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Short Communication

Different disposal mechanisms and Isocyanate Waste - A Short Communication

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Abstract: The present communication deals with different waste disposal mechanisms and their feasibility with Isocyanate wastes produced in the Production Plant. Isocyanate wastes pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of or otherwise managed. These wastes cause for eye irritation, respiratory problems, occupational asthma, damage to the neurological system, immune system, heart, kidney, mental disorder in the early age, as well as tumors and cancer as reported by WHO, EPA. We have discussed the scope of each and bioreactor landfills, ocean dumping is considered as suitable after proper decontamination of the waste.
Keywords: Isocyanate, Waste, toxic, disposal

INTRODUCTION

The hazards resulting from the disposal of the thousands of Industrial compounds commonly used by industry were largely not known until the 1970s. Drums containing waste petroleum, solvent, pesticide, intermediates and other compounds were commonly disposed of by unsafe methods for decades. These hazardous and persistent wastes migrated through soils and underground to water supply wells and began appearing in drinking water [1, 2]. The emission to the environment of these substances poses a serious risk to life. Every newborn chemical generated is spread to our body and environment by human activity. Each substance in a certain way affects humans. Many do not degrade but persist and accumulate in the body.

Isocyanate wastes are no exception to that. These chemicals are colorless to light colored liquid, few are solid and capable of producing measurable physiological deviation in human system and come under Toxic hazard [3-5]. Gas tragedy in pesticide factory of Union Carbide India Limited in Bhopal, makes us cautious to avoid the recurrence. The generated wastes are empty drums/container, intermediates, unused material, and spill while handling in industry and documented to cause asthma, lungs, kidney damage and severe fatal reaction. The challenge associated with this type of toxic chemical is that it retains lethality even in tiny doses over the decades. Hence, these wastes need proper treatment [6, 7] so that concentration of the free active chemical should be made zero or vicinity to zero before discharging in the identified landfill.

Scope of 3R's to isocyanate Waste

Truly speaking waste disposal is a growing problem worldwide and is directly connected to industrial development and population growth. Since early modern times, disposing of waste has been an important concern for individuals and community officials. Although there have been recent advancements in waste disposal, it remains an overall public safety and environmental health issues that countries around the world continue to address. We have focused on some adopted methodologies which are commonly deployed in industry for disposal.

Methods used include land filling, incineration, and composting, with both upstream and downstream separation of usable materials for recycling. There is also an increasing interest and awareness in the reuse of materials, as well as in source reduction through product redesign and efficient packaging. Together these are often referred to as the 3R's- Reduce, Reuse, and Recycle.

The concepts of 3R's are failed in case of Isocyanate wastes which are potential hazards in production Plant. This kind of affairs for such waste involved tremendous safety challenges. Moreover the process won't not give economic benefit. Once the material generates waste, it is required to give a treatment for safe to environment. The followings are the methods [8-10] adopted for disposal of different waste and their scope for Isocyanates.

METHODS AND DISCUSSION

Prevention and Reduction

The best method of managing waste is prevention and reduction, which can achieved in a number of ways like recycling and making use of secondhand items. Waste reduction and reuse of products are both methods of waste prevention. They eliminate the production of waste at the source of usual generation and reduce the demands for large scale treatment and disposal facilities. Methods of waste reduction include manufacturing products with less packaging, encouraging customers to bring their own reusable bags for packaging, encouraging the public to choose reusable products such as cloth napkins and reusable plastic and glass containers, backyard composting and sharing and donating any unwanted items rather than discarding them. All of the methods of waste prevention mentioned require public participation. In order to get the public onboard, training and educational programmes need to be undertaken to educate the public about their role in the process. The Wastes generated on usages of Isocyanate in production plant is unavoidable but can be reduced on precautionary measure. Overall this technology is not full safeguard to process plant.

Energy Recovery

Anaerobic digestion like composting uses biological processes to decompose organic waste. However, where composting can use a variety of microbes and must have air, anaerobic digestion uses bacteria and an oxygen free environment to decompose the waste. Aerobic respiration, typical of composting, results in the formation of Carbon dioxide and water. While the anaerobic respiration results in the formation of Carbon Dioxide and methane. In addition to generating the humus which is used as a soil enhancer, Anaerobic Digestion is also used as a method of producing biogas which can be used to generate electricity and most importantly is a substitute of LPG. Optimal conditions for the process require nutrients such as nitrogen, phosphorous and potassium, it requires that the pH be maintained around 7 and the alkalinity be appropriate to buffer pH changes, temperature should also be controlled. The method is not applicable to Isocyanate wastes even though it's organic nature as it produces toxic gases like CO, HCN under both conditions

Biological Reprocessing

Biological reprocessing methods such as composting are used for organic waste like food, paper and plant material. Composting is the controlled aerobic decomposition of organic matter by the action of micro organisms and small invertebrates. There are a number of composting techniques being used today. These include: in vessel composting, windrow composting, vermin composting and static pile composting. The process is controlled by making the environmental conditions optimum for the waste decomposers to thrive. The rate of compost formation is controlled by the composition and constituents of the materials i.e. their Carbon/Nitrogen (C/N) ratio, the temperature, the moisture content and the amount of air.

The C/N ratio is very important for the process to be efficient. The micro organisms require carbon as an energy source and nitrogen for the synthesis of some proteins. If the correct C/N ration is not achieved, then application of the compost with either a high or low C/N ratio can have adverse effects on both the soil and the plants. A high C/N ratio can be corrected by dehydrated mud and a low ratio corrected by adding cellulose. Moisture content greatly influences the composting process. The microbes need the moisture to perform their metabolic functions. If the waste becomes too dry the composting is not favoured. If however there is too much moisture then it is possible that it may displace the air in the compost heap depriving the organisms of oxygen and drowning them.

A high temperature is desirable for the elimination of pathogenic organisms. However, if temperatures are too high, above 75C then the organisms necessary to complete the composting process are destroyed. Optimum temperatures for the process are in the range of 50-60oC with the ideal being 60oC. Aeration is a very important and the quantity of air needs to be properly controlled when composting. If there is insufficient oxygen the aerobes will begin to die and will be replaced by anaerobes. The anaerobes are undesirable since they will slow the process, produce odors and also produce the highly flammable methane gas. Air can be incorporated by churning the compost. The disposal of aromatic diisocyanate via this method need high temperature and the process discharges CH_4, CO, NO, NO_2 like toxic gases but the organisms destroyed at high temperature and hence could not be the solution.

Sanitary Landfill

Sanitary Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality. They are usually placed in areas where land features act as natural buffers between the landfill and the environment. For example the area may be comprised of clay soil which is fairly impermeable due to its tightly packed particles, or the area may be characterized by a low water table and an absence of surface water bodies thus preventing the threat of water contamination. In addition to the strategic placement of the landfill other protective measures are incorporated into its design. The bottom and sides of landfills are lined with layers of clay or plastic to keep the liquid waste, known as leach ate, from escaping into the soil.

The leach ate is collected and pumped to the surface for treatment. Boreholes or monitoring wells are dug in the vicinity of the landfill to monitor groundwater quality. A landfill is divided into a series of individual cells and only a few cells of the site are filled with trash at any one time. This minimizes exposure to wind and rain. The daily waste is spread and compacted to reduce the volume, a cover is then applied to reduce odours and keep out pests. When the landfill has reached its capacity it is capped with an impermeable seal which is typically composed of clay soil. Some sanitary landfills are used to recover energy. The natural anaerobic decomposition of the waste in the landfill produces landfill gases which include Carbon Dioxide, methane and traces of other gases. Methane can be used as an energy source to produce heat or electricity. Thus some landfills are fitted with landfill gas collection (LFG) systems to capitalize on the methane being produced. The process of generating gas is very slow, for the energy recovery system to be successful there needs to be large volumes of wastes.

These landfills present the least environmental and health risk and the records kept can be a good source of information for future use in waste management, however, the cost of establishing these sanitary landfills are high when compared to the other land disposal methods. The method may give partial relief but can't be sustained for Isocyanate waste disposal due to its potential hazard nature.

Incineration

Incineration is the most common thermal treatment process. This is the combustion of waste in the presence of oxygen. After incineration, the wastes are converted to carbon dioxide, water vapor and ash. This method may be used as a means of recovering energy to be used in heating or the supply of electricity. In addition to supplying energy incineration technologies have the advantage of reducing the volume of the waste, rendering it harmless, reducing transportation costs and reducing the production of the green house gas methane. In Japan, incineration is popular due to the minimal land available for disposal, but there is some concern about the release of micro-pollutants like dioxins from incinerator stacks.

The process is not recommended for disposal of Isocyanate wastes. It produces dense black smoke, toxic gases namely CO, HCN which constitute a poisonous atmosphere and add further problem to the society.

Pyrolysis and Gasification

Pyrolysis and gasification are similar processes they both decompose organic waste by exposing it to high temperatures and low amounts of oxygen. Gasification uses a low oxygen environment while pyrolysis allows no oxygen. These techniques use heat and an oxygen starved environment to convert biomass into other forms. A mixture of combustible and non-combustible gases as well as pyroligenous liquid is produced by these processes. All of these products have a high heat value and can be utilized. Gasification is advantageous since it allows for the incineration of waste with energy recovery and without the air pollution that is characteristic of other incineration methods. This method also failed to treat Isocyanate waste in a better way.

Bioreactor Landfills

Recent technological advances have lead to the introduction of the Bioreactor Landfill. The Bioreactor landfills use enhanced microbiological processes to accelerate the decomposition of waste. The main controlling factor is the constant addition of liquid to maintain optimum moisture for microbial digestion. This liquid is usually added by re-circulating the landfill leach ate. In cases where leach ate in not enough, water or other liquid waste such as sewage sludge can be used. The landfill may use either anaerobic or aerobic microbial digestion or it may be designed to combine the two. These enhanced microbial processes have the advantage of rapidly reducing the volume of the waste creating more space for additional waste, they also maximize the production and capture of methane for energy recovery systems and they reduce the costs associated with leach ate management. For Bioreactor landfills to be successful the waste should be comprised predominantly of organic matter and should be produced in large volumes and is suitable for Isocyanate wastes only after neutralization.

Ocean Dumping

Controversy surrounds ocean dumping as a waste disposal method. Although the waste may provides nutrients to sea life, its widely believed that the harmful effects would outweigh any benefits. But after suitably treatment, Isocyanate is converted into polyurea which is good nutrients to sea coral. Marine ecosystem will not been disturbed. Hence ocean dumping is an attractive, economically benefited method of disposal of Isocyanate waste after decontamination only.

CONCLUSION

Thermal treatment, biological reprocessing, burning of isocyanate wastes will add further toxicant into environment. Sanitary land filling will give partial relief. But after suitable neutralization and confirmation of the absence of free isocyanate in waste, the same can be dumped into bioreactor land filling or into sea. On treatment of waste, these are converted into polyurea, polyurethane and potential hazardousness of the material is no longer sustained. Regulation of EPA on marine ecology is also protected.

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