CHAPTER 26

INDUSTRIAL WASTE MANAGEMENT WITH SPECIFIC ALLUSION TO THE MEAT AND MINING INDUSTRIES IN DEVELOPING COUNTRIES

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Introduction

Developing countries tend to specialise in industries processing natural resources such as minerals. They also tend to be geared towards agricultural production, primarily due to a predominantlty rural agrarian nature of their environments. The **meat industry** is one of the major processing industry types in developing countries. Botswana, for instance, ranks among the world's largest exporters of beef. *Handling wastes from meat industries may seem straightforward since the waste is purely of organic nature, but there are setbacks in managing these wastes.* The Botswana Meat Commission, for instance, practices resource recovery with most of its wastes. *Studies have shown that treatment of wastes from meat industries become efficient when anaerobic biological techniques are applied. This chapter focuses on environmental problems that are associated with the meat processing industry.*

Developing countries have rich mineral resources. This may be the result of the inherent nature of the predominantly warm environments, which enhance decomposing of organic wastes into fossils, and eventually to minerals such as coal and petroleum. **Mining industries** *struggle to handle and manage their wastes in an environmentally sound way.* When attention is given to a specific copper mine, for example, it becomes clear why wastes from this industry are difficult to handle. One must note that *mining industries by their nature damage the environment and produce pollutants.* The copper mine for instance produces solids, wastewater and gaseous wastes, all of which adversely affect the environment. In addition to the meat processing industry, this chapter focuses on treatment methods applied in mining industries in developing countries, and discusses some problems encountered in the process. Recommendations suggested for solving difficulties encountered along the way.

Overview

The types of industries in an area will dictate the characteristics of wastes that will be generated. Developing countries seem to experience a bloom of all sorts of industries, but waste management seems to lag behind.

Planning for economic development in developing countries appear to continue without the necessary waste management programme in place for the particular

development. A majority of developing countries produce natural resources in the form of minerals or rely on agricultural products for economic support. This is especially so in the African continent and in most developing countries elsewhere. As a consequence the affected industries produce large quantities of wastes that must be handled in an environmentally safe manner.

This chapter focuses on those industries common in developing countries. **Abattoirs or meat-packing and processing factories** exist in most developing countries especially since the communities have a culture of practising livestock farming for the production of meat and milk. Wastes produced from meat industries, particularly slaughterhouses are primarily organic. For instance blood contains biochemical oxygen demand in excess of 150 000 ppm (Anonymous, 1992).

The diversity of **mining industries and the method of mining** dictate the nature of wastes generated as a result of the processes of extraction, transportation, processing. *Due to the nature of the processes associated with the mining industry, lots of earth material is produced, there are also numerous amounts of solid wastes, liquid and gaseous waste products that are generated during the mining and processing stages.* The major constituents of mining industries are chemical substances, which become more complex and expensive to handle. An example of this type of industry is the one mining copper and nickel in northern Botswana. It produces waste rocks and earth, fissure water, waste oils from machinery, hazardous chemicals and gases from processing. There is also noise and vibration from blasting, which is not a waste per say but more of a pollutant.

The type of treatment method employed for industrial wastewater depends on a number of factors, including, for instance, the *characteristics of the wastes*, namely, whether for example the wastes contain numerous amounts of suspended solids or more dissolved constituents. The *quality of the effluent required* also determines the selection of the treatment process (Eckenfelder, 1989). For instance a number of developing countries, including Botswana, use the World Health Organisation (WHO) guidelines for wastewater quality prior to discharge into receiving streams. These guidelines, for example, require that the maximum biochemical oxygen demand (BOD) content does not to exceed 30 mg/l in ephemeral streams.

Another factor that will dictate the nature of treatment type selected for a given type of industrial wastewater is the extent to which the wastewater is biodegradable or toxic. Economic factors such as *cost effectiveness of the technique used* is a vital factor to consider when selecting a process of treatment, as such a cost analysis should be prepared before the selected process is designed. The type of method selected will also depend on *land availability* as, for example, when stabilisation ponds are selected, there must be consideration of the size of land required.

Wastes from Meat Industry

Wastes in abattoirs *are produced in the form of* blood during slaughtering, use of wastewater, and trimmings. There may also be *sludge from ruminant wastes.* Ruminant waste may be dried and used as soil conditioner or otherwise landfilled. The Botswana Meat Commission, the largest beef industry in Botswana, extracts fluids from paunch contents prior to disposal; the extracted fluids then undergo treatment. The factories under the Botswana Meat Commission reclaim blood and recycle it (Mannathoko, 1995). Blood is dried and processed to produce blood meal, which becomes used as animal feed.

Horns from livestock have found many uses, In Africa, for instance, horns are variously recovered and utilised to make buttons, ornaments, and various decorations such as lamp covers. Kasane, in Northwest Botswana, is a living testimony to this kind of waste re-use. According to Mannathoko, (1995) the Botswana Meat Commission reclaims trimmings, mainly fats collected from wastewater, which are channelled in wastewater to a treatment station, where fats are removed and processed to make tallow, which is a constituent used to make soaps and detergents.

Anaerobic biological methods of treatment *are preferred as the best and least expensive methods of treating wastes from meat industries.* The convenience of this technique is that it does not need oxygen supply, hence less energy cost requirement. Another advantage is that there is less sludge generated when anaerobic treatment is applied. **Anaerobic ponds** are a practical demonstration of the anaerobic biological method of treatment. The average depths for anaerobic ponds are 6 metres. The anaerobic contact "*process has also been used successfully for the stabilisation of meat packing and other high-strength soluble wastes*" (Metcalf and Eddy, 1992). The anaerobic contact reactor consists of a digester with mixing equipment, a degasifier in which biogas such as methane and sulphur dioxide are eliminated, and clarifiers for sludge separation from liquid. Anaerobic treatment techniques are known to have BOD removals of up to 95% (Eckenfelder, 1989). However, the selection of treatment processes varies according to the nature of the waste, the treatment efficiency required, economic factors and other limitations. The Botswana Meat Commission as an example treats its wastewater by applying the bio-filtration technique. Anaerobic treatment can be followed by aerobic treatment perhaps through lagoons for further treatment of the waste.

Mining Industry Wastes

The management of wastes in a mine set-up involves a number of elements, depending on the mineral being mined, the size and extent of mining, and the

processes applied to extract the mineral from the ore. A case study of a copper nickel mine in North Eastern Botswana will he used to assess the wastes dealt with in mining industries.

The mining process produces a number of substances, which become wastes, such material as waste rocks from the blasting and excavating processes. Fissure water from underground also must be pumped to the surface and treated prior to discharge to any water coarse. This water has high mineral content and is found to be low in pH particularly at the copper mine in Botswana, Waste oils are produced from machinery being used in the mine. The chemicals used in processing minerals also increase the chemical contents released to the environment.

Once the mineral ore has been brought from underground, it is sent for crushing in the concentrator. The rocks are crushed to powder form then water is added to aid in the separation process. The water from the concentrator is sent to a tailings dam. The tailings dam is just an earth embankment used to hold wastewater mixed with mud. The heavy metal concentration is usually high in this water. The minerals are then transferred to the smelter for further purification. Waste products from the smelter include heavy metals, hot wastewater containing acids and metals, gaseous sulphur products. Slag (solid) from the smelter is disposed of at the slag dump; these solid wastes contain a lot of iron.

The copper nickel mine in Northeast Botswana has measures in place to reduce pollution of the environment. Though these wastes have already damaged the environment, efforts are being made to control the adverse impacts on the environment. The hot water from the smelter for example is sent to holding ponds to cool prior to being discharged. Gaseous contaminants such as sulphur dioxide are not controlled but emitted levels are tested in the upwind and downwind sides of the mine, to assess if the mine complies with the required air quality standards. A portion of the fissure water is used in some of the mining processes, the rest is discarded.

Tests are being carried in order to assess the concentration levels of substances released to the environment, these are carried out on soil, vegetation and water. The results of this analysis are not yet interpreted to detect the extent of impact these wastes cause.

The tailings dam causes a lot of degradation to the environment. Tailing impoundments are bound to overflow during rainy seasons; they become eroded because of the slope, wastewater seeps easily from the embankment since it is constructed from unconsolidated material. A tailings dam in Spain failed during the late 1990s when parts of the dam collapsed. The accident released 5 million cubic metres of wastes containing heavy metals such as zinc, lead and cadmium. According to Hersh (1998), the accident contaminated aquifers, farmland as well as the Guadiamar River in Spain.

Mining waste is quite expensive to handle. Constructing a tailing pond requires a properly designed stable structure. The pond should sustain pressures as wastewater and rainwater flow in, seepage must be reduced underneath to the barest minimum because seepage further weakens the structure, moreover the seepage contaminates the surrounding.

Treating heavy metals in mining effluent is quite expensive. Copper may be removed by precipitation to its hydroxide state; this is done at an alkaline pH value. A substance such as sodium hydroxide may be used for the precipitation. Other processes of removal include ion exchange and evaporation. On the other hand nickel may also be removed by precipitation. When lime is used, nickel forms the insoluble nickel hydroxide (Eckenfelder).

Conclusion

Industrial waste management should become part of the development of any industry. The common practise is that industrial structures are put in place yet the aspect of managing wastes that will emanate from them are not included as part of the plan. Inadequate management of industrial wastes results in hazardous effects on health and detrimental impacts on the environment.

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