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The Bio-Facility Waste Management Quandary: A Logical Approach

(refer to accompanying (quandary logic chart. pdf)

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Bio-facility managers must consider many issues when making decisions on the disposal of biological waste. The ‘waste’ being discussed in this article includes animal tissue, carcasses from necropsy rooms, and waste water from various wash-down procedures performed in pathology labs and necropsy rooms. Depending on the lab and the type of research or service being offered, a facility may be dealing with a whole gamut of waste ranging from highly infectious diseases down to non-infectious tissue, carcasses, and water waste.

What is the state of waste disposal in today’s lab animal facilities? The practice of incinerating waste continues in many facilities today simply because incineration has been used for years. Some of these older incinerators continue to function adequately but some are becoming increasingly unreliable, and some have high maintenance costs. All incinerators have high operational costs in terms of energy and maintenance compared to newer technology waste disposal systems. Users have claimed values as high as $.50 to $.75 per pound. Another fact of today’s world is a lab’s liability when carting waste to a landfill site or an incinerator off-site. The liability of that waste lies with the originator, the lab, forever. In today’s litigious business world, liability becomes an important consideration. Many facilities now find themselves planning for alternative means of waste disposal.

Figure 1 represents a logical approach to this quandary of what to do with bio-waste output from the many animal research and veterinary education facilities world-wide. The methods commonly used for waste disposal are:

1. Incinerator on-site
2. Transport to landfill
3. Transport to external incinerator or contract with waste processing company
4. Autoclave
5. Tissue Digester using Alkaline Hydrolysis process

Each of these methods will be explored in more detail here to minimize the perplexity of the alternatives.

1. **Incinerator On-site**: In addition to the issues stated above, permits must be considered when a facility wants its own incinerator on-site. In most municipalities, it is impossible to get a new permit for such an incinerator from either the EPA or the local community. With residential growth over the years, housing is closing in on existing research

facilities and forcing them to shut down their incinerators. The basic rule of no incineration gases within five miles of a residential area allows the EPA to enforce incinerator closures. With this doom over existing and future incinerators, alternatives must be investigated and planned.

Additionally, there are operational costs to consider. The cost of waste disposal using incinerators can run as high as $.50 to $.75 per pound. Some of the newer methods can get operational cost down to less than $.10 per pound. The savings are significant. Given a facility that processes 6,000 lbs per week, this conservatively saves $.40 per pound or $120,000 per year (6,000 pounds X 50 weeks per year X $.40). Even facilities processing only at 1,000 pounds per week would save $20,000 per year.

Another consideration with incinerators is temperature. 1800° F needs to be achieved within the center of a tissue mass to effectively break down the ‘nastiest’ tissue, a Prion protein chain. Measuring and confirming this can be a challenge. Most vendors guarantee a temperature at the discharge flue, but one might question the temperature in the center of all tissue masses in the incinerator. Achieving consistent, high temperature throughout the tissue masses is critical to de-activate any diseased cells. A high temperature incinerator is a method approved by the EU, USDA, and CFIA for destruction of Prions, hence the interest in continuing use or investigating use, exists.

The final point considered in the Figure 1 flow diagram, is reliability. New (up to 10 year old) incinerators most likely operate reliably. Many incinerators, however, are older and requiring liners to be replaced, burners be serviced regularly, or exhaust flues checked for corrosion and leaks. In these cases, a replacement or an alternative should be planned by the facility. But, in reality, and you pass a ‘yes’ along the logic diagram, there are many incinerators out there working fine and facilities don’t need to make any changes… for now.

2. **Transport to Landfill:** This is a common method to dispose of bio-waste used by smaller facilities where infectious disease is not part of the research program. In this case, the waste is inserted into bio-degradable bags and merely treated as normal trash inserted into a dumpster and carted by truck to a municipal landfill site. In most locations the contents of trash from a ‘medical’ facility has to be exposed and when waste contains carcasses and tissue, many landfill authorities will add surcharge fees. Then the liability issue arises; ‘what if’ there is some infection in the waste that can get into the landfill, where raptors (carnivore birds) can transport such infection into a livestock pasture, and on and on? There is also a potential for bad publicity if a trash carrier is involved in an auto accident or accidentally dumps the load. This can be big news in some markets and the facility of origination, often a low-key research center, can receive unwanted

exposure. Costs of transport to landfill can range from $.30 to $.70 per pound if special fees apply. If the facility will someday do some research with the 'nasties' like Prions or CJD, this is not a suitable method.

3. **Transport to External Incinerator:** Transporting waste to an external incinerator is a popular approach used by many facilities that do not have access to an incinerator or have a tissue digester. Many areas have such bio-waste management contractors that cart lab waste away and dispose of it. In most cases it is incinerated in one of their high temperature incinerators where other medical waste from hospitals in the region is incinerated. With this approach, as the flow diagram shows, the liability issues occur during the transport, when potential exposure problems can arise. The cost of this contactor service is usually $.60 to $1.40 per lb. It has the advantage of a proper conscientious procedure on the part of the facility to destroy waste effectively, but the 'nasties' point in method two above still applies.

4. **Autoclave**: This method is used by several BSL-3 facilities using rodents for infection research. The autoclave provides a convenient pass-thru system to move tissue from a high-containment area to a lower containment area. There a few points to consider with autoclaves, including the logistical fact that most large pieces are cut up to expose as much surface area to the autoclave steam as possible. These logistics are not practical for large waste volume. This can be a messy, smelly, time consuming process. Autoclaves do not sterilize all the way through tissue masses, thus an autoclave is not an approved method for Prion destruction. Many facilities have autoclaves for sterilizing cages, tools, bedding, gowns, etc., making them a convenient way to do *some* disinfection, allowing certain waste to be processed further by other waste management methods outside of a high-containment area. If 'nasties' are being worked on, an alternative *must* be used.

5. **Tissue Digesters:** This method is relatively new, and has only been in use since the early 1990s. The technology is actually based on an old, well-proven science of alkaline hydrolysis; the natural decay process of tissue waste being buried in the ground. The tissue digester merely speeds up that decay process – a non-Prion load can be processed in about seven hours, depending on digester size, output type, and load size. Prion loads can take longer depending upon the vendor and machine type used. The modern tissue digester is a recognized and approved method of destroying Prions as long as the machine meets the various parameters defined by the EU, CFIA, and USDA. Those parameters are temperature (302°F), alkaline content (1 Molar of KOH, or 9% of 45% KOH solution, per pound of tissue/carcass), and time exposed to the above (greater than six hours). The interesting benefits beyond Prion destruction are the low operating cost (less than $.10 per pound for a dry system) and convenience of output disposal.

A Closer Look at Tissue Digesters

There are two types of tissue digesters available today; one with a ‘wet’ discharge and one with a ‘dry’ discharge. This discharge method becomes a fairly major part of the selection process since only one known vendor offers the ‘dry’ process. The ‘wet’ discharge is often referred to as the older or original tissue digester design. The output of this system is wet ‘slurry’ that can flow satisfactorily into a sanitary sewer at a maximum temperature of 140° F. A fair amount of dilution with other water is required to impede any plugging of drains with this waste. The pH of the discharge slurry is also a concern. Most sewer authorities do not want sewage with pH higher than 9.5, and the older technology digesters typically exceed that number, so further complex process equipment is needed using CO_2 or copious amounts of water for dilution. The addition of acid can also reduce pH, but it is dangerous and toxic to handle.

The ‘wet’ system waste has a high Biological Oxygen Demand (BOD) – up to 280,000 mg/l. This high BOD sewage must be analyzed by sewage authorities to determine if it is acceptable, and if so, what value of financial penalty will apply. If the digester has a small capacity, say less than 200 lbs (for a small rodent lab), then it may be an acceptable sewage input, since it gets diluted with other waste water from the facility. If it is a larger capacity system, such as 500 lb typical for small livestock facilities or 4,000 lb plus for larger livestock, this wet discharge can be a major problem and is often a ‘show stopper.’

The ‘dry’ system minimizes the sewage problem since it has a solid waste output known as an extirpated aggregate (totally sterile, with all ‘nasties’ de-activated) that can be safely carted to a landfill with no penalties. This solid waste comes out of the bottom of the digester like a cake mix and becomes firm with very little odor as it cools. The digester operating the ‘dry’ system dehydrates the mix after the alkaline process has met the various temperature, time, and alkaline parameters. This condensate is almost clear water with an ammonia smell, a pH below 9.5, and a much lower BOD than the ‘wet’ system output; generally 10,000 or lower. This waste water is more acceptable to the sewage authorities and if that is even too high, an optional EDS (Effluent Decontamination System) can be added to the digester to reduce the BOD to the normal sewage levels of 300-600.

One way of looking at BOD is to consider it to be the amount of ‘bugs’ needed by the sewage treatment plant to break down the sewage as part of their process. In some cases, certain sewage treatment plants actually want higher BOD waste, but only at certain times. Tissue Digester vendors can offer a timed discharge system to accommodate such discharge regulation, if it meshes well with the capacity of waste to be handled. Basically, a holding tank is provided and a timer releases the waste to a sewer. The low BOD water from the dry system is easy to control as a timed discharged or trickled discharge. The high BOD slurry discharge poses more difficulty since it must be kept heated around 140 deg F and agitated, to ensure it can flow. The decision flow diagram also highlights issues involved with designing a new tissue digester system into a facility. The tissue digester will need to interface to building utilities such a steam, chilled water, electric power, compressed air, fill-water supply, and drains. An initial layout is very handy and most digester vendors will assist the facility planner with this. Two questions that need to be answered before a selection or design are handed to a vendor, architect, engineer, or general contractor are 1) what is the volume of waste material needs to be processed through the digester and 2) what is the largest piece to be processed? From that information, a digester size can be determined, an orientation (vertical or horizontal digester design) can be selected, and the utilities, digester room size, and room egress can be planned.

Tissue digesters can also play a role in disaster and emergency preparedness. This is a subject that presently gets lots of discussion but unfortunately hasn't seen much action. The tissue digester is available in a mobile format for transport by truck or large helicopter for processing a bio-terrorism disaster or disease outbreak. The 'dry' digester discussed here provides an excellent solution since it can be transported and diseased tissue can be process on-site, and can be contained and converted into a de-activated substance for reasonably easy disposal. Of all the methods discussed, tissue digestion is the most practical solution for this purpose and has only been made available within the last two years due to developments in waste management technology.

Summary

A logical approach can be taken to the complex issue of what to do with bio-waste from an animal research facility. It has been said that "once all the facts are known, the decision is obvious." There are several methods to handle such waste and a detailed analysis along with good information and the logical decision chart like the one found in this article, can help determine the best solution for a facility. Tissue Digesters provide the newest technology and while installation may appear a bit more complex, the problem of solving the waste treatment dilemma with a Tissue Digester is worth serious consideration.

Mr. Kim Etherington is a Professional Engineer whom has had many recent discussions with Bio-facility managers, equipment vendors, lab operators, lab planners, architects and engineers. The contents of this article are a summary from an engineer's point of view of the knowledge obtained during these many discussions. He is currently the Business Development Manager for PharmaMedSci Group in Toronto, Canada. PharmaMedSci is an affiliate of Hydrol Pro Technologies from Florida. He holds a B.A.Sc. Degree in Engineering and a P. Eng. status in Ontario. Kim has been active in technical marketing, business development, and sales for the past 29 years in USA and Canada. Contact him at kim.e@rogers.com.