WASTE DISPOSAL - IMPACTS ON ENVIRONMENT

***Ivona ŠKULTÉTYOVÁ[1]**

[1]Slovak University of Technology, Faculty of Civil Engineering, ivona.skultetyova@stuba.sk
*Radlinského 11, 81368 Bratislava, Slovakia

Abstract: *Historical trends in waste generation show an increase in the quantities of waste generated for most countries and it is clear that the trend will continue. The average European now creates more than half a tone of municipal solid waste each year.*
Treatment methods are used to reduce the amount of residual waste for disposal, and to achieve one or more of the following goals -reduce the potential environmental impacts of the waste, separate and recovery materials or energy, reduce transport costs, reduce the volume of landfill needed, reduce the minimise overall costs
The treatment and disposal of solid waste involves a range of processes including landfill, incineration, composting, pyrolysis/gasification, etc., all of which may result in emissions to the environment. Residents near undesirable facilities are often highly concerned about the facility's impact on people's health, environment and property values.

Keywords:, *landfill, landfill gas, leachate, pollution,* w*aste*

Introduction

We are now in an age where the aspects of public and occupational health and safety have been joined by policy needs on environmental protection, resource consumption and sustainability. The design, management, and control of waste facilities, e.g. landfills, has changed considerably in recent years in response to a better understanding of the pollution potential of wastes and of more effective means of control.

Landfills

Landfills have been identified as one of the major threats to groundwater resources. Landfill represents the largest route for the disposal of waste the modern landfill site is an advanced treatment and disposal option designed and managed as an engineering project in which the waste is degraded to a stabilised product and the product leachate is treated to minimise pollution (see table 1) to the environment and the landfill gas is recovered for energy [3].
A common landfill classification system for reflects the type of waste each receives. There are landfills for hazardous wastes, municipal wastes and inert wastes.
Areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local resource user and to the natural environment [6].

Table 1.
Sanitary Landfilling: Matrix of Health Impacts: Biophysical Environment

Nature of Stressor	Impact on Environment	Affected Area	Control Measures	Standards or Recommendations
Fire	Smoke/dust deposits	Plume dispersion	Covering	Application of provincial laws and regulations concerning landfill site management
Explosion	Destruction	Site and perimeter	Biogas management, leak-proof site	
Biogas	Greenhouse effect	Global	Collection and burning	None
CH_4, CO_2	Greenhouse effect	Global	None	International commitments to counter the greenhouse effect
VOC_s	Air pollution	Local and regional	Collection and destruction	Benzene: 15 mg/m^3 (e.g. tumor producing effects) Dichloromethane: 2200 mg/m^3 Trichloroethylene: 82 mg/m^3
Leachate BOD, COD[1]; heavy metals, organic compounds, and microorganisms	All pollutants: disturbance of aquatic life, pollution of surface and ground water	Local and in receiving environment (down-stream) or in water table	All pollutants: collection and pro-cessing in the water treatment plant	BOD: none For metals, organic compounds, and microorganisms: e.g. drinking water guidelines
N/A	N/A	N/A	N/A	N/A
Noise	Unhealthy conditions	Vicinity and community	All these nuisances: buffer zone; litter fence; daily covering; reduction in waste handling operations	L_{eq}[2] 55 dBA (day) and 45 dBA (night) (WHO guidelines)
Odors	Unhealthy conditions	Vicinity and community		None
Airborne waste	Aesthetics and unhealthy conditions	Air/ground perimeter		None
Vermin	Unhealthy conditions	Local		None

[1] COD = chemical oxygen demand
[2] L_{eq} = Equivalent sound pressure level

Municipal solid waste is a bioreactive type of waste, which undergoes biodegradation in the landfill site. The processes of degradation of bioreactive waste in landfills take many years to complete and involve not only biological processes but also inter-related physical and chemical processes.

Figure 1. shows the major stages of municipal solid waste degradation in landfills [4].

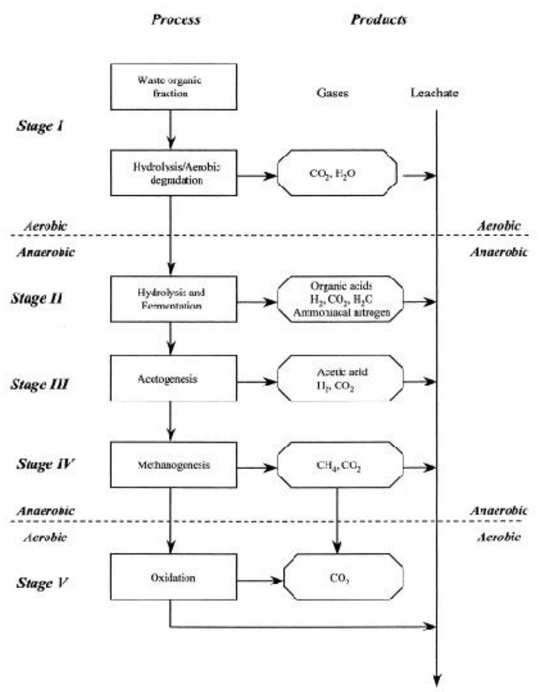

Figure 1. Major stages of bioreactive waste degradation in landfills

Biological processes

The wide varieties of fill components that can be broken down biologically constitute the biodegradable organic fraction of MSW. More than half of household waste is organic. This degrades gradually through five stages within a landfill: aerobic hydrolysis, in which micro-organisms convert some carbohydrates to simple sugars (such as glucose), carbon dioxide and water; hydrolysis and fermentation, when carbohydrates, lipids and proteins are broken down and fermented yielding volatile acids, acetate, carbon dioxide hydrogen and inorganic salts; acetogenesis, where bacteria turn soluble acids to carbon dioxide and hydrogen. These, with carbohydrates are also transformed into acetic acid; methanogenesis, in which bacteria convert acetic acid to methane and carbon dioxide. Finally, conditions may become aerobic again as the landfill becomes more stabilized [4].

Chemical processes

Two general types of chemical reactions take place within landfilled waste. Obviously, the extent of the oxidation reactions is rather limited, inasmuch as the reactions depend upon the presence of oxygen trapped in the fill when the fill was made. Ferrous metals are the components likely to be most affected [2].
Secondly, acid-metal reactions, due to the presence of organic acids and carbon dioxide. These processes mobilise metallic ions and salts which are potential pollutants. However, once methane generation is established the landfill becomes less acid and metals (especially mercury, lead and cadmium) are generally retained (as relatively immobile sulphides).

Physical processes

Compaction of waste has a strong bearing on its behavior. This process begins at the collection stage, takes place at the landfill site and continues within the landfill itself. The effects of water as it passes through the landfill also have a profound influence on the long-term behavior of the waste, dissolving soluble materials and transporting unreacted matter. The absorption of dissolved pollutants (by, for example, cellulose-based matter within a landfill), helps retain materials, at least before saturation occurs. Finally, adsorption is an important factor within a landfill, as wastes become bonded to the surface of other materials [5].

Pollution from landfills

A waste disposal facility must guarantee adequate control over the two main types of pollution — leachate and landfill gas. When landfill gas is collected some liquid (condensate) is also collected. Leachate is generated as a result of moisture entry into a landfill, either as rain, snow melt, and run-on or as moisture in the waste itself. A typical landfill design includes run-on control and a final cover to minimise moisture flow into the waste.

The two most significant components of leachate are organic chemicals and heavy metals. These may be conserved in the landfill in the short term, but through biochemical processes can be mobilised and released.

Organic chemicals are present as soluble decomposition products (e.g. organic acids). They are also present as organic chemicals (e.g. benzene, toluene, dioxins, halogenated aliphatics, pesticides, PCBs and organophosphates) discarded in the waste.

Heavy metals, such as mercury, chromium, nickel, lead, cadmium, copper and zinc, are often found in landfill leachate. Discharges depend mainly on the acidity and the rates of flow of leachate. Many heavy metals come from the non-regulated hazardous waste fractions from households and businesses. No engineering design can guarantee total containment, and some migration of leachate to contaminate groundwater supplies may occur. Policy-makers generally demand quality control systems and the use of comprehensive environmental impact and risk analysis techniques. Leachate management systems tend to be one of the three following types: on-site treatment (generally some form of aeration tank system), disposal to sewerage systems, or transport off-site for treatment elsewhere.

Leachate

The water percolating through landfills is called leachate. It is a complex, highly variable mixture, consisting of various organic and inorganic compounds and microorganisms. Leachate is generated by precipitation or by other moisture that enters the landfill from the breakdown of organic matter or from ground water (water table). It is generally characterized by a strong odor and dark brown color and contains high levels of pollutants, creating a BOD of 5000 mg/L, compared to 100-200 mg/L for typical municipal wastewater. The average absorptive capacity of household waste in landfill is 8.5 cm of liquid per meter of thickness.

Inorganic pollutants consist essentially of heavy metals, generally present at low concentrations, with the exception of iron and manganese, which are usually present in the form of more or less insoluble metal salts. Some particularly toxic metals can pose a risk if they infiltrate ground water aquifers used for drinking water [1].

Organic compounds come from many domestic products: disinfectants, deodorants, cleaning agents, pesticides, furniture cleaners and waxes, cosmetics, soaps and shampoos, dyes, paints and varnishes, medications, etc. Landfills contain thousands of organic compounds. However, the following compounds are universally found or are found in larger concentrations in leachate:

- benzene (solvents, dyes, pesticides, detergents);
- vinyl chloride (manufacturing of various products);
- dichloromethane (solvents, liquid refrigerant, use by the pharmaceutical industry);

- tetrachloroethylene (dry-cleaning solvent, inks, rubber solutions, paint solvents);
- carbon tetrachloride (aerosols, dry cleaning);
- toluene (solvents, dyes, pharmaceutical manufacturing);
- 1,1,1-trichloroethane (cosmetics, aerosols); and
- xylene (dyes, pharmaceutical products, insecticides, solvents, resins, varnish, and polyester products).

The main sources of pathogens are facial tissues, pet feces, diapers, paper towels, and food waste. Wastewater treatment sludge, contaminated industrial waste, and biomedical wastes can also be transported to certain sanitary landfills, thus increasing the number of microorganisms. The presence of vermin (rats, wild animals, birds, and insects) also contributes to increasing the pathogen load.

Leachate contains bacteria (including coliforms, fecal coliform bacteria, and Pseudomonas aeruginosa and Aeromonas hydrophila); viruses (particularly the hepatitis A and Norwalk group viruses); and protozoan parasites (such as Giardia lamblia and Cryptosporidium parvum).

Landfill gas

The various gases produced at landfill sites are collectively known as biogas. It is formed by the microbial decomposition of the organic matter in the waste. The process can last several decades and occurs in several stages: hydrolysis of organic matter into basic molecules (amino acids, sugars, fatty acids, etc.) and simple molecules or atoms (NH_3, hydrogen, CO_2, etc.); acetogenesis of the simple molecules or atoms (conversion to acetic acid); and methanogenesis (conversion of acetic acid to CH_4 and CO_2).

The composition of a mature biogas is almost always constant and consists essentially of equal parts of CH_4 and CO_2 (47% each). It also contains gaseous nitrogen (close to 4%) as well as several dozen compounds in concentrations of less than 1%. The principal classes are:

- aromatic hydrocarbons, including VOCs (e.g., benzene, toluene, xylene);
- halogenated hydrocarbons (e.g., vinyl chloride, dichloromethane, chloroform);
- sulphide compounds (e.g., H_2S, mercaptans);
- various alcohols (e.g., methanol, isopropanol); and
- other substances, such as acetone, ethane, and propane.

The accumulation of CH_4 in confined spaces or enclosed structures can result in asphyxia, explosions, and fires, which may cause injury or loss of life. The risk of CH_4 gas explosions is highest at ambient concentrations of between 5% and 15%. Underground migration of biogas (lateral migration) can result in its infiltration into buildings and can cause explosions or asphyxia in confined spaces.

A number of polluting gases can have a variety of impacts on health [3, 4]. CO_2 and CH_4 are greenhouse gases partially responsible for global warming.

A number of organic compounds are toxic, including several VOCs, which can cause health problems following chronic exposure. These include, for example, aplastic anemia; teratogenic and fetotoxic effects; damage to the liver, lungs, and kidneys; nervous system damage; and various cancers, such as leukemia and myelomas. It is important to note, however, that these effects are associated with high concentrations, which are not necessarily found in proximity to landfills. Those at greatest risk are landfill workers, particularly operators of heavy equipment used to compact the waste.

There are some health impacts in the table 1.

Conclusion

To prevent off-site migration of leachate and landfill gas, the landfill site must be naturally impermeable (clay soil) or a watertight geomembrane barrier and gas collected system must be installed. The leachate must be collected by means of a network of perforated piping and transported to a treatment plant similar to that used to treat urban wastewater. Both physicochemical treatment (oil removal system, filters, coagulation, precipitation, etc.) and biological treatment (biofilters, activated sludge, etc.) are generally required, given the very high levels of contaminants in landfill leachate. The local hydrogeology and the containment technologies and impermeabilization systems employed are therefore key factors in terms of environmental and health risks. An uncontrolled above-grade landfill located near a stream poses considerable risks to water quality.

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