Hospitals and other health care facilities have used chemical agents routinely for decades, in applications ranging from disinfecting reusable instruments to general cleaning of work surfaces. When applied to medical waste treatment, the main problem is how to ensure contact between the chemical and infectious waste with a high enough concentration and sufficient exposure time to achieve proper levels of disinfection. Chemical-based disinfection technologies generally incorporate internal shredding and mixing to resolve the problem of contact and exposure. To maintain the proper concentration, chemical technologies must be able to replenish chemicals lost through volatilization, decomposition, adsorption on waste surfaces, and interaction with microorganisms. Other factors such as pH, temperature, and the presence of other chemicals that may interfere with the disinfection process should also be considered.

Depending on the nature of the chemicals, occupational exposures of workers to concentrations in the air and through skin contact may be a concern. Since many chemical-based technologies release substantial quantities of liquid effluent or wastewater into the sewer, the releases must comply with limits set in effluent discharge permits. In addition, it is important to determine what the long-term environmental consequences of those releases might be.

In the past, the most common chemical disinfectants for treating medical waste were chlorine-based because of the ability of chlorine and hypochlorite to inactivate a broad range of microorganisms. Solutions of sodium hypochlorite (bleach) were regularly used. Recently, non-chlorine chemical disinfectants have been introduced into the market, such as peroxyacetic acid (also known as peracetic acid), glutaraldehyde, sodium hydroxide, ozone gas, and calcium oxide. Some of these are commonly used in disinfecting medical instruments.

The technologies in this chapter are divided into chlorine and non-chlorine based technologies, in part because of environmental concerns that have been raised with some chlorinated compounds as discussed below.

**Types of Waste Treated**
The types of waste commonly treated in chemical-based technologies are: cultures and stocks, sharps, liquid human and animal wastes including blood and body fluids (in some technologies, this may be limited to a certain percentage of the waste), isolation and surgery wastes, laboratory waste (excluding chemical waste), and soft wastes (gauze, bandages, drapes, gowns, bedding, etc.) from patient care. Ethical, legal, cultural, and other considerations may preclude treatment of human anatomical wastes in chemical treatment systems.

Volatile and semi-volatile organic compounds, chemotherapeutic wastes, mercury, other hazardous chemical wastes, and radiological wastes should not be treated in chemical treatment units. Large metal objects may damage internal shredders.

**Emissions and Waste Residues**
Since chemical processes usually require shredding, the release of pathogens through aerosol formation may be a concern. Chemical-based technologies commonly operate as closed systems or under negative pressure passing their air exhaust through HEPA and other filters. These safeguards should not be compromised. Another issue relates to occupational exposures to the chemical disinfectant itself through fugitive emissions, accidental leaks or spills from storage containers, discharges from the treatment unit, volatilized chemicals from treated waste or liquid effluent, etc. Chemical disinfectants are sometimes stored in concentrated form, thus increasing the hazards. The study by the National Institute for Occupational Safety and Health (NIOSH) found no volatile organic compounds (VOCs) in a worker’s personal air space and work area at a mechanical/chemical treatment facility that exceeded permissible exposure limits set by the Occupational Safety and Health Administration. The highest VOC level in the facility was ethanol, measured at 4732 mg/m³.

**Microbial Inactivation**
Microorganisms vary in their resistance to chemical treatment. The least resistant are vegetative bacteria, vegetative fungi, fungal spores, and lipophilic viruses; the more resistant organisms are hydrophilic viruses, mycobacteria, and bacterial spores such as B. stearothermophilus.
Tests of microbial inactivation efficacy should be conducted to show that a $10^4$ kill or greater of at least B. stearothermophilus spores is achieved at the chemical concentrations and treatment conditions of normal operation of the technology.

**Advantages and Disadvantages**

Chemical treatment technologies have the following advantages:
- The technologies using sodium hypochlorite have been used since the early 1980s and have a long track record. The process is well-understood.
- The technologies are well-automated and easy to use.
- Liquid effluents generally can be discharged into the sanitary sewer.
- No combustion byproducts are produced.
- If the technology incorporates shredding, the waste is rendered unrecognizable.

The disadvantages include the following:
- There are concerns of possible toxic byproducts in the wastewater from large-scale chlorine and hypochlorite systems.
- Chemical hazards are a potential problem with chemical-based systems.
- If hazardous chemicals are in the waste, these toxic contaminants are released into the air and wastewater, remain in the waste to contaminate the landfill, or they may react with the chemical disinfectant forming other compounds which may or may not be hazardous.
- Noise levels, such as from a hammermill process or a shredder, can be very high.
- There may be some offensive odors around some chemical treatment units.
- Any large, hard metal object in the waste can damage mechanical devices such as shredders.

**Other Considerations**

Below are some ideas to consider when selecting chemical treatment systems:
- Again, make sure that an effective waste segregation plan is in place to keep hazardous materials from being treated in a chemical system.
- Work areas should be monitored for ambient concentrations of chemicals to ensure at the very least that OSHA permissible exposure limits are not exceeded.
- Maintain records of chemical or biological indicator tests, treatment parameters (such as chemical concentrations), preventive maintenance activities, and periodic inspections.
- Provide sufficient ventilation to reduce odors and chemical concentrations in air.
- Install emergency wash-down hoses, showers, eyewash stations, and first aid kits specifically designed for accidental chemical exposures. Workers should have chemical-resistant goggles, gloves, aprons, and other personal protective equipment such as respirators appropriate for emergencies given the chemicals in use.
- Provide hearing protection for workers if hammermill operations are too noisy.
- Ask the technology manufacturer what reactions are possible between the disinfectant and chemicals that may inadvertently be present in the waste. Find out how this might affect the process; what hazardous materials, if any, may be produced; what emergency response is needed, and how these problems could be avoided.
- Facilities must report chemical spills (if they exceed specified “reportable quantities”) to regulatory agencies as required by law.
- Provide worker training to include: a basic understanding of chemical-based treatment systems, standard operating procedures, occupational safety (Material Safety Data Sheets, toxicity, chemical incompatibilities and reactivities, exposure limits, ergonomics, proper waste handling techniques, personal protective equipment, etc.), recordkeeping, identifying waste that should not be treated in the unit, recognizing technical problems, periodic maintenance schedules, and contingency plans (e.g., what to do in case of a hazardous spill).

**CHLORINE-BASED SYSTEMS**

Sodium hypochlorite (NaOCl), a commonly used disinfectant in health care facilities, is manufactured by reacting chlorine with sodium hydroxide and water. Household bleach is a 3-6 percent concentration of sodium hypochlorite. It is effective in inactivating bacteria, fungi, and viruses, and in controlling odor. It is used extensively as a disinfectant for drinking water, swimming pools, and sewage treatment. Not surprisingly, it was one of the first chemical disinfectants to be used in treating medical waste.

Under ideal conditions, sodium hypochlorite breaks down to form table salt. In recent years, however, concerns have been raised about small amounts of toxic byproducts
associated with the use of large quantities of chlorine and hypochlorite such as in the pulp and paper industry. Apparently, no studies have been done to establish whether or not this problem exists downstream of chemical treatment facilities for medical waste. It is believed, however, that reactions between chlorine/hypochlorite and organic matter produce trihalomethanes, haloacetic acids, and chlorinated aromatic compounds that are toxic. Furthermore, dioxin has been found in bleached paper products, waste discharges from pulp and paper mills that use chlorine and hypochlorite bleach, and aquatic eco-systems downstream of those mills. Reactions of chlorine with ammonia in the water may also release toxic chloramines.

Chlorine dioxide, ClO₂, has been offered as an alternative to hypochlorite in the pulp and paper, municipal water treatment, and food industries. Chlorine dioxide in air is an unstable gas that decomposes to form toxic chlorine gas and heat. Due to its instability, it is generated and used on site using sodium chlorite, sodium chlorate, or electrochemical means. It is stable as a dilute aqueous solution. Like chlorine and hypochlorite, chlorine dioxide is a strong biocide. Importantly, from an environmental standpoint, chlorine dioxide has the advantage of forming chlorite ion which decomposes to form salt. Because many organic compounds such as ammonia, alcohols, and aromatic compounds do not react readily with chlorine dioxide, there are indications that trihalomethanes, haloacetic acids, dioxin, and other chlorinated byproducts may be significantly reduced. With chlorine dioxide, safety hazards must be considered.

Both chemicals have to be handled carefully. Sodium hypochlorite can irritate the respiratory tract, skin, and eyes. Persons with respiratory and heart disorders may be especially susceptible to the health effects of hypochlorite. The OSHA permissible exposure limit is 0.5 ppm (time-weighted average). Local exhaust ventilation is important. A full-facepiece respirator with acid gas cartridge or a positive-pressure air-supplied respirator (for high concentrations) is needed if ambient concentrations exceed the OSHA limit. Chlorine dioxide is a poisonous gas that is readily soluble in water. It has a maximum recommended limit of 0.1 ppm (8-hour average). A self-contained breathing apparatus is required if ambient concentrations are higher than the limit. Proper ventilation is also vital. Workers should review the Material Safety Data Sheets for the chemicals used to generate chlorine dioxide since the feed chemicals are also hazardous.

The technologies described below use either hypochlorite or chlorine dioxide as the disinfecting agent.

Descriptions of Chlorine-Based Systems

Circle Medical Products1 (formerly Medical SafeTEC) has been producing a shredder-chemical disinfection system since 1985. Their older models such as MST 300 have been replaced by a newer model, LFB 12-5. The technology uses sodium hypochlorite (bleach) to destroy pathogens. Medical waste is placed on a belt conveyor and transferred under negative pressure into the system where it is soaked in hypochlorite solution. It is then shredded and pulverized in a high-speed three-chambered hammermill. From the hammermill, the material goes to a pressurized tank, where a mixing device saturates the shredded waste at a set pressure. The higher pressure apparently forces sodium hypochlorite deeper into the waste and increases the level of disinfection. The waste is then passed through an extruder to remove excess liquid and reduce the weight of the treated waste, which is augered to an on-site waste container such as a dumpster or compactor. The complete process takes place in about five minutes. At the end of a prescribed number of operating hours, the spent liquids are neutralized, filtered, and discharged to the sewer system. The major components are: feed conveyer, high-speed hammermill, sodium hypochlorite injection system, pressurized kill tank, auger system, HEPA filters, and controls. Processing speeds are rated up to 3,000 pounds per hour. The LFB 12-5 has a capital cost of about $295,000. (Circle Medical Products, Inc., 3950 Culligan Avenue #D, Indianapolis, IN 46218; Ph. 317-541-8080)

MedWaste Technologies Corporation2 has developed a mobile medical waste treatment unit using sodium hypochlorite as a chemical disinfectant. The waste is shredded and treated with the chemical. The mobile unit can be driven to a hospital where infectious waste is treated on-site and then dumped into the hospital’s trash dumpsters to be disposed as regular waste. The company is seeking approval in various states and provides a service to health care facilities. (MedWaste Technologies Corporation, 6830 N. Eldridge Parkway, Building 110, Houston, TX 77041; Ph. 713-849-5480; Fax 713-849-9774; www.medwastetech.com)

Encore3 combines chemical treatment using chlorine dioxide and an industrial shredder and granulator. A proprietary generation process produces chlorine dioxide on-site. The Encore unit is capable of treating 2,500 to 3,000 pounds per hour. The technology is used by Medical Compliance Services, a regional treatment center in Texas. (Medical Compliance Services, Ph. 800-274-4627)
NON-CHLORINE TECHNOLOGIES

The non-chlorine processes are quite varied – from systems that use a gas such as ozone, a liquid such as alkali, or a dry chemical such as calcium oxide. Some chemicals, like ozone, do not physically alter the waste, while others initiate chemical reactions that change the chemical and physical characteristics of the waste. Non-chlorine processes have the advantage of not producing dioxins or other toxic chlorinated byproducts. However, some formulations are proprietary. If so, facilities should request from vendors data on their chemical agents in relation to microbial inactivation, environmental emissions, occupational hazards, etc.

Calcium oxide, also called lime or quicklime, is a white or gray odorless powder produced by heating limestone. It has a myriad of uses including as an ingredient in medicines, water softeners, and cements, as well as in making glass, purifying sugar, and treating soils. It reacts with water to form calcium hydroxide and can irritate the eyes and upper respiratory tract. The NIOSH recommended exposure limit is 2 mg/m³.

Ozone is an oxidizing agent that contains three atoms of oxygen (O₃) rather than the usual two (O₂). Trace amounts of ozone are formed by the sun or when lightning strikes. It is an component of smog and also makes up a protective layer around the earth. Because it is highly reactive, ozone is a strong oxidizer that can break down easily back to its more stable form (O₂). Trace amounts of ozone are formed by the sun or when lightning strikes. Ozone can cause permanent scarring, blindness, or even death. Aerosols of the alkali can cause lung injury. Exposure limits are 2 mg/m³.

Alkali or caustic, such as sodium or potassium hydroxide, are extremely corrosive. They are used in chemical manufacturing, pH control, soap production, cleaners, textile processing, and a wider range of other uses. Solid cakes or pellets of the alkali react strongly with water releasing heat. Contact with various chemicals including metals may cause fire. Concentrated alkaline solutions are corrosive enough to cause permanent scarring, blindness, or even death. Aerosols of the alkali can cause lung injury. Exposure limits are 2 mg/m³.

Peracetic acid (peroxyacetic acid) is used in hospitals to sterilize the surfaces of medical instruments and may be found in a hospital’s laboratory, central supply, and patient care units. It is a strong skin, eye, and mucous membrane irritant and continued skin exposure may cause liver, kidney, and heart problems. Direct skin contact and exposure to vapors should be restricted. Peracetic acid breaks down eventually into an acetic acid solution (vinegar).

The types of waste treated in non-chlorine technologies depend on the specific technology and disinfecting agent used. For example, alkaline hydrolysis is especially suited for tissue waste, animal carcasses, anatomical parts, blood, and body fluids; it can also destroy aldehydes, fixatives, and cytotoxic agents. Peracetic acid-based technologies equipped with mechanical destruction can handle sharps, glassware, laboratory waste, blood, other body fluids, cultures, and other contaminated materials.

Descriptions of Non-Chlorine Based Systems

The Steris EcoCycle 10⁴ is a compact system designed to treat small volumes and can be used at or near the point of generation of waste. It treats five to eight pounds of waste every 10 minutes including syringes, needles, glassware, laboratory waste, blood, other body fluids, specimens, cultures, and other contaminated materials. The waste is collected in a portable processing chamber at the point of generation. When filled, the chamber is transported to a processor using an optional caddy. A peracetic acid-based decontaminant in a single-use container is dropped into the chamber (the specific formulation used depends on how much fluid is in the waste). As the processing cycle begins, the material is ground up, breaking open the decontaminant vial and chemically disinfecting the waste in 10-12 minutes. The processing cap contains a replaceable HEPA filter to prevent the escape of aerosolized pathogens. At the end of the cycle, the chamber is put on a tilt bracket and its contents are dumped into the liquid separation unit which has a plastic bag. Water is used to rinse the waste. The liquid effluent is filtered before being discharged into the sewer drain, while the waste is retained in the plastic bag for disposal as regular trash. The chemical byproducts of the decontaminant are acetic acid and some hydrogen peroxide which eventually break down into a weak vinegar solution. Microbial inactivation tests demonstrate a 6 to 8 log₁₀ kill for 13 microorganisms including B. subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, bacteriophage MS-2, Mycobacterium bovis, Poliovirus, Aspergillus fumigatus, Candida albicans, and Giardia muris. Steris markets its decontaminant in two doses: STERIS-SW mainly for solid wastes with low organic load; STERIS-LW for waste with high amounts of liquids and a high organic load. EcoCycle 10 units have dimensions of 45.5 W x 31” D x 52” H and require an electrical connection (208 V, 1-phase, 30 A), water (40-100 psi, 1.5 gallons per cycle) and a drain. The units are manufactured by Steris on demand only and sell for about $20,000. (Steris Corporation, 5960 Heisley Road, Mentor, OH 44060; Ph. 800-548-4873 or 440-354-2600; Fax 440-639-4450; www.steris.com)
CHAPTER 8: CHEMICAL-BASED TECHNOLOGIES

Waste Reduction By Waste Reduction, Inc. or WR² offers an alkaline digestion process to convert animal and microbial tissues into a neutral, decontaminated, aqueous solution. The WR² process utilizes alkaline hydrolysis at elevated temperatures. The alkali also destroys fixatives in tissues and various hazardous chemicals including formaldehyde and glutaraldehyde. The Tissue Digester is an insulated, steam-jacketed, stainless steel tank with a retainer basket for bone remnants and a clam-shell lid. After the waste is loaded in the hermetically sealed tank, alkali in amounts proportional to the quantity of tissue in the tank is added along with water. The contents are heated usually to between 230°F to 260°F (110°C to 127°C) or up to about 300°F (150°C) while being stirred. The tanks are rated at 100 psia but are operated at less than 70 psia. Depending on the amount of alkali and temperature used, digestion times range from six to eight hours. The technology does not handle the full range of waste streams in a health care facility but is only designed for tissue wastes including anatomical parts, organs, placentas, blood, body fluids, specimens, degradable bags, degradable fabrics (such as Isolyser’s Orex and Enviroguard), and animal carcasses.

The WR² technology is a non-incineration alternative that can handle chemotherapy waste. All antineoplastic drugs listed by the U.S. EPA as hazardous waste are destroyed by the hot alkali solution. Other antineoplastic agents, especially alkylating agents based on nitrogen mustard, can be decomposed by alkaline hydrolysis but facilities should check with the vendor and regulators to ensure that all specific chemotherapy agents in their waste can indeed be destroyed using this technology.

Other types of waste should not be treated unless it can be shown that the heated alkali can breakdown the material without any adverse environmental impact. (Animal carcasses labeled with radionuclides have been treated using the WR² process; in the case of 125I and 131I, for example, the radioiodine after treatment in the WR² process was not found in the dry bones but was distributed in the digest and wash.) In general, low-level radioactive aqueous waste containing low-activity radionuclides with short half-lives can be “stored for decay” [i.e., kept secure in a storage area usually for 10 times the half-life], subsequently surveyed to confirm decay to background levels, and only then disposed in the sewer [assuming there are no other hazardous properties]. Other federal or local license and regulatory conditions may apply. Radioactive waste with high-activity radionuclides and long half-lives should not be released down the sewer but should be transferred to an authorized radioactive waste disposal site.

The byproducts from the WR² process are biodegradable: mineral constituents of bones and teeth (which can be crushed and recovered as sterile bone meal) and an aqueous solution of peptide chains, amino acids, sugars, soaps, and salts. Facilities should check with local municipal districts to ensure that the alkaline liquid waste can be discharged to the sewer. An excess of hydroxide could lead to a pH greater than 12.5 for the liquid waste which would be classified as hazardous waste. Materials such as ceramics, stainless steel catheters and needles, rubber, etc., are unaffected by alkaline hydrolysis and are retained in the processing basket from which they can be recovered after the treatment. Microbial inactivation efficacy tests showed a greater than 99.9 percent kill rate for the following microorganisms: Aspergillus fumigatus, B. subtilis, Pseudomonas aeruginosa, Giardia cysts, Mycobacterium bovis BCG, Giardia muris, MS-2 bacteriophage, Staphylococcus aureus, Mycobacterium fortuitum, and Candida albicans. Because the process hydrolyzes proteins, it is believed that prions cannot survive the process intact. In light of the growing concern over spongiform encephalopathies (e.g., mad cow disease), this would be important to verify when dealing with animal carcasses.

The process is automated and designed to be left unattended during the processing cycle. Digesters range in size from five to 150 gallons (19 to 568 liters) or more, and may include a weighing system, chart recorder for documentation, and electrical heating. Among the more common hospital sizes are models 100-18-20 and 100-30-26 which handle 80 and 200 pounds, respectively. WR² recently opened a European subsidiary and acquired Sterile Technologies Industries described above under steam treatment systems. (Waste Reduction by Waste Reduction, Inc., 5711 W. Minnesota Street, Indianapolis, IN 46241; Ph. 317-484-4200; Fax 317-484-4201; www.wr2.net; wr2@wr2.net)

Lynntech has been developing a technology that uses ozone as the decontaminant. Ozone is a strong oxidant that can destroy microorganisms and converts readily to molecular oxygen. In the Lynntech system, medical waste is placed in a treatment chamber containing a slow-speed, high-torque shredder. An electrochemical ozone generator produces five pounds of ozone per day at concentrations as much as 18 wt% ozone under pressure using water as a source. Water is circulated between a storage reservoir and an electrochemical cell stack in which ozone and oxygen are generated at room temperature. When 100 kg of shredded medical waste are exposed to about 14 wt% ozone for four hours, a 4 log reduction of B. subtilis endospores is achieved. A pilot-scale unit was tested for three weeks at Lackland Air Force Base in Texas. The technology can be used as a field-portable disinfection system. Ozoneation technology is also being...
considered for disinfection of medical instruments, treatment of contaminated groundwater, and other applications. A demonstration unit is capable of treating to 220- to 518-pound batches (100 to 235 kg). (Lynntech, Inc., 7610 Eastmark Drive, Suite 105, College Station, TX 77840; Ph. 409-693-0017; Fax 409-764-7479)

**MCM Environmental Technologies** has developed SteriMed, a compact automated system (the size of a washer/dryer) which combines shredding, mixing, and disinfection using a proprietary disinfectant. According to the vendor, the proprietary disinfectant called SteriCid deodorizes waste and is 90 percent biodegradable. As with all proprietary formulations, facilities should ask the vendor for data on emissions and potential occupational hazards. Tests done for MCM Environmental Technologies show that at 0.5% SteriCid for 12-minute exposures, greater than 6 Log10 kill can be achieved with *B. subtilis*, *S. aureus*, *C. albicans*, *Aspergillus niger*, *M. phlei*, *M. bovis* var BCG, *P. aeruginosa*, *E. aerones*, *Giardia* cysts, and *Polio* virus Type 2 at various exposure times. SteriMed treats up to 20 gallons per 15-minute cycle. SteriMed has reportedly received approval as an alternative technology in New York and in 23 other states. There is a beta site at Gambro Healthcare facilities in St. Louis, MO. (MCM Environmental Technologies, Moledet, M.P. Gilboa 19130 Israel; Ph. 972-6-653-1104)

The **Matrix** is a large-scale treatment system that decontaminates and deodorizes the waste using disinfecting agents. The disinfecting agents are themselves converted to water, clays, and carbonates. The waste is shredded and turns into an inert, amorphous, solid product. Operating costs are reported to be low. (Matrix Technology Pty. Ltd., B.O. Box 1213, Cairns, Queensland, Australia 4870; Ph. 617-40512955; Fax 617-40518709; www.iig.com.au/matrix)

The **MMT 3000** is a dry chemical treatment technology incorporating physical destruction in a unique horizontal shredder along with chemical disinfection using a dry inorganic (calcium oxide-based) powder called Cold-Ster. Microbial inactivation tests showed a greater than 6 log10 kill for *B. subtilis* and *B. stearothermophilus*. Waste is shredded and the chemical is added with a small amount of water. The process takes about six minutes and does not produce a liquid effluent. The unit was previously marketed by Medical Materials & Technology but is now offered by Positive Impact Waste Solutions, Inc. (4110 Rice Dryer Boulevard, Pearland, TX 77581; Ph. 281-412-9991; Fax 281-997-1007).

**Premier Medical Technology** (PMT) has developed a system that combines physical destruction with a proprietary dry chemical powder. Studies commissioned by PMT have shown that the powder inactivates *B. subtilis* and *B. stearothermophilus* (greater than 6 log10 kill), HIV (5 log10 kill), duck hepatitis B virus, *Mycobacterium chelonei*, *Staphylococcus aureus*, *Pseudomonas cepacia*, and Vesicular stomatitis virus. The medical waste is loaded into a hopper and sent through a high-torque cutting and grinding process while being mixed with a dry, inorganic disinfectant. The mixture then goes through a high-speed shredder and sent to a trash compactor. The major components include a waste measuring and loading system, two cutting assemblies, two mixing augers, weighing/feeding subsystem, water subsystem, waste pretreatment, air filtration, and controls. The unit, with capacities of 600 to 900 pounds per hour (272 to 408 kg/hr), requires a water supply and a 460V, 3-phase, 150A supply. (Premier Medical Technology, Inc., 525 North Sam Houston Parkway East, Houston, TX 77060; Ph. 281-448-2399)

**Delphi Research** is developing an electrocatalytic wet oxidation process called MEDETOX to treat medical waste, as well as hazardous and radioactive wastes. The system uses a patented combination of homogeneous metal catalysts and co-catalysts in a dilute acidic solution. As waste is introduced in the reactor, organic material is oxidized in the solution; many metals are dissolved, concentrated, and may be recovered. (Delphi Research, Inc., 701 Haines Avenue NW, Albuquerque, NM 87102; Ph. 505-292-9315)

**CerOx Corporation** is developing a catalyzed electrochemical oxidation technology that uses cerium, a metal catalyst, in an acidic solution to oxidize organic waste in a reactor. It is being developed to destroy cytotoxic waste, pharmaceuticals, alcohols, chlorinated solvents, dioxins, PCBs, pesticides, low-level radioactive waste, and other organics. (CerOx Corporation, 760 San Aleso Avenue, Sunnyvale, CA 94086; Ph. 408-744-9180; www.cerox.com)

**WR2**

**Description**

(See above)

**Models-Capacities**

Small: Model #100-18-20 – 50 lbs or 23 kg
Medium: Model #100-30-26 – 200 lbs or 91 kg; #100-48-32 – 750 lbs or 340 kg
Large: Model #100-48-52 – 1,500 lbs or 682 kg; #100-72-52 – 3,000 lbs or 1364 kg; #100-96-68 – 7,000 lbs or 3,200 kg
Approximate Dimensions (Vessel diameter and height, not including lid lifts)
Model #100-18-20 – 18” dia x 20” H; #100-30-26 – 30” x 26”; #100-48-32 – 48” x 32”; #100-48-52 – 58” x 52”; #100-72-52 – 72” x 52”; #100-96-68 – 96” x 68”

Approximate Energy Consumption
Model #100-18-20 – 0.104 kWh per lb of waste; #100-30-26 – 0.041; #100-48-32 – 0.011; #100-48-52 – 0.005; #100-72-52 – 0.005’; #100-96-68 – 0.002

Typical Installation Requirements
Steam supply, electrical service, hot and cold water, diked area and floor drain, eye wash and chemical shower stations, sink, cabinet for personnel protection equipment, and area for chemical storage tanks

Features & Options
WR2 supplies processing baskets, basket hoists, automated hydraulic lid latching system, fully automated cycle controls, handling carts, gurneys, soluble processing bags, and alkali. Remote computer monitoring is also available.

Stage of Commercialization
Fully commercialized

Approximate Costs
N/a

Vendor Information
Waste Reduction by Waste Reduction, Inc., 5711 W. Minnesota Street, Indianapolis, IN 46241; Ph. 317-484-4200; Fax 317-484-4201; www.wr2.net

Note: Health Care Without Harm does not endorse any specific technology or company. This technology is presented here as an example of a non-incineration treatment technology. Always check with the vendor for the latest and most accurate data and specifications.

OTHER SYSTEMS
Not included in this report are technologies that use chemical compounds not necessarily for their disinfecting potential but for their ability to solidify or encapsulate waste. Examples are: Premicide, Premisorb, Canister Express, and Solidifier from OBF Industries (Downers Grove, IL) for liquid medical waste and suction canisters; and LTS Plus, ALDEX, and Raysorb made by Isolyser (Norcross, GA) for liquids, aldehydes, and x-ray wastes, respectively. Some encapsulating agents are fast-acting acrylic or epoxy-based polymers incorporating anti-microbial agents to disinfect the waste. Many claim to be non-toxic and to reduce biohazardous fluids into non-hazardous materials.

Any chemical disinfectant that makes anti-microbial claims must be registered with the EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Recently, the State of California withdrew the approval of one liquid treatment system due to questions about its ability to achieve a $4 \log_{10}$ kill of Bacillus spores in 100 percent serum solution. In another case, the EPA penalized a company that makes solidifiers and fluid absorbents due to unsubstantiated claims of germ-killing effectiveness.

Facilities should ask for and carefully review results of microbial inactivation efficacy tests, TCLP, toxicity tests, occupational exposure tests, etc. to ascertain claims that the resulting solidified waste is indeed disinfected and non-hazardous. Because organic material in liquid medical waste can lessen anti-microbial effectiveness, tests for disinfection should be conducted using 100% serum at the use dilution specified on the product label. Facilities should also determine from the vendors whether the solidifying and sanitizing agents are themselves hazardous substances and whether the resulting encapsulated waste can be disposed in a landfill. Some states may not recognize encapsulation as an accepted treatment method for medical waste.

NOTES
1. Based on vendor literature and technical data provided by Medical SafeTec, later Circle Medical Products, from 1994 to 2000, responses to technical questions, and personal communications with Jon Watson.
2. Based on vendor brochure provided by MTC in 2000.
3. Based on limited information provided in 1995 and past personal communication with Ottley Smith and Nelson Slavik.
4. Based on vendor website, literature provided by Ecomed beginning in 1993 and by Steris from 1995 to 1999, and personal communications with various Steris personnel.
7. Data provided by Dr. Gordon Kaye, WR2.
8. Data on the destruction of radioactive tissue provided by WR2.


11. Based on technical data provided by Lynntech from 1998 to 2000, and personal communications with Tom Rogers.

12. Based on vendor website and literature obtained in 2000.


15. Based on vendor website.


18. Based on vendor literature provided by PMT from 1993 to 1995, and past personal communications with Terry Shelton and Dick Taylor.

19. Studies by Prof. Miles Cloyd, Department of Microbiology, University of Texas Medical Branch at Galveston, August 13, 1992; Dr. John Pugh, Fox Chase Cancer Center, Philadelphia, PA, May 20, 1993; Dr. Howard Gratzner, Consultants in Biotechnology, Houston, TX, October 9, 1991, May 11, 1992, and March 23, 1993.


21. Based on vendor website.

22. Based on vendor website, brochures and technical data provided by WR2 from 1998 to 2000, and personal communications with Gordon Kaye and John Wilson.