PRODUCTEMPHASIS

Selecting the Right Biosolids Dryer: Part I

When deciding on an appropriate biosolids management technology, municipalities must consider many options. In the end, many municipalities opt for heat drying, but which is the right drying technology for the facility? Finding the right drying solution can be a confusing task when you need to consider safety and cost-effectiveness.

By Joey Herndon

This article reviews the basic process to help select an appropriate drying technology. Factors such as dryer operation, type of sludge, operation schedule, air emissions, fuel requirements, end-product quality and storage must all be considered.

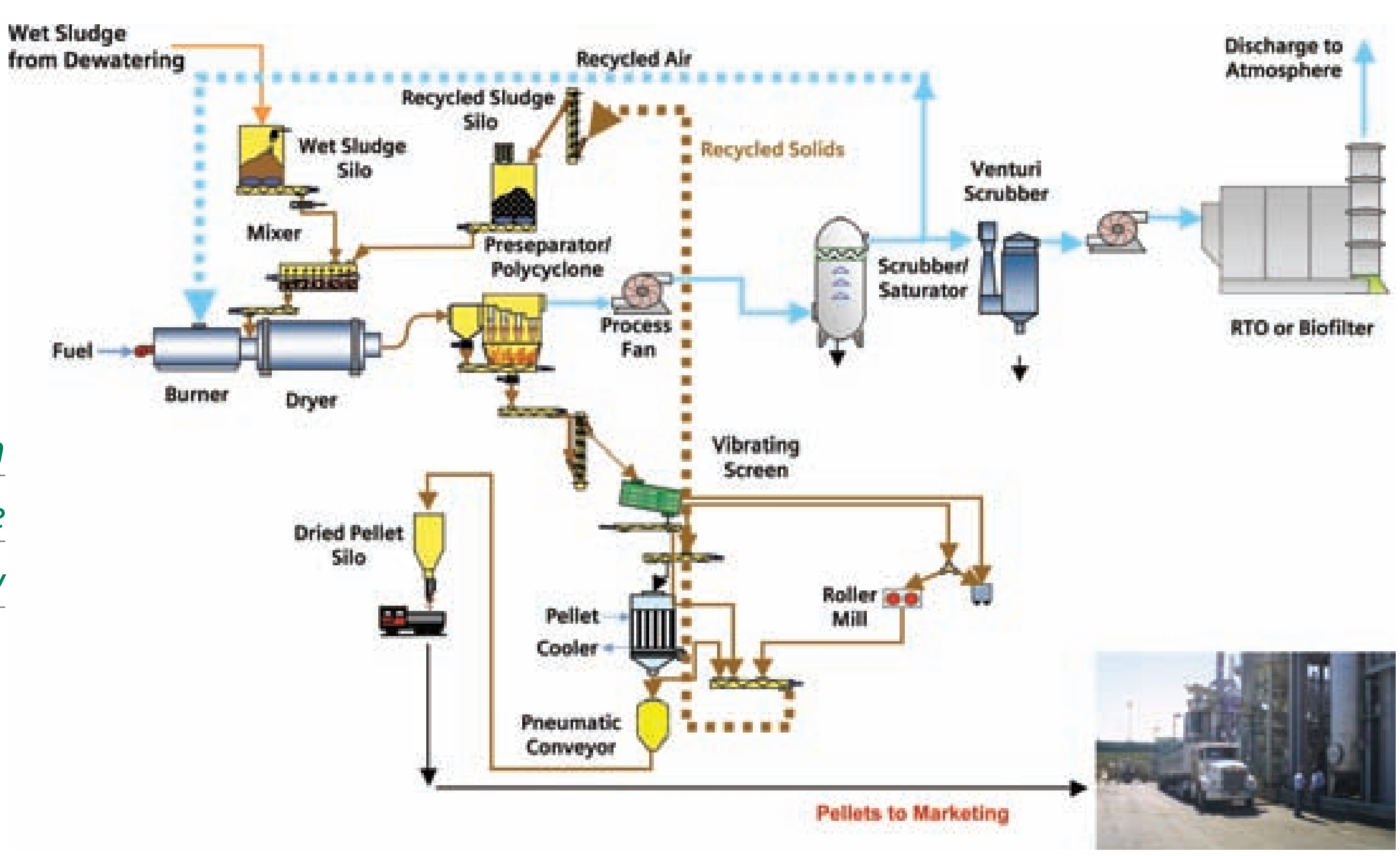
Producing U.S. EPA 40 CFR, Part 503 Class A biosolids is the greatest benefit of heat-dried biosolids, allowing the dried material to be used for beneficial reuse. Heat drying also cuts sludge volume by a ratio of 4:1 and produces Class A biosolids with more than 90% dry solids content. By producing a Class A product, the amount of record keeping for state documentation is reduced or totally eliminated. But how do you select, with confidence, the dryer that will work best for your wastewater treatment plant (WWTP)?

Two Distinct Categories

Heat dryers typically fall into two distinct categories, convection and conduction. Convection dryers are commonly referred to as direct dryers and can include a variety of mechanical designs such as triple-pass drum dryers, single-pass drum dryers, belt dryers and fluidized bed systems. Some of the typical characteristics of a direct dryer are: its heat source comes into direct contact with the sludge being dried; it is equipment-intensive; the dried product must be back-mixed with the wet cake feed; a "pelletized" end-product is produced; large volumes of dryer air emissions must be handled and treated; and its operation requires increased levels of maintenance.

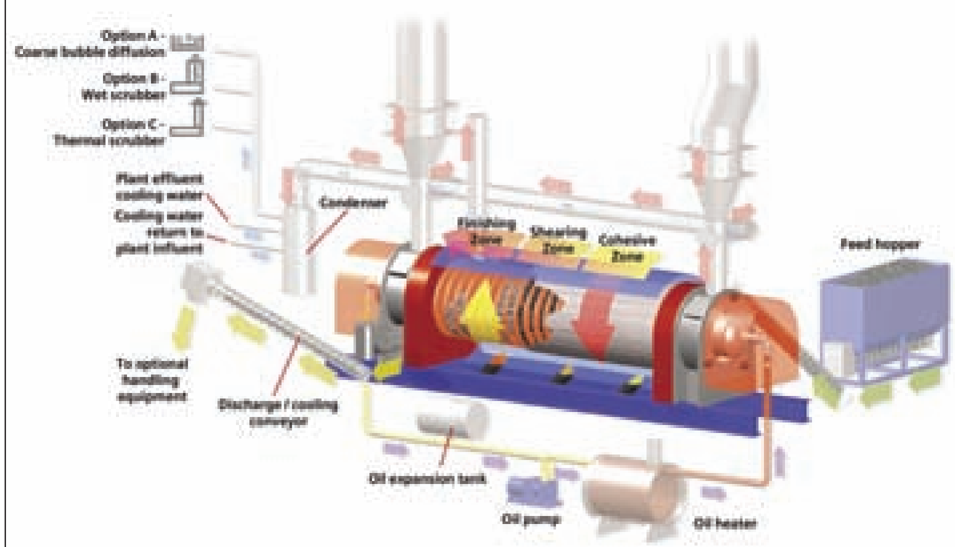
Conduction dryers are commonly referred to as indirect dryers and can include mechanical designs such as the rotating chamber, paddle-mixer style and batch dryers.

FIGURE 1: The equipment and flow pattern of a typical direct dryer.



Considering all factors when selecting the appropriate drying technology

FIGURE 2: The equipment and flow pattern of a typical indirect dryer.



Dragon dryer system, Newport, Tenn.

Some of the typical characteristics of the indirect dryers are: its heat source does not come into contact with the sludge; it gives off low air emissions; less equipment is required; it involves one-step operation with optional back-mixing; and a "granular" end-product is produced.

Dryer Operation

Direct dryer. The required equipment and flow pattern of a typical direct dryer is shown in Figure 1 (see page 18). A mixture of wet sludge cake from the dewatering device (14% to 25% dry solids) and recycled dried product from the dryer (90% to 100% dry solids) are blended together to form a cake solid between 60% and 80% dry solids. The solids are then conveyed to the dryer's inlet, where the drying process begins with a heated airflow (10,000 to 15,000 standard cu ft per minute [cfm]) coming in contact with the sludge. The airflow carries the product from the dryer into the separator/baghouse system, where the air and dried product are separated. The product is then conveyed to the screening system, which grades it into various sizes. The desired size product is conveyed to the storage area, and the rejected, dried product is reduced to a uniform size and conveyed to recycle storage.

The air from the separator/baghouse system is piped to one or more pieces of equipment that may include a heat exchanger for beneficial reuse of the waste-heat. It should also always include an odor-control device such as a thermal oxidizer.

Indirect dryer. The flow schematic in Figure 2 shows the required equipment and flow pattern of a typical indirect dryer. While the mechanics of the various indirect dryers may differ, the basic technology is the same. Most municipal indirect dryers use a synthetic heating fluid (hot oil) as the heat-transfer medium, but steam is also an option.

The sludge cake from the dewatering device (14% to 30% dry solids) is collected in the dryer's feed hopper, from which it is metered into the dryer inlet port. The hot oil is heated in a heat exchanger to the preset temperature (typically 350°F to 500°F), pumped through the hollow flights/paddles of the internal mechanism and returned to the heat exchanger for reheating.

As Figure 2 shows, three individually controlled burners heat the drying chamber. However, in most indirect dryers, the hot oil is circulated around the drying chamber by the same pump systems that pump it through the internal mechanism. The sludge is dewatered inside the drying chamber by indirectly heating the sludge and releasing water as steam. The dried product is discharged from the dryer and is conveyed to the dried product storage. The steam from the drying chamber is drawn through a condenser that uses plant water to condense the steam back to water. The water from the condenser is returned to the plant's headworks, and the vapors (200 to 1,500 cfm) from the condenser are carried to some type of odor-control device.

It should be noted that most all-combustible fuels could be used for both the direct and indirect dryers. Natural gas is the most commonly used and is one of the few fuels that can be piped to the dryer site. It is also possible to use two different types of fuel, such as natural gas and digester gas, for a dryer system.

Areas of Concern

Several areas of concern should be addressed when selecting a heat drying system. Just as WWTPs are different, the mechanics of each drying technology, direct and indirect, are also different. One important common area is the basic operational safety design of the dryer and its components. Regardless of the type of dryer being considered, at a minimum, the hot oil system, dehydration chamber, product discharge conveyors and end-product storage should be designed using established standards such as those of the National Fire Protection Association and the American Society of Mechanical Engineers.

The evaluation of a drying system should include, but not be limited to, the following areas:

The type of sludge to be dried. Various types of sludge have different handling characteristics and dry differently. Whether drying only one type of sludge or several different types mixed together, the consistency of the sludge being fed to the dryer is one of the most important aspects of the drying operation.

To ensure a smooth-running dryer that requires limited operator interface, it is very important to have a "managed" sludge feed to the dryer. Managed sludge means that the complete process is monitored and controlled—from the holding tank, dewatering device, dryer feed hopper and dried product—to ensure a consistent sludge. The municipality must understand that prior to installing a dryer system, managed sludge was not necessary because the sludge cake was sent to a landfill or for direct land application. For this reason, the cake's consistency was not as important.

Operational schedule of the WWTP. The operation schedule of the WWTP must be considered when selecting a dryer. All dryers operate more efficiently when they run continuously. This means that a 24-hour operating schedule should be seriously considered because heating up a dryer and shutting it down each day wastes fuel and causes additional wear on the dryer's components. WWD

In the second half of this article, to be published in the March issue of Water & Wastes Digest, *we will discuss: controlling abrasion and corrosion; avoiding combustion during operation; controlling air emissions; fuel requirements; building requirements; end-product quality and use; and end-product storage.*

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Selecting the Right Biosolids Dryer: Part II

Considering all factors when selecting the appropriate drying technology

By Joey Herndon

In the first half of this article, published in the February issue of *Water & Wastes Digest,* we discussed the two distinct categories of heat dryers—convection and conduction—and their characteristics, plus the required equipment and flow pattern of a typical direct dryer and indirect dryer. Also discussed were some of the areas of concern that should be addressed when selecting a heat drying system.

The second half of this article deals with controlling abrasion and corrosion and discusses other areas to consider when evaluating a drying system.

To read the entire article, please visit the *Water & Wastes Digest* website at www.wwdmag.com./lm.cfm/wd030813.

Things to Consider

Controlling abrasion and corrosion. Controlling abrasion and corrosion are real concerns in a wastewater treatment plant (WWTP) and should be considered when selecting a dryer system. The different dryers' construction materials and mechanical operation also need to be considered. Knowing the answers to the following questions and understanding the different ways dryers operate will help minimize these concerns. During the drying operation:

1. How fast does the dryer's mechanical equipment operate?
2. Does the dryer move the sludge straight through, or does it work the sludge against itself?
3. What is the operating condition inside the dryer?
4. Is there an inert blanket inside the dryer?

Avoiding combustion during operation. This is not only an area of concern but also a safety issue. All dryers have the potential for an undesirable event. Understanding how a dryer operates and which safeguards are designed into the system will go a long way toward selecting a safe dryer. Additional considerations may include:

1. Does the dryer have an inert blanket inside that meets the NFPA guidelines during the drying operation? This includes the startup and shutdown process.
2. Is the dryer equipped with a pressure-relief system, designed to the NFPA guidelines, which is vented to the atmosphere?
3. Is the end-product's temperature monitored by the PLC?
4. Does the end-product discharge have a factor mutual-approved spark detection system?
5. What safety interlocks does the operational program include?
6. Does the HMI have passcode protection?
7. Does the dryer have a fire-suppression system control near the PLC?

Controlling air emissions. Where there are air emissions from a dryer, it is safe to assume there is an accompanying odor. Therefore, it is important to plan for treating these air emissions. While there are several different ways to accomplish this, it is important to understand how the different dryers operate and what the subsequent amount of air volume will be.

Direct dryers typically have a higher air volume to handle and treat than indirect dryers. In most cases, direct dryers will require thermal oxidization of the dryers' air emissions. This is usually a costly piece of equipment that requires a fuel source, which in turn will provide a recurring monthly cost.

The indirect dryers' low air emissions are easier to handle and treat. These systems typically use air diffusion or small chemical scrubbers as their odor-control system.

Fuel requirements. While natural gas is by far the easiest fuel to use, it is sometimes not available at sites where dryers are being considered. Typically, all dryers use commercially available burners, which allows for several different fuels to be used. Alternatives to natural gas include propane, fuel oil, digester and landfill gas.

It is also possible to use more than one fuel in a given dryer operation. For example, the fuel of choice may be natural gas, but there may be a digester gas source on site that could help offset the natural gas cost. In this case, it is possible to use both natural and digester gas. However, using two fuels can involve two gas trains and a possible need for some of a dryer's equipment to be built from stainless steel due to the corrosive nature of digester gas.

Operational cost also is an important factor in determining fuel requirements. When considering different fuel types, it is important to understand the fuel volume (BTUs) required by different dryers and choose a dryer that offers the most flexibility.

Building requirements. Building sizes and requirements for the different dryer systems vary as much as the dryer equipment itself. There are basic housing needs for dryer systems, and personal preference can also influence the building size and design.

When considering housing for drying equipment, it is possible to overlook some very important areas. First, it is necessary to comply with state and local building codes and give due consideration to the NFPA and OSHA codes with relation to the building classification and personnel protection.

Some other areas that should be reviewed and considered are:

1. Which service platforms are required, and are they part of the drying system?
2. Is the dryer's equipment insulated to provide personnel protection?
3. Can the oil heater be isolated for personnel protection?
4. Does the building need an HVAC system?
5. What size door is required for proper maintenance or possible equipment replacement?
6. Does the building need a sprinkler system?
7. Does the building need a gas leak-detection system?
8. Do state or local authorities limit the PSI of gas entering the building?
9. What type of ventilation is needed in the building?
10. What utilities are required inside the building for the dryer system's proper operation?

Figure 1. Pelletized product.

Figure 2. Granular product.

End-product quality and use. End-product from the different types of dryers is one of the most hotly debated issues in the sludge-drying business. Most direct dryers use screening and back-mixing to produce a pelletized product, while most indirect dryers use a single-pass design to produce a granular product.

The pelletized products are more uniform in size and contain limited fines. This product is more desirable in the fertilizer-blending market but is more expensive to produce. Studies have shown that the pelletized product breaks down more slowly and may not break down after extended periods of time.

The granular product contains various sizes, including fines and dust. The market for this product is direct land application and soil blending. The granular product is a better product for landowners because of its physical characteristics. The fines in the granular product break down quickly and give immediate benefit to the landowner, while the other sizes break down more slowly depending on their size.

A dust-control product (binding agent) should be considered for both the pelletized and granular products. This process cost would involve the binding agent's application equipment and monthly use. Of course, the monthly usage will vary depending on the amount of dried product being produced.

Generally, both the pelletized and granular products will weigh around 45 lb/cu ft, are easy to spread with common application equipment and presently enjoy an active market.

End-product storage. A good storage system is an important element of the overall drying process. Storing dried biosolids is a controversial topic. It can be as simple as conveying the product to a waiting truck or storage bunker, or installing an elaborate silo system with automatic truck-loading equipment. Capital cost will certainly guide the decision process. However, it is necessary to first and foremost consider safety, no matter which storage system is selected.

Regardless of the type of storage system employed, it is possible to have product reheating that may cause a smoldering fire and, in some cases, a flame. In certain storage equipment like a silo, where dust buildup can occur, it may be possible to have conditions that will facilitate an explosion.

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The following should be carefully considered when deciding on a biosolids storage system:

1. What is the intended market for the dried product? This will provide an idea of what type of truck will be removing the product from the storage site.
2. Does the WWTP have a front-end loader that can be used to load the dried product?
3. How many cubic feet of dried product per operational day will the dryer produce?
4. How many days of storage will be needed? This will typically be one to two weeks.
5. What will be the distance between the dryer discharge and the dry product storage?
6. What type of dust control will be used? And what is the estimated annual cost?
7. Will a baghouse be required? If so, what type of permitting will be needed?
8. If the storage space is confined, how will it be vented for abnormal pressure increases?
9. What type of sensors will be used to provide information to the PLC and operation personnel?
10. What type of pressure-relief system is provided, and is it designed to the NFPA guidelines?
11. What type of fire-suppression or extinguishing system will be used, and is it designed to the NFPA guidelines?
12. When using a storage silo, how will the system be grounded and bonded to prevent a static discharge?

A good storage system is found at the end of every successful drying operation. The two go hand-in-hand, and an equipment evaluation that answers the 12 questions above will certainly help in selecting the best storage system for the selected drying operation.

Overall Benefits

Heat drying is a viable solution to the sludge disposal problems that are common across the U.S.

The greatest benefits of heat-dried biosolids are the production of Class A biosolids and maximum volume reduction. With the production of a Class A pelletized or granular beneficial use end-product, municipalities can help offset the operational costs of their drying facilities by marketing the dried biosolids as a fertilizer supplement or soil amendment. Even if marketing the product is not an option, smaller volumes mean related storage and disposal costs are dramatically reduced.

Many questions need to be answered when considering heat drying. Going through the evaluation process and answering the suggested questions will help with the correct application of risk assessments, design and mitigation measures associated with heat drying and storage systems. WWD

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