capacities at cement plants in Skopje as well as a clear interest in processing of waste tires.

Waste oils and oil waste

At the moment, in Macedonia, there is no system for collection and processing of used motor oils and their components. Most of the motor oil components are deposited or poured in an inappropriate way. Most of the waste oils and oil emulsions that are created in enterprises and due to other activities are burnt.

Waste batteries and accumulators

Waste batteries used for appliances are deposited on landfills mainly as part of the communal solid waste. A large number of companies that import waste motor batteries (around 7.000 tons/per annum) disassemble batteries and export the components that can be recycled to processing capacities beyond the country.

Waste metalworks

There is no organized collection of waste metalworks. The remains of vehicles are usually collected through the informal sector and are processed for the purpose of returning the spare parts in production cycles.

PHB waste

Recent investigations related to PHB waste have indicated that a considerable amount of transformers which are considered to contain PHB oil are still used in the power supply system. Some of these oil wastes are intended for collection, export and depositing in Switzerland. There is doubt that waste containing PHB is created in some industries as are the railway capacities. It should be noted that the local laboratories in Macedonia do not have capacities for identification of PHB or PHT content in solid waste.

Construction waste/debris (waste from tearing down structures)

The construction waste/construction debris (waste created during tearing down) is generated by activities as is construction of structures/buildings and civil infrastructure, complete or partial tearing down of structures/buildings and civil infrastructure, planning and maintenance of the road structure. This waste usually consists from: concrete, tiles, reinforcement, asphalt pavement, asphalt cover material, timber material, gypsum plates, stone, earth and minor remains. These materials may also contain dangerous constituents: fluorescent tubes, asbestos, lead, mercury and paints. The creation of this type of waste at annual level depends very much upon the construction activities in the public or the private sector.

3. Financing/ coverage of expenditures

Based on the “the polluter pays” principle, the expenses for the financing of the communal solid waste management should be provided through the compensations paid by the users of communal services, for instance the households. These compensations are invoiced and collected directly by the public works companies, not the municipalities, which may impose some hindrances as to increased participation in the refuse collection activities of the private sector. The basis for definition of the level of compensations is different among the municipalities whereat one may differentiate among the following variable criteria:

- Payment per m² for houses and courtyards (mainly in urban municipalities);
- Fixed compensation (lump sum) per household/per month (which is most commonly the case with the rural and some semi-urban municipalities);
- Payment per household member (the only case is the Tetovo municipality).

For collection and depositing of the industrial non-hazardous and commercial waste, the public works companies also invoice fixed

compensations but with tariffs that are higher than those for the communal solid waste.

4. Infrastructure and waste management capacities

4.1. Capacities for Depositing

Solid waste created in Macedonia is most frequently deposited. Drisla landfill that is used for the Skopje region is the only landfill in Macedonia that is relatively well managed. In any case, the plans for installation of impermeable base for the purpose of prevention of possible contamination of underground waters have still not been realized. The area surrounding the landfill consists of permeable sand and gravel deposits. However, not any special construction measures have been taken to prevent possible penetration of drained matter into the subsoil and the deeper aquifers. At the municipal landfills or the “unlicensed” landfills in rural areas, the public works companies simply throw the waste without operative expenditures except some general expenses (payment for the keepers, if any) and occasional expenditures related to consumption of water for extinguishing occasional fires on the landfill (Table 7).

Table 7. Review of municipal landfills

| Municipal landfill | Functions since | Deposits (m ²) | Area (m ²) |
|------------------------------|-----------------|----------------------------|------------------------|
| Kumanovo/”Kраста” | 1960 | 1,832,200 | 65,000 |
| Pehchevo/”Суви Дол” | 1974 | 20,000 | 4,500 |
| Murtino/”Dineva Bara” | 1999 | 5,000 | 4,500 |
| Krivogashtani/”Livadski Pat” | 2004 | 800 | 900 |
| Novo Selo/”Solena Reka” | 2004 | 480 | 600 |
| Resen/”Alchevi Koshari” | 1966 | 200,000 | 30,000 |
| Bitola/”Meglentsi” | 1982 | 1,500,000 | 75,000 |
| Belchishta (4) | 2002 | 16,250 | 10,000 |
| Valandovo/”Suvodolitsa” | 1972 | 80,000 | 15,000 |
| Zletovo/”Melishte” | 1974 | 72.000 | 70.000 |
| Krushevo(2)/”Kole Nalcho” | 1970 | 5.400 | 3.000 |
| Sveti Nikole/”Nemanjetsi” | 1977 | 60.000 | 12.000 |
| Veles/”Bunardere” | 1980 | 620.000 | 75.000 |
| Probishtip/”Strmos” | 1975 | 12.000 | 1.600 |
| Kriva Palanka/”Konopnitsa” | 1982 | 120.000 | 5.500 |
| Lipkovo (4)/”Nikushtak” | 1998 | n/a | n/a |
| Струмица | 1986 | 350.000 | 80.000 |

| | | | |
|---------------------------------|------|---------|---------|
| Kavadartsi/"Meltsi" | 1978 | 480.000 | 60.000 |
| Kochani/"Belski Pat" | 1975 | 300.000 | 120.000 |
| Vinitsa/"Leski" | 1971 | 430.000 | 15.000 |
| Mesheishta | 2002 | 6.240 | 3.000 |
| Karbintsi(4) | 1998 | 5.824 | 4.500 |
| Kichevo | 1998 | 50.000 | 30.000 |
| Mak.Kamenitsa/"Kamenichki Rid" | 1986 | 50.000 | 5.000 |
| Miravtsi/"Karainovi Kuli" | 1998 | 2.000 | 1.300 |
| Delchevo/"Ostrets" | 1989 | 175.000 | 25.000 |
| Gevgeliya/"Suva Reka" | 1976 | 20.000 | 15.000 |
| Gostivar/"Sushitski Most" | 1971 | 720.000 | 32.000 |
| Doyran/"Dekil Tas" | 1975 | 12.000 | 6.500 |
| Blatets/"Pochivalo" | 2000 | 3.840 | 900 |
| Orizari/"Bel Kamen" | 1997 | 7.000 | 20.000 |
| Obleshevo/"Yaz" | 2002 | n/a | n/a |
| Mak. Brod/"Barbaros" | 1995 | 12.000 | 8.000 |
| Ohrid/"Bukovo" | 1972 | 200.000 | 60.000 |
| Dolneni/"Tsrnilishte" | 2004 | 1.000 | 800 |
| Prilep/"Omets" | 1974 | 530.000 | 38.000 |
| Shtip/"Treshtena Skala" | 2004 | 8.000 | 6.000 |
| Berovo/"Iljadin Valog" | 1992 | 22.000 | 5.600 |
| Debar/"Krivitsi" | 1971 | 150.000 | 19.000 |
| Kratovo/"Zelezniitsa" | 1968 | 20.000 | 2.500 |
| Radovish | n/a | 50.000 | 11.000 |
| Bogdantsi/"Brdanov Kamen" | 1967 | 50.000 | 20.000 |
| Demir Kapija/"Pchenichni Dupki" | 1982 | 101.200 | 35.000 |

4.2. Industrial Landfills – “Foci”

The Macedonian mining-processing industries are facing big problems in the transitional period, with the prospective to cease their activities without chances for a re-start in the near future. Their “unlicensed” landfills for in situ processing/treatment of waste were abandoned, without any or with very few information on the history of their use and the type and quantity of deposited waste. The made list/inventory resulted in identification of 16 larger industrial contaminated locations (Table 8).

Table 8. Industrial contaminated locations

| No. | Focus | Operational status | | Deposits (m ²) | Area (m ²) |
|-----|--|-------------------------------|-------------|----------------------------|------------------------|
| 1 | OHIS stock holding company | Facility for chlorine alkalis | Abandoned | 252.200 | 76.725 |
| | | Facility for lindane | Abandoned | | |
| | | HCH “unlicensed” landfill | Abandoned | | |
| | | “unlicensed” landfill | Functioning | | |
| 2 | Buchim (copper mine) | Flotation tailing | Functioning | 196.000.000 | 900.000 |
| 3 | MHK Zletovo (smeltery) | Mine tailings | Functioning | 1.115.000 | 95.000 |
| 4 | Loyane –mine for chromium, arsenic and antimony | Abandoned | | 1,000,000 | 100,000 |
| 5 | Sasa (lead and zinc mine) | Abandoned | | 30,000,000 | 285,000 |
| 6 | Silmak (facility for iron and steel) | Functioning | | 851,000 | 80,000 |
| 7 | Toranitsa (lead and zinc) | Abandoned | | 3,000,000 | 25,000 |
| 8 | Makstil (facility for iron and steel) | Функционира | | 2,500,000 | 125,000 |
| 9 | Zletovo (lead and zinc mine) | Напуштен | | 14,000,000 | 280,000 |
| 10 | REK Bitola (electric power plant and coal mine) | Functioning | | 11,000,000 | 100,000 |
| 11 | FENI (smeltery for iron and nickel) | Functioning | | 2,200,000 | 167,000 |
| 12 | MHK Zletovo (artificial fertilizers) | Abandoned | | 3,700,000 | 70,000 |
| 13 | REK Osłomey (electric power plant and coal mine) | Functioning | | 2,000,000 | 280,000 |

| | | | | |
|----|--|-------------|--------------------|------------------|
| 14 | Godel leather factory | Abandoned | 5,600 | 500 |
| 15 | OKTA (oil refinery) | Functioning | 3,000 | 6,000 |
| 16 | Tane Caleski (treatment of metal surfaces) | Abandoned | 10 | 100 |
| | Average/total | | 267,626,810 | 2,590,325 |

Except for the larger industrial “unlicensed” landfills that are considered national “foci”, there are also minor “unlicensed” landfills on which processed and hazardous waste is deposited (Table 9).

Table 9. Remaining industrial deposits (on own location)

| Capacity | Type of waste | Deposits (tons/per annum) |
|--|------------------------------------|---------------------------|
| Dimko Mitrev-Veles | Leather remains and animal corpses | 357 |
| Agropin, Skopje/Kavadartsi | Silt from PSOV | 0,1 |
| | Wrappings | 0,2 |
| | Coal ashes | 850 |
| MITTAL – Skopje | Wrappings | 20 |
| MZT Foundry – Skopje | Moulded sand and core | 2,500 |
| Algreta stock holding company, Resen | Silt | 20 |
| EMO steel columns Ltd. Kichevo | Oil emulsion | 0,7 |
| | Filter | |
| Alumina – Skopje | NaAlO ₂ | 8 |
| Leov – Proluks, Prilep | Silt from electrical coatings | 4 |
| Ezerka – Ohrid | Silt from PSOV | 0,3 |
| EMO Industrial processing of metal and surface coating | Silt from galvanization of zinc | 3 |
| | | 2 |
| | Silt from galvanization of silver | 0,6 |
| | Silt from galvanization of nickel | 2 |
| Amak SP stock holding company Ohrid | Silt from PSOV – filter | 20 |
| | Mechanical treatment of waste | 1 |
| Rade Konchar, Skopje | Silt from galvanization | 3 |

4.3. Incineration/Combustion

In Macedonia, there are no capacities for incineration/combustion in solid waste management, except for partial combustion of medical waste. At the Drisla landfill that provides services for the Skopje area, an incinerator for medical waste is installed. It became operational in 2000. The main characteristics of the incinerator are shown in (Table 10) It is evaluated that about 35% of the total amount of hazardous medical waste generated in Macedonia is incinerated/combusted.

Table 10. Main characteristics of the medical waste incinerator in Drisla

| Item | Specification |
|-------------------------------------|---|
| Capacity (hour) | 200 kg/hour, approximately 1 ton/shift |
| Actual entry of waste (per annum) | 2001:230 tons, 2002: 240 tons (assessment) |
| Incineration/combustion temperature | Chamber 1: 800 ⁰ C, Chamber 2: 1000 ⁰ C |
| Number and type of employees | 5 workers, 1 engineer, 1 administrator |
| Liquid gas cleaning system | There is no additional cleaning system beside the secondary chamber |
| Data on emissions | Inspection by the Inspectorate of the Ministry of Environment and Physical Planning |
| Depositing of ash | Depositing |

5. Legislation and effectuation

The measures and/or the physical infrastructure that will be realized for enlargement of the existing systems for establishment of an integrated system for solid waste management, are only part of the successful implementation of the National Plan for Solid Waste Management which will mostly depend on the application of the adopted legislations, through a successful system for monitoring and effectuation. The implementation and the effectuation of the EU standards and legislation is a big challenge. Macedonia is a relatively poor country, with relatively low levels of income and generally, low living standards. The introducing and the payment of realistic compensations for waste management is a difficult and complicated task. In addition to capital investments for improvement of current standards for waste management, there will be needed considerable additional expenditures for urgent closure and/or activities for re-cultivation of old or abandoned municipal and industrial landfills.

6. Strategic goals

For the purpose of achieving a realistic progress, there have been formulated series of global strategic goals for future waste management. For that purpose, the Ministry of Environment will have to:

- face the increasing quantities of generated waste, weaken or possibly disrupt the connection between the economic growth and the generation of waste;
- introduce processing and recycling of that part of the generated waste that can be further used;
- introduce a national system for waste management, taking into account the best available technologies/techniques without excessive costs;per sectors;
- Levels of recycling according to materials;
- Quantities of produced and treated industrial hazardous waste;
- Quantities of produced and treated medical hazardous waste.

7. Conclusions

For the last two years, Macedonia has been undergoing intensive development of legislation referring to solid waste management. The preparation of the Draft Law on Waste Management (“Official Gazette of Rm” no. 68/04, 71/04) has contributed to the current process of approximation enabling the country a modern and comprehensive law based on the EU Directives on Waste and Hazardous Waste. The Law on Waste Management provides the general rules referring to the following issues: strategy, formulation of plans and programme, waste management procedures, hazardous waste management, landfills, incineration and co-incineration of waste, import, export and transit of waste through the territory of the Republic of Macedonia, monitoring and management of data, information system, financing, supervision and competent authorities, penal provisions, transitional and finishing provisions.

Namely, the Law on Organization of the State Administration Authorities, the Law on Local Self-Government, the Law on Public Enterprises, the Law on Physical and Urban Planning, the Law on Investment Structures, the Law on Concessions, the Law on Public Procurement regulate certain issues that are important for the Waste Management Sector in the Republic of Macedonia, assigning different competences in the implementation of individual aspects of WM. What is important to point out is that not all of the above stated laws have achieved complete harmonization with the legal regulations of EU and they will be the subject of further considerations and modifications by the regulating body.

References

- Bitton, Gabriel. *Wastewater Microbiology*. John Wiley and Sons, Inc. Hoboken, NJ, 2005.
- Burke, Dennis A. Dairy, *Waste Anaerobic Digestion*. Handbook Environmental Energy Company, Olympia, WA, 2001.
- Haandel, Adrianus and Lettinga, Gatzke, *Anaerobic Sewage Treatment: A Practical Guide for Regions with a Hot Climate*. John Wiley and Sons Ltd., West Sussex, England, 1994.
- Lettinga, G., et al. *High-Rate Anaerobic Treatment of Wastewater at Low Temperatures*. Applied and Environmental Microbiology, pp. 1696-1702, 1999.
- Ohmura, T. Sakai, Y. Shindo, K. Nakamura, T. Ike and Y. Katayama, *Start-up of full scale anaerobic digesters treating municipal solid waste*. Water Science and Technology, Vol. 48, No. 4, pp. 249-252, 2003.
- Townsend, T., *Solid and Hazardous Waste Management*, Class Notes. University of Florida, Department of Environmental Engineering Sciences, 2005.
- Vandevivere, P.L. De Baere and W. Verstraete, *Types of Anaerobic Solid-Liquid Bioreactor for Food Waste Digestion* Biotechnology Letters 24: 757-761, 2002.

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