Non-Incineration Medical Waste Treatment Technologies

A Resource for Hospital Administrators, Facility Managers, Health Care Professionals, Environmental Advocates, and Community Members

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Executive Summary

Medical waste incinerators emit toxic air pollutants and are a major source of dioxins in the environment. They also generate ash that is potentially hazardous. In 1997, the EPA promulgated regulations for new and existing medical waste incinerators. The EPA requirements in effect increase the cost of incineration. Faced with increasing public opposition to incinerators, many health care facilities are searching for alternatives. This resource book provides information regarding non-incineration treatment technologies.

In order to maximize the benefits of non-incineration technologies, a strategic framework is presented of which the underlying elements are waste minimization and segregation. By implementing a program that includes segregation, source reduction, recycling, and other pollution prevention techniques, one can reduce the amount of infectious waste that needs to be decontaminated. A strategic framework also entails the implementation of an effective waste collection, transport, and storage system; development of waste management and contingency plans; occupational safety and health considerations; and proper siting of the non-incineration technology.

Analysis of the medical waste stream is an important first step in selecting a non-incineration technology. Hospitals generate between 8 to 45 pounds of waste per bed per day in the form of general trash, infectious (red bag) waste, hazardous waste, and low-level radioactive waste. Infectious waste is estimated to be about 15% or less of the overall waste. The following categories are commonly used in describing the components of infectious waste: cultures and stocks, pathological wastes, blood and blood products, sharps, animal wastes, and isolation wastes. A medical waste audit is a useful tool to find out the sources of waste in a health care facility, their compositions, and rates of generation. An audit may also provide information on waste minimization and handling practices, segregation efficiency, "overclassification," regulatory compliance, and costs. After an analysis of the hospital's waste is completed, the facility is in a better position to determine what kind and what size of non-incineration treatment technology would best meet their needs.

Four basic processes are used in medical waste treatment: thermal, chemical, irradiative, and biological. Thermal processes rely on heat to destroy pathogens (disease-causing microorganisms). They can be further classified as low-heat thermal processes (operating below 350°F or 177°C), medium-heat thermal processes (between 350 to about 700°F), and high-heat thermal processes (operating from around 1000°F to over 15,000°F). The low-heat processes utilize moist heat (usually steam) or dry heat. High-heat processes involve major chemical and physical changes that result in the total destruction of the waste. Chemical processes employ disinfectants to destroy pathogens or chemicals to react with the waste. Irradiation involves ionizing radiation to destroy microorganisms while biological processes use enzymes to decompose organic matter. Mechanical processes, such as shredders, mixing arms, or compactors, are added as supplementary processes to render the waste unrecognizable, improve heat or mass transfer, or reduce the volume of treated waste.

For each of these processes, an overview and principles of operation are presented along with information on the types of waste treated, emissions and waste residues, microbial inactivation efficacy, advantages, disadvantages, and other issues. Specific examples of technologies are provided. Technology descriptions are based on vendor data, independent evaluations, and other non-proprietary sources where available. Many technologies are fully commercialized, while others are still under development or newly commercialized. Since technologies change quickly in a dynamic market, facilities should contact vendors to get the latest and most accurate data on the technologies when conducting their technical and economic evaluation of any technology. ***Health Care Without Harm does not endorse any technology, company, or brand name, and does not claim to present a comprehensive list of technologies.***

Steam disinfection, a standard process in hospitals, is done in autoclaves and retorts. The following steam treatment systems are described as examples: Bondtech, ETC, Mark-Costello, Sierra Industries, SteriTech, and Tuttnauer. More recent designs have incorporated vacuuming, continuous feeding, shredding, mixing, fragmenting, drying, chemical treatment, and/or compaction to modify the basic autoclave system. Examples of these so-called advanced autoclaves are: San-I-Pak, Tempico Rotoclave, STI

Chem-Clav, Antaeus SSM, Ecolotec, Hydroclave, Aegis Bio-Systems, and LogMed. Microwave technology is essentially a steam-based low-heat thermal process since disinfection occurs through the action of moist heat and steam. Sanitec and Sintion are examples of large and small microwave units, respectively. Dry-heat processes do not use of water or steam. Some heat the waste by forced convection, circulating heated air around the waste or using radiant heaters. KC MediWaste and TWT Demolizer are examples of large and small dry-heat systems, respectively. EWI and CWT depolymerize the waste and are examples of medium-heat thermal processes.

High-heat thermal processes operate at or above the temperatures achieved in incineration. As such, they can handle the full range of medical waste. In most of these technologies, pyrolysis (not combustion or burning) is the dominant process. Pyrolysis involves a set of chemical reactions different from incineration and hence, different gaseous products and waste residues are produced. In many cases, pollutant emissions from pyrolysis units are at levels lower than those from incinerators. Waste residues may be in the form of a glassy aggregate, recoverable metals, or carbon black. The high heat needed for pyrolysis can be provided by resistance heating (Bio-Oxidation), plasma energy (e.g., Anara, Daystar, EPI/Svedala, HI Disposal PBPV, MSE, Plasma Pyrolysis Systems, Startech, Unitel, Vance IDS, and VRI), induction heating (Vanish), natural gas (Balboa Pacific), or a combination of plasma, resistance heating, and superheated steam (IET). Superheated steam reforming (Duratek) is another high-heat thermal process. An advanced burn technology (NCE TurboClean) is included because of its unique features and low emissions. Pyrolysis systems are a relatively new technology and require careful evaluation.

Chemical technologies use disinfecting agents in a process that integrates internal shredding or mixing to ensure sufficient exposure to the chemical. Until recently, chlorine-based technologies (sodium hypochlorite and chloride dioxide) were the most commonly used; examples include Circle Medical Products, MedWaste Technologies Corporation, and Encore. Some controversy exists regarding possible long-term environmental effects especially of hypochlorite and its byproducts in wastewater. Non-chlorine technologies are quite varied in the way they operate and the chemical agents employed. Some use peroxyacetic acid (Steris EcoCycle 10), ozone gas (Lynntech), lime-based dry powder (MMT, Premier Medical Technology), acid and metal catalysts (Delphi MEDETOX and CerOx), or biodegradable proprietary disinfectants (MCM). The alkaline hydrolysis technology (WR2) is designed for tissue and animal wastes as well as fixatives, cytotoxic agents, and other specific chemicals. Safety and occupational exposures should be monitored when using any chemical technology.

Electron beam technology bombards medical waste with ionizing radiation, causing damage to the cells of microorganisms. Examples of e-beam technologies designed for medical waste treatment include BioSterile Technology, Biosiris and the University of Miami's Laboratories for Pollution Control Technologies. Unlike cobalt-60 irradiation, electron beam technology does not have residual radiation after the beam is turned off. However, shields and safety interlocks are necessary to prevent worker exposure to the ionizing radiation.

Biological processes, such as the Bio-Converter, use enzymes to decompose organic waste. Several examples of small-scale sharps treatment technologies are also presented in this resource book.

Health care facilities should consider the following factors when selecting an non-incineration technology: throughput capacity, types of waste treated, microbial inactivation efficacy, environmental emissions and waste residues, regulatory acceptance, space requirements, utility and other installation requirements, waste reduction, occupational safety and health, noise, odor, automation, reliability, level of commercialization, background of the technology manufacturer or vendor, cost, and community and staff acceptance. Some common techniques for comparing costs of non-incineration technologies include annual cash flow projections, net present value, and life-cycle cost methods. Where available, capital cost estimates of non-incineration technologies are provided along with other comparative data. Various general approaches to acquiring a technology, including financing options, are also presented.

No one technology offers a panacea to the problem of medical waste disposal. Each technology has its advantages and disadvantages. Facilities have to determine which non-incineration technology best meets their needs while minimizing the impact on the environment, enhancing occupational safety, and demonstrating a commitment to public health. This resource book provides general information to assist hospital administrators, facility managers, health care professionals, environmental advocates, and community members towards achieving those goals.