THE
ROTARY DRYER
HANDBOOK

FROM THE FEECO
PROCESS EQUIPMENT SERIES

FEECO INTERNATIONAL

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Introduction

FEECO International was founded in 1951 as an engineering and manufacturing company. We quickly became known as the material experts, able to solve all sorts of material processing and handling problems, and now serve nearly every industry, from energy and agriculture, to mining and minerals.

As experts in the field of thermal processing, FEECO has been solving problems through material testing, process development, and custom thermal processing equipment, including rotary dryers, since the 1950s. We've helped our customers process hundreds of materials into value-added products, eliminating handling and transportation problems, improving product characteristics, and creating marketable products.

Many of the world's top companies have come to rely on FEECO for the best in custom process equipment and solutions. Some of these companies include:

3M Nestlé RioTinto PotashCorp Helping Nature Provide Honeywell

For further information on drying, contact a FEECO expert today.

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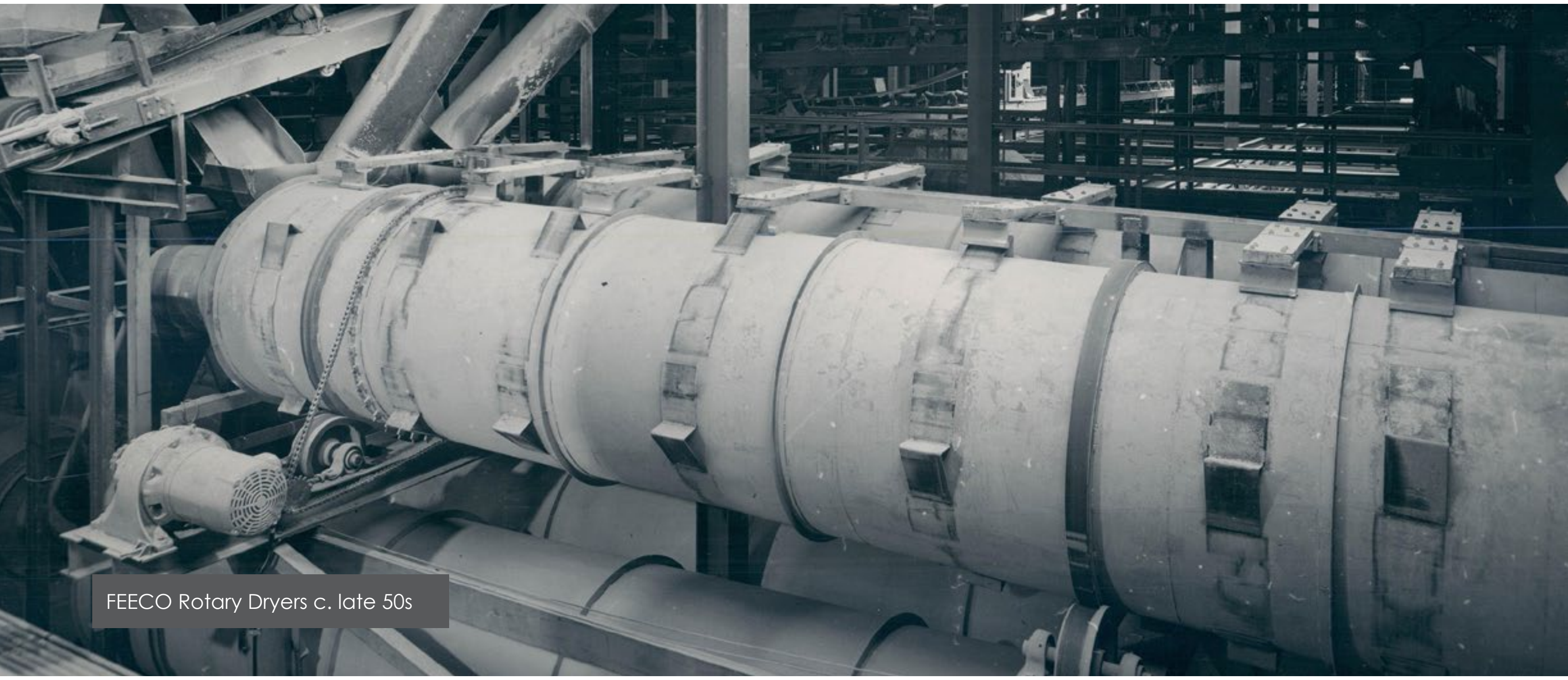
Intro to

ROTARY DRYERS



FEECO Rotary Dryers c. late 50s

AN INTRO TO ROTARY DRYERS

The field of industrial drying has been around for centuries, even if rudimentary at first. Drying began with only the wind and sun as its tools, but as civilization demanded faster drying methods, people began to use these tools in a more controlled manner to maximize the drying process. Soon, basic ovens were tasked with drying goods and materials, and as industrial needs continued to expand, so too did drying technologies.[1]

Today, advanced drying systems allow us to produce materials and products at unprecedented speeds. Industrial drying systems continue to become more advanced, further increasing the efficiency and effectiveness of the drying process.

When it comes to drying bulk solids, rotary dryers are often the industrial drying equipment of choice. For over a century, their robust build, reliability, and aptitude for handling variation in feedstock has made them an ideal choice for efficiently drying bulk solids of nearly all types.

The flexibility of rotary dryers has allowed them to expand into nearly every industry, from food and specialty chemicals, to minerals, fertilizers, and nearly everything in between.

And while rotary dryers are commonplace in many industries, they are still surrounded by a multitude of questions and opportunity for confusion.

This resource serves to give a basic overview of rotary dryers and the industrial drying process, as well as answer some of the common questions asked about these robust industrial drying systems.

1. R. B. Keey. *Drying: Principles and Practice*. Oxford, 1972. Print.

ROTARY DRYER OPERATION

HOW ROTARY DRYERS WORK | DIRECT VS. INDIRECT | SIZING & DESIGN | SYSTEMS

FEECO Rotary Dryer for frac sand

HOW ROTARY DRYERS WORK

Rotary dryers use a tumbling action in combination with a drying air in order to efficiently dry materials. Most often, rotary dryers are of the direct configuration, meaning that the drying air is in direct contact with the material. Some dryers, however, are of the indirect type, whereby the dryer is heated externally, to avoid direct contact between the material and the drying air.

Rotary dryers are comprised of a rotating drum, into which the material is fed in combination with the drying air. Flights, or lifters, pick up the material from the bed, carrying it over, and dropping it through the air stream to maximize heat transfer between the material and drying air (in the case of direct dryers).

Material is processed for a specified amount of time, referred to as the retention time, at the desired temperature, in order to produce a product with the required moisture content.

While rotary dryers are often available in standardized models, designing a rotary dryer around the unique characteristics of the material and process needs will produce the best results and offer the most reliability. Various aspects of the dryer are considered during initial design in order to reach the exact desired parameters of the end product.

ROTARY DRYER CONSTRUCTION

While FEECO rotary dryers are custom designed around the material to be processed, the basis of a rotary dryer is somewhat standard, with customizations coming in terms of sizing, materials, mechanical components, and add-ons, among other items. The diagram on the next page shows some of the basic standard components found on a direct rotary dryer. The page following illustrates an indirect dryer. Below, some of the standard components of a rotary dryer are summarized.

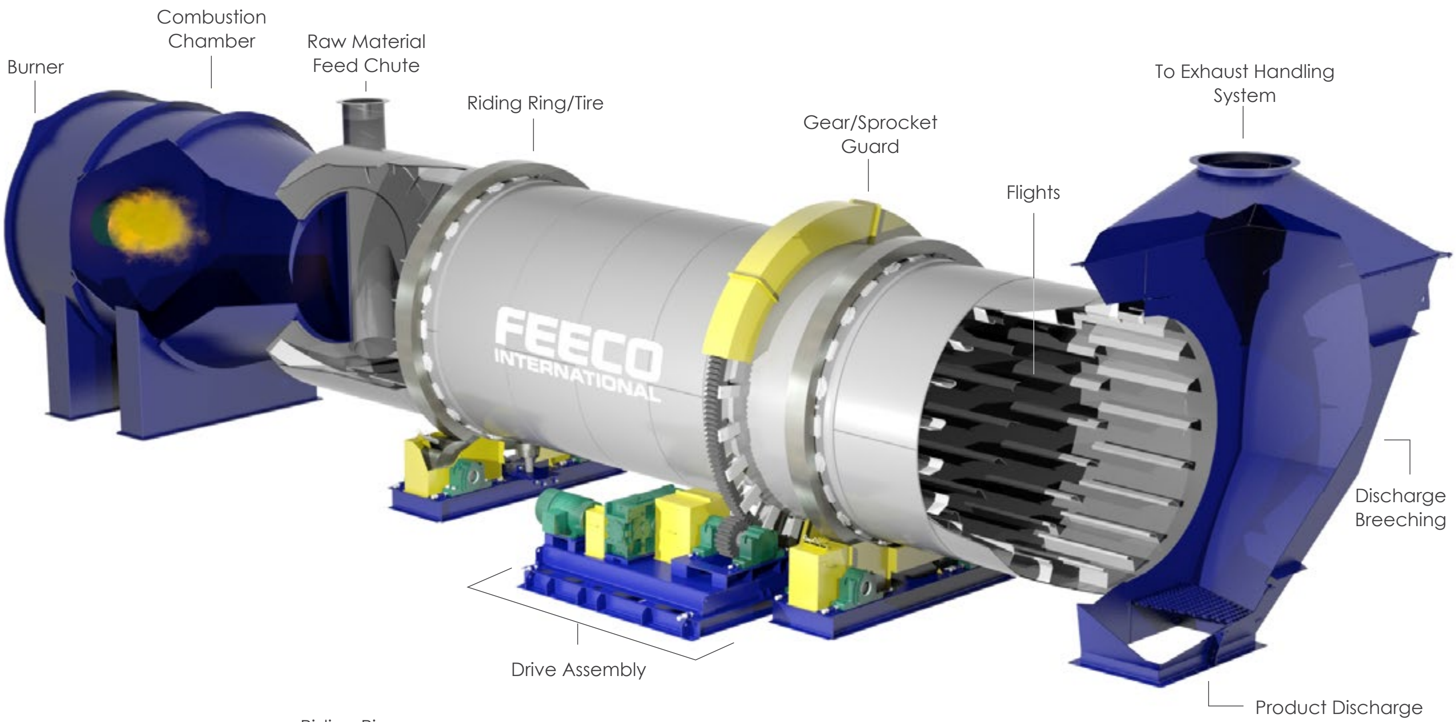
SHELL:

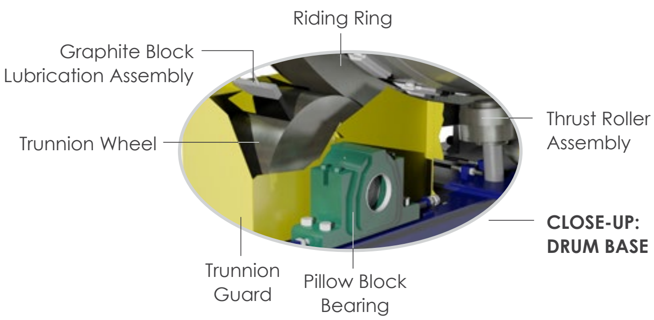
The shell of a rotary dryer can be made from a variety of materials, including carbon steel, stainless steel, hastelloy, Inconel, and a variety of other alloys. The shell may also be customized in different ways, depending on the needs of the material and the process. For example, shell thickness can be adjusted for situations where heat retention inside the dryer is of the utmost importance. The shell may also be insulated in order to aid in retaining heat. Manufacturing techniques are vital on the shell; the shell needs to run true and concentric in order to work properly. A poorly manufactured drum will promote wear on all components and reduce equipment efficiency.

THE COMBUSTION CHAMBER:

The combustion chamber houses the actual combustion reaction and directs the airflow of the rotary dryer. Combustion chambers can be integrated into either co-current (airflow in direction of material flow) or counter current dryers, with the goal being to keep the material from coming into direct contact with the burner flame. A variety of combustion chambers are available, with customizations including single or double shell, refractory lined, and angled. Combustion chambers can also accommodate a wide variety of burners.

CONSTRUCTION OF A DIRECT ROTARY DRYER





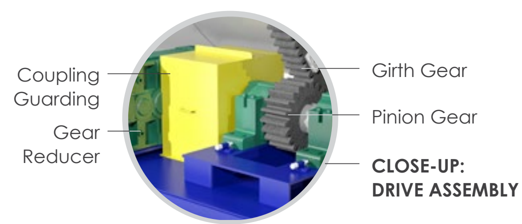


TABLE: **FEECO DIRECT DRYERS AT A GLANCE:**

DIAMETER	3' - 15' (1 - 4.6m)
CAPACITY	1 TPH - 200 TPH+ (1 MTPH - 181 MTPH)
CUSTOMIZABLE?	Yes

Finding a quality combustion chamber is important to the quality of the product, and the energy consumed to get to the end product. When a low-quality combustion chamber is used, many problems can result, from inefficiency, to product breakdown, and in some cases, a short combustion chamber lifespan.

BURNER:

The burner is the engine behind any dryer, determining the output of BTU's/Watts. Burners can be designed for a multitude of fuel sources, including natural gas, propane, diesel, and more. Choosing the appropriate burner specifications is essential for proper and efficient drying of the material. FEECO can design burners to meet a wide variety of process needs.

RAW MATERIAL FEED:

The raw material feed area is where feedstock is fed

CONSTRUCTION OF AN INDIRECT ROTARY DRYER

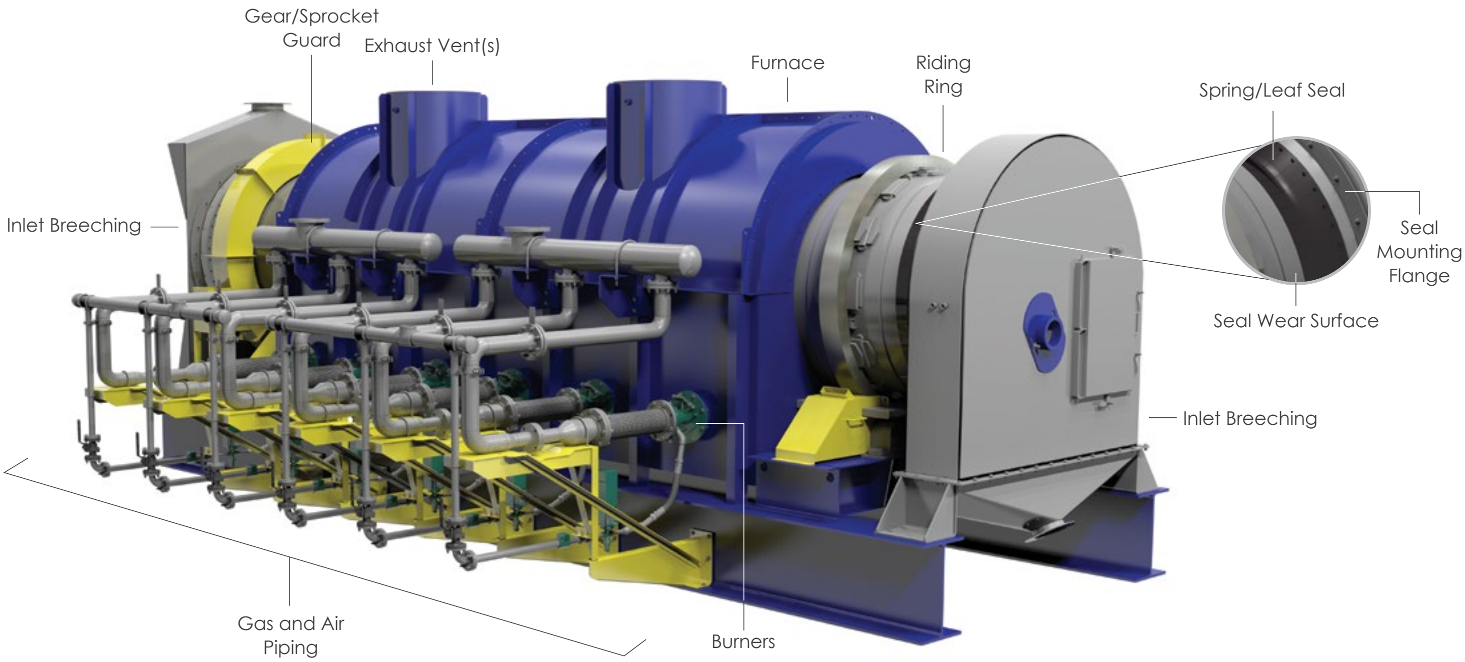


TABLE: **FEECO INDIRECT DRYERS AT A GLANCE:**

DIAMETER	3' - 15' (1 - 4.6m)
CAPACITY	1 TPH - 200 TPH+ (1 MTPH - 181 MTPH)
CUSTOMIZABLE?	Yes

into the system—typically by a feed screw or chute. The feed chute is specifically designed to be robust, resistant to wear, and to reduce material buildup.

AIR SEAL

Where the combustion chamber and discharge breeching meet the drum, a seal is needed to connect the stationary component to the rotating drum. The purpose is to keep air and material from leaving the drum prematurely. FEECO offers several different seal types, depending on the needs of the system at hand. This includes the labyrinth seal, single and double leaf seals, and the bellows seal.

DRIVE ASSEMBLY

The drive assembly is the mechanism that facilitates the rotation of the drum. Several options are available here: a chain and sprocket, gear and pinion, friction drive, or direct drive setup. A chain and sprocket setup is ideal for smaller rotary drums running up to 75 horsepower (55kW).

Gear and pinion drive assemblies are reserved for more heavy-duty applications running above 75 horsepower (55kW). A reducer decreases the speed of the motor for higher torque applications with both drive assembly types.

Friction drive assemblies are used for very small drums, typically around 6' (1.8m) diameter and under, with low horsepower. In this setup, two of the four trunnion wheels are connected by one shaft and driven by a shaft-mounted reducer and motor arrangement.

The direct drive setup is used for small- to medium-size drums with motor sizes up to 75 horsepower (55kW). The design consists of a shaft mounted to a solid discharge end plate at the outlet of the dryer. The motor and reducer are either directly connected to this shaft with a coupling, or a shaft mount arrangement.

TIRES (RIDING RINGS)

Tires (riding rings) add structural support for the drum, and serve as a place for pressure to be absorbed. The riding ring rides on the support roller.

THRUST ROLLERS

Thrust rollers push on the riding ring to stop the drum from drifting, or moving horizontally.

TRUNNION WHEELS

The trunnion wheels act as the cradle for the rotating drum shell. They ensure smooth and concentric rotation during operation. The wheels are mounted to steel support bases with sealed roller bearings. Support rollers bear the weight of the drum.

FLIGHTS

Available in several designs, material lifters, or flights, help to maximize efficiency of heat transfer between the material and the drying air. Flights pick up material and shower it through the air stream as the drum rotates, promoting efficient heat transfer between the material and drying air. Both flight design and flight pattern are customizable.

ADVANCING FLIGHTS

Advancing flights help to advance material into the drum, in order to prevent buildup near the wet feed discharge. Incorporating advancing flights into a rotary dryer also gives material a chance to dry before it reaches the next flights, a process which can help prevent potential sticking issues.

DISCHARGE BREECHING

The discharge breeching is where two main functions occur: product exits the dryer, moving on to screening, cooling, storage, or shipping, and the exhaust gas system removes off-gases from the system. Exhaust gas systems provide a place for spent gases and hot air (and small particulates) to exit the system.

COMMON ADD-ONS:

KNOCKING SYSTEMS

Knocking systems help to prevent buildup within the dryer, by “knocking off” material as the drum rotates. Various options are available for knocking systems.

DIRECT VS. INDIRECT DRYING

Direct dryers are used more frequently than their indirect counterparts, because of the efficiency they offer. And while direct rotary dryers are most often the selected drying method, indirect rotary dryers are a valuable alternative for specific processing needs. Below are some of the key differences between these two types of industrial dryers.

OPERATION

While both types of dryers are comprised of a rotating drum in which the processing occurs, these two types of dryers utilize very different methods to process the material.

Direct dryers rely on direct contact between the material and drying air to efficiently dry materials. As mentioned, efficiency is further increased by the addition of lifting flights affixed to the internal walls of the dryer.

Conversely, indirect dryers do not utilize direct contact with the drying air to reduce the material's moisture content. In fact, this is the precise advantage of an indirect rotary dryer; indirect drying allows the processing environment to be tightly controlled—an ideal characteristic when working with materials that can be combustible in certain settings.

Indirect dryers rely on the heat transferred through the externally heated drum's shell to dry the material via conduction and radiation. Subsequently, indirect dryers would not benefit from the addition of lifting flights, and instead utilize tumbling flights, which aid in material rotation and help to ensure process consistency.

Indirect rotary dryers also require an internal air flow, referred to as sweep air. Sweep air carries the evaporated moisture, along with dust particles from inside the dryer, to the exhaust system at the discharge breeching. This process ensures that the material is being dried to the required moisture percentage.

Furthermore, because the furnace exhaust is kept separate from the drying air, indirect dryers have the added benefit of requiring less exit gas treatment. This exit gas can even be used to preheat the combustion air and increase burner efficiency.

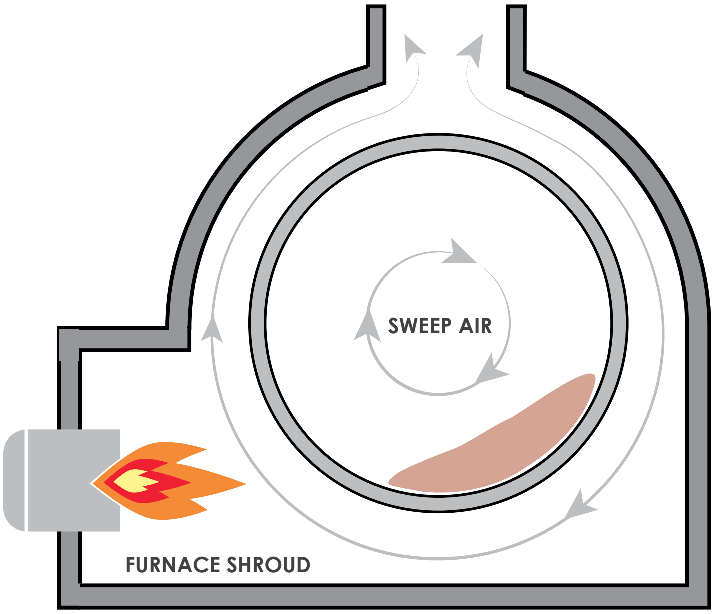


Diagram: The diagram above illustrates the air flow in an indirect rotary dryer, referred to as sweep air.

MATERIAL OF CONSTRUCTION

Unlike their direct counterparts, which are typically constructed of carbon steel, indirect rotary dryers are constructed using a high-temperature alloy in order to maintain the integrity of the drum, despite the constant exposure to high temperatures that the shell must endure.

INDUSTRIAL USE/APPLICATIONS

Direct rotary dryers account for most of the bulk solids drying applications, and are used throughout a multitude of industries, including agriculture, mining, specialty chemicals, and more. They offer heavy-duty processing and consistent reliability.

Indirect rotary dryers are better suited for niche applications, and are ideal for processing dusty, fine materials, or materials that cannot be exposed to drying air during processing. This is commonly seen with highly combustible materials, organics such as grains and pulps, and fine materials such as pigments.

ROTARY DRYER SIZING & DESIGN

The process of sizing a rotary dryer is one of precise engineering, involving complex calculations and meticulous design. While the process is not well simplified into a few paragraphs, an explanation can be offered as to some of the concepts behind the sizing process.

Many of the calculations behind sizing a dryer are based upon the characteristics of the material to be processed. The combination of characteristics such as moisture content, bulk density, specific heat, and heat transfer properties help predict how the material will behave in the dryer, and subsequently, how best to address the needs of that material through design and construction. These characteristics will not only help to determine the sizing of the actual drum itself, but also the operational mechanics of the dryer as well.

CHARACTERISTICS THAT AFFECT ROTARY DRYER DESIGN

RAW MATERIAL MOISTURE

Because the primary job of a rotary dryer is to dry the material, the first material characteristic to look at is the percentage of moisture the material holds in its raw state, as well as the desired moisture percentage of the output, commonly referred to as the inlet and outlet moisture, respectively. The difference between actual and desired percent moisture sets the stage for what the rotary dryer will need to accomplish, and how hard it will have to work to reach the end product goal.

BULK DENSITY

The bulk density of a material will also figure into the equation of sizing a rotary dryer. Typically, this is calculated in pounds per cubic foot in US units, or kg/m^3 in metric units, and refers to the weight of a material per a specific volume. For example, a material with a high bulk density, such as metal ore, will require significantly more energy per cubic foot than a material with a low bulk density, such as paper fluff. The amount of energy needed per cubic foot will in part determine how hard the dryer will have to work, and subsequently, will dictate the load on bearings, gear train, trunnion wheels, and the motor. This load will determine the sizing of these components to ensure they are fit to withstand the operational load.

SPECIFIC HEAT

The specific heat of a material also works into the sizing equation. Specific heat is defined as the amount of energy it takes to raise one gram of material by one degree Celsius. In other words, it refers to how resistant a material is to heating. Put simply, the specific heat of a material will help to figure out how much energy is needed to cause the desired change in temperature for that specific material.

HEAT TRANSFER PROPERTIES

The heat transfer properties of a material will also have an impact on dryer sizing and design. While some materials carry their moisture on the surface, other materials carry moisture on the inside of the material, making it more difficult to draw out. So while two materials may have the same percentage of moisture, they can require very different amounts of energy to reach the desired level of moisture.

MATERIAL LIMITATIONS

Materials are often accompanied by limitations that will steer the design process in one direction or another. Such is the case with materials that have the potential for combustion in certain settings, or when a material requires absolute sterility. In unique cases such as these, a direct rotary dryer would not be an option, so an indirect dryer would be used instead. The need for sterility can also dictate the material of construction used for the shell of the dryer. Other examples of material limitations that can affect the design process include:

- **Fragility:** Some materials may be too fragile to withstand lifting flights at the inlet of the dryer. Here, a "bald" section (a section where flights are not used) would allow the material a chance to harden before gradually being introduced to the dropping action.

- **Consistency:** Sludge-like materials, or other sticky materials, have the potential to stick to the shell of the dryer. The material then continues to stick and dry, until it becomes dry and poses a potential risk of fire. Materials like these will require extra attention to ensure efficient drying.

- **Use:** Some materials, particularly those that will be used by consumers, must remain sterile, and drying with an air stream would not be an option. Again, in situations such as these, an indirect dryer would be the drying method of choice.

PROCESSING ENVIRONMENT

In addition to material characteristics, the processing environment can also have an effect on dryer design and sizing. Factors such as humidity, elevation, and temperature can all change how a dryer will perform and how much energy will be required to produce the desired results.

FLIGHT DESIGN

The flight design inside the rotary dryer is also engineered around the material's unique characteristics. The objective with flight design is to create the ideal "curtain" of material. The curtain refers to the span of material created as the material is dropped from the flights, through the drying air. Ideally, the curtain will span the width of the interior of the drum, evenly falling from one side to the other.

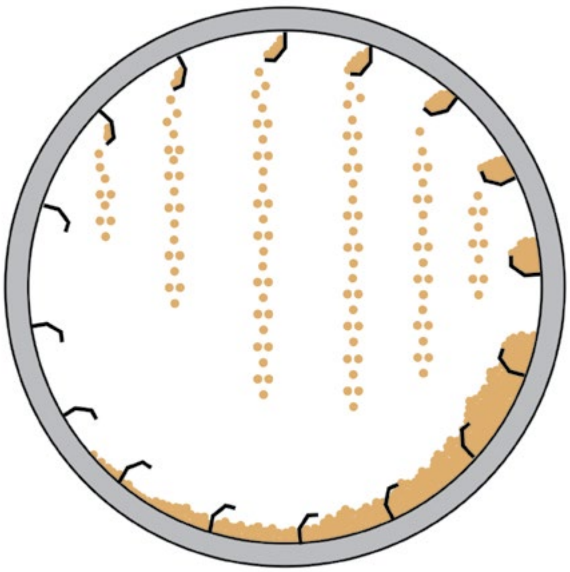
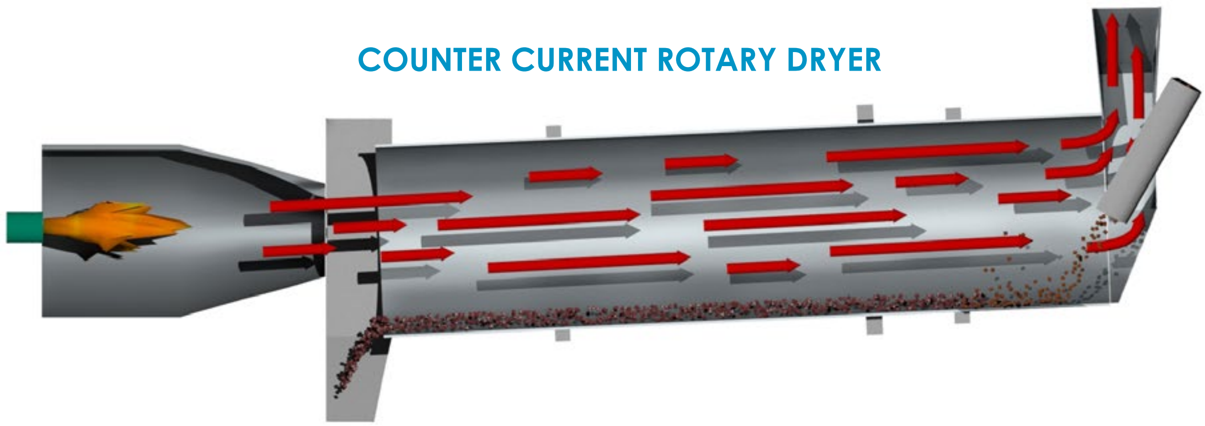
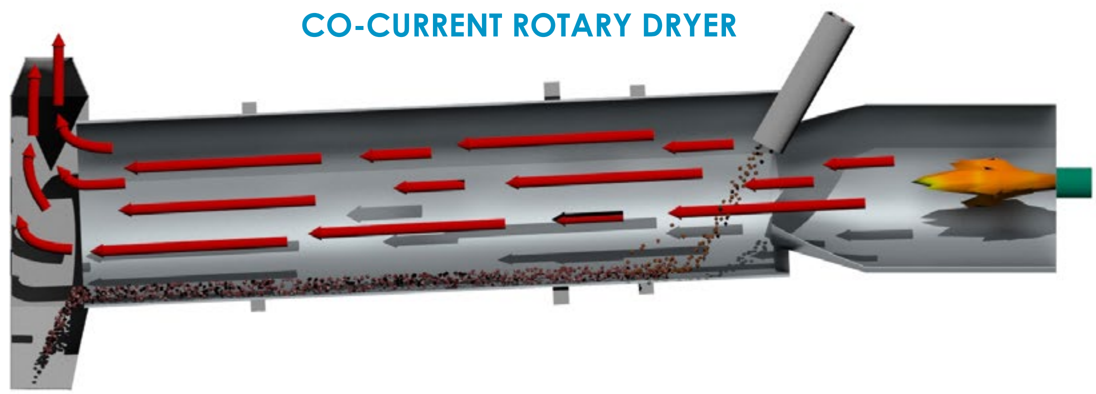


Diagram: The diagram above illustrates how flights create the curtain in a rotary dryer to maximize heat transfer.

COUNTER CURRENT ROTARY DRYER



CO-CURRENT ROTARY DRYER



The optimal curtain is created through designing the flights and flight pattern around material characteristics such as angle of repose, flowability, and more. As mentioned, both flight design and flight pattern can be customized to maximize processing efficiency.

AIR FLOW

Another critical factor in designing a rotary dryer that produces the desired end product characteristics is the air flow configuration, or the direction in which the drying air flows through the dryer in relation to the material.

As discussed, direct rotary dryers are available in two types of air flow configurations: co-current and counter current. Both options have been developed through extensive research and development in order to maximize the thermal efficiency of the rotary drying process. The selection of which air flow configuration will best suit the process is based on the material's properties, as well as overall process requirements. Even though the material characteristics are ultimately the deciding factor, it is important to understand how each air flow option is designed to fully understand the benefits each has to offer.

Co-current drying, which is also referred to as *parallel flow*, is when the drying air flows in the same direction as the material flow. This immediately puts the wettest material in contact with the hottest drying air, resulting in quick initial drying. This system also causes rapid cooling of the drying air, which results in a cooler surface temperature of the dryer shell compared to a counter current dryer. Furthermore, this design makes it much easier to control the temperature of the dried material, because it correlates directly with the air temperature. Co-current dryers work best with materials that have high external/surface moisture, such as glass. These materials require immediate heat to efficiently dry the material, while minimizing the opportunity for overheating.

Counter current drying is when the drying air flows in the opposite direction of the material flow. In this design, the wettest material comes in contact with the coolest drying air. Unlike the co-current system, the material will come in contact with the hottest drying air at the discharge end of the dryer, at its most dehydrated state. Because of this, the counter current method provides increased thermal efficiency for materials that need to be heated to high temperatures. For example, some mineral and ore processing applications require the material to be heated up to several hundred degrees. A counter current system is also beneficial for materials that retain moisture internally and require higher heat and a longer drying cycle to draw out the moisture.

Understanding how each air flow system works is only one of the many steps in designing the most efficient rotary dryer for the job. Both configurations have their unique and varying benefits for drying.

A Note on Preheating Combustion Air with Waste Heat: Rotary dryer burners require combustion air, dilution air, and a fuel source (natural gas, propane, fuel oil, etc.) for proper combustion. In most cases, this combustion air source comes from a blower that is forcing ambient air into the burner. This air is usually substantially lower in temperature than the process air temperature inside the rotary dryer. As a result, the burner needs to fire at a higher rate to accommodate heating of the ambient air, which increases the amount of combustion fuel needed and decreases burner efficiency.

One option to reduce the consumption of combustion fuel, is to use waste heat to preheat the combustion air. The ambient air is introduced to the waste heat system before traveling to the dryer (usually with an air-to-air or steam-to-air heat exchanger), raising the temperature significantly, which in turn, lowers the amount of combustion fuel needed for the desired dryer temperature. This waste heat can come from a couple of different sources. For example, leftover steam from another process in the facility could be used. Or, in the case of an indirect dryer, the heated furnace exhaust air may be recirculated into the combustion process since the air does not come into contact with any of the material being dried.

Recycling heated air from a direct rotary dryer is less desirable, because the exhaust air leaving the dryer is contaminated with dust particles that would need to be filtered before entering back into the combustion process. The filtering process (e.g., wet scrubber system, baghouse, etc.) may drop the temperature of the recycled air to a point where it would no longer be beneficial for preheating.

RETENTION TIME

Retention time is also an important consideration

FEECO rotary dryer and granulation drums being prepared for shipment

during dryer design. This is the duration of time that a material will need to remain in the dryer in order to achieve the desired results. Retention time is determined through looking at the specific heat, heat transfer properties, and moisture content of the material, and can be controlled through a combination of many factors, including dryer length, drum slope, dam plates, and more. A material that requires a lengthy retention time, for example, may require a longer dryer, where a process with a high throughput may require a dryer that is larger in diameter.

DRYER SIZING

In order to select a dryer with proper diameter x length, the total moisture load to be evaporated must first be determined. Total moisture is related to such items as amount of recycle, water added for proper granulation, amount of chemical heat (available and utilized), desired outlet moisture, ambient temperature and humidity. In addition, different materials have different specific heat values and vastly different coefficients of surface heat diffusion. Because these variables are somewhat interdependent and difficult to measure or predict, the selection of rotary dryers cannot be calculated, although some engineering analysis is required for proper size.

DRUM DIAMETER SELECTION

Diameter of the drum is generally selected on the basis of velocity of air flow. The velocity of air flow needs to be determined so minimal dust is carried over to the exhaust gas handling equipment. A larger diameter yields lower velocities with less carry over, as well as increased drying volume, but practical limits of diameter are generally established by price, space limitations, and consideration of particle breakage and attrition when falling in large diameter drums.

DRYER LENGTH SELECTION

Because of the variables mentioned, and such individual considerations as flighting pattern, rotational speed, efficiency of seals, and retention time, length must generally be related to diameter.

Though highly simplified, the concepts here offer a basic explanation for some of the theories behind the design and sizing of a rotary dryer, and demonstrate the importance that material characteristics hold in the sizing process. Sizing a rotary dryer often means finding the balance between how a material will behave in the dryer, the needed capacity, and the desired end product.

FEECO encourages that each material go through a research and development process at our on-site, concept testing facility—The Innovation Center. The information gained through our proven testing procedures allows us to design the most efficient and beneficial drying system for a given project's unique requirements.

ROTARY DRYER SYSTEMS: SUPPORTING EQUIPMENT

Rotary dryers are often supplied as a system, with the dryer being accompanied by several pieces of support equipment.

Sometimes referred to as "dryer islands," these systems foster seamless operation through ensuring that the rotary dryer is properly fed and meets the required exhaust handling specifications.

The typical support equipment that makes up a complete drying system is outlined here. In addition to our custom rotary dryers, FEECO can provide the listed equipment as part of a complete drying system.

TABLE: TYPICAL ROTARY **DRYER DATA**

The chart below illustrates common rotary dryer data points. Please note that all FEECO equipment is custom engineered around the project at hand, and this data is only a general representation.

STANDARD				METRIC					
DIAMETER (Ft.)	**LENGTH (Ft.)**	**CAPACITY (STPH)***	**HP**	**DIAMETER (m)**	**LENGTH (m)**	**CAPACITY (MTPH)***	**kW**	**HEAT SOURCE**	**DRIVE SPROCKET OR GEAR**
3'	20-30	8	7 1/2	0.9	6-9	7	5.5	Gas or Oil	Sprocket
4'	20-30	20	10-15	1.2	6-9	18	7.5-11	Gas or Oil	Sprocket
5'	20-40	30	15-25	1.5	6-12	27	11.0-18.5	Gas or Oil	Sprocket
6'	30-50	45	25-40	1.8	9-15	41	18.5-30	Gas or Oil	Sprocket
7'	40-60	60	50-60	2.1	12-18	55	37-45	Gas or Oil	Sprocket
8'	50-70	80	75-125	2.4	15-21	73	55-90	Gas or Oil	Sprocket
9'	50-80	100	100-125	2.7	15-24	91	75-90	Gas or Oil	Sprocket
10'	50-80	125	100-200	3.0	15-24	114	75-150	Gas or Oil	Gear
11'	60-90	150	150-250	3.4	18-27	136	110-150	Gas or Oil	Gear
12'	60-90	180	200-300	3.6	18-27	164	150-220	Gas or Oil	Gear
13'	70-100	210	250-350	4.0	21-31	191	185-260	Gas or Oil	Gear
14'	70-100	250	300-400	4.3	21-31	227	225-300	Gas or Oil	Gear

*Varies with materials to be dried. Capacity based on 60#/Cu. Ft. granular fertilizer materials having up to 10% moisture removal.

FEECO INTERNATIONAL

EXHAUST GAS HANDLING SYSTEMS & EQUIPMENT

All direct rotary dryers must be equipped with exhaust gas handling equipment. The level of exhaust gas handling required is based on the unique emissions requirements of the material being processed, combined with local, state, and federal regulations. Design of the exhaust handling system will differ based on the level of treatment needed.

Depending on the requirements, the exhaust gas handling system typically consists of one of the setups listed here. However, no matter what type of exhaust gas handling system is employed, an induced draft (ID) fan will be required.

ID FAN

The use of an ID fan creates a negative pressure environment, drawing exhaust gas, air and particulates, or "flue gas" through the system and facilitating their removal.

When a baghouse or baghouse & cyclone combination (outlined below) are implemented, the ID fan is always positioned after these items so it can be used to draw the exhaust through them.

For cyclone and scrubber applications, the ID fan can be positioned between the cyclone & scrubber or after the cyclone and scrubber. It is desirable to place it after the cyclone (and before the scrubber) when the exhaust gas contains chemicals that become corrosive when mixed with water from the scrubber. By doing this, the fan can be fabricated from carbon steel as opposed to a special alloy.

BAGHOUSE AND INDUCED DRAFT (ID) FAN

The baghouse with ID fan is typically the system of choice when there is not excessive carryover or a requirement to treat the exhaust gas for chemical pollutants such as VOCs, fluorine, etc.

The baghouse or bag filter collects any particulates that may have become entrained in the process gas and carried out through the exhaust air, which can especially be an issue when a high air flow velocity is combined with a fine material. Preventing the release of captured particulates into the atmosphere is a critical part of emissions control.

Not only do baghouses aid in air pollution control, but they can also be used to reduce wasted product; the dust and fines collected by the baghouse can often be recovered and reintroduced to the process, mitigating any waste lost as dust. In some operations, producers may choose to implement an agglomeration circuit to process baghouse fines or send them back to the process as recycle.

In the baghouse + ID fan configuration, the baghouse is positioned immediately after the dryer and before the ID fan.

CYCLONE, BAGHOUSE, AND INDUCED DRAFT (ID) FAN

When excessive carryover exists, the baghouse and ID fan are preceded by a cyclone to provide optimal exhaust handling.

Cyclones use centrifugal force to separate out larger dust particles. Incorporating a cyclone into the system prior to the baghouse increases dust and product

The discharge end of a rotary dryer (at right). Ducting carries air and particulates out to a cyclone and baghouse.

recovery. For this reason, this system is particularly beneficial when maximum recovery of dust and product is desirable, such as when working with a highly valuable material.

Cyclones first remove the bulk of the larger particulates, leaving the baghouse, which is not ideal for handling a lot of carryover, to filter out the remaining dust. As a result, this setup can help to prolong baghouse life and reduce the frequency of maintenance since the cyclone reduces the burden on the baghouse by handling the bulk of particulates. Furthermore, this setup allows baghouses to be effective in situations where they otherwise could not due to incompatible material characteristics (again because the cyclone removes the bulk of entrained material before the baghouse).

CYCLONE, SCRUBBER, AND INDUCED DRAFT (ID) FAN

A cyclone combined with a scrubber and ID fan can be the best option when chemical pollutants are present.

Unlike the two aforementioned systems, which are considered dry handling, the cyclone and scrubber combination is considered wet handling.

The scrubber utilizes a fluid solution (often water) to clean contaminants and particulates from exhaust gas. In this setup, the cyclone serves to remove the majority of the particulates, while the scrubber removes the remainder, along with any harmful chemical components.

COMBUSTION REQUIREMENTS

In direct rotary dryers, a controlled combustion reaction is used to produce the process drying gas. This will always require a burner, and in some cases, a combustion chamber.

BURNER

The burner provides the source of combustion, using the fuel source, along with combustion and dilution air to create a combustion reaction that produces the required energy.

Shown here is the burner integrated into the combustion chamber of a rotary dryer for processing frac sand.

Burners can be designed to accept several fuel sources, including natural gas, propane, diesel, and more.

As mentioned, waste heat from various sources can sometimes be used to preheat combustion or dilution air to improve burner efficiency. The combustion air required to assist in the combustion reaction typically comes from a blower forcing air into the burner. The burner heats up the combustion and dilution air to produce the necessary process drying gas. An air-to-air or steam-to-air heat exchanger can be used to raise the temperature of waste heat, allowing it to be fed in as the combustion or dilution air, reducing the burden on the burner and increasing efficiency.

COMBUSTION CHAMBER (OPTIONAL)

Combustion chambers are not required in all settings, but can be a valuable add-on. Combustion chambers serve to house the combustion reaction and direct the airflow into the dryer (either co-currently or counter currently).

Implementing a combustion chamber can offer a number of benefits. Perhaps most importantly, the addition of a combustion chamber can promote a quality product by preventing contact between the burner flame and the material being processed.

Combustion chambers are highly customizable. The base design of a FEECO combustion chamber offers the following benefits:

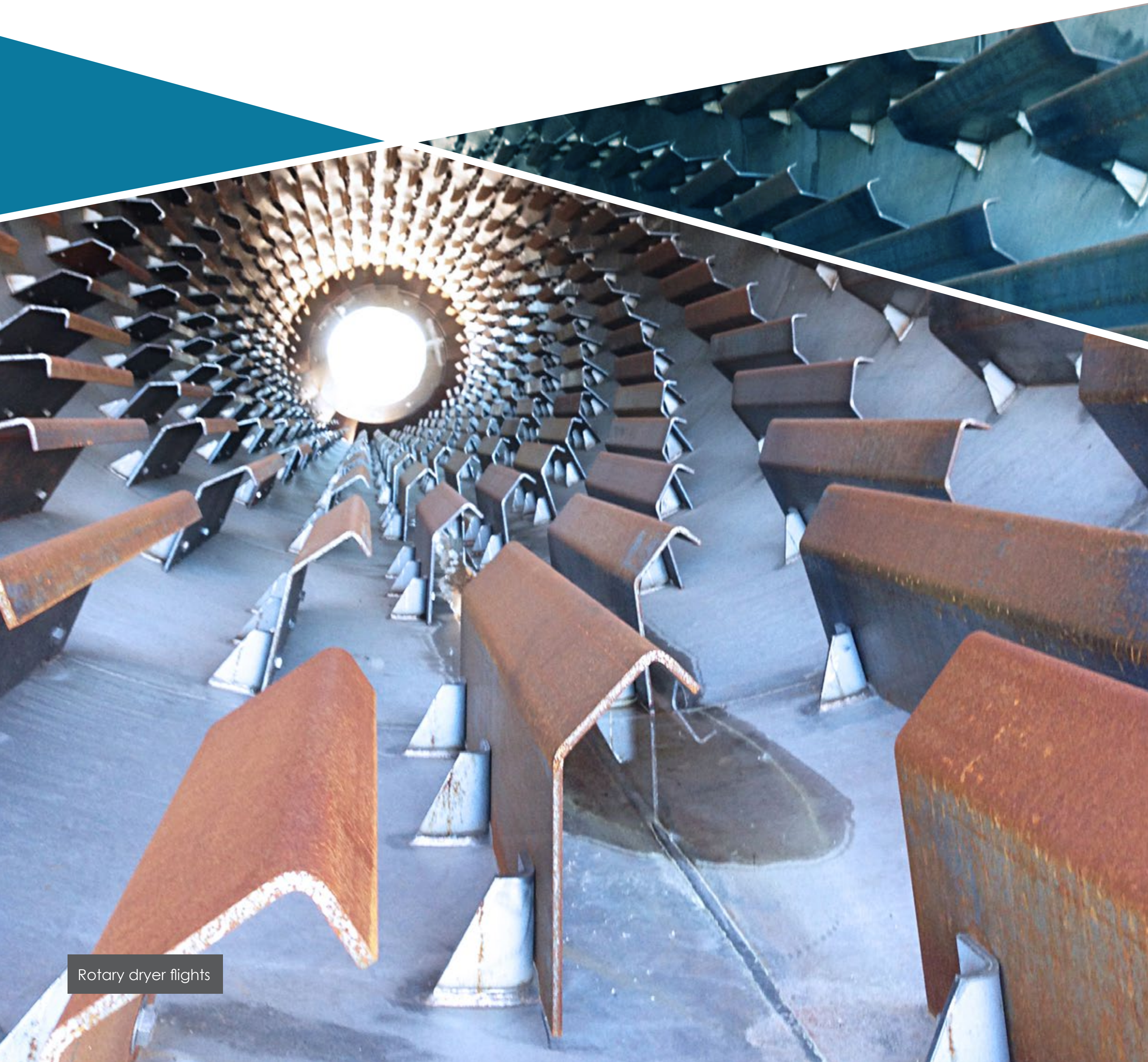
- Lower drying cost through a more complete combustion of fuel
- More uniform drying
- Avoidance of product breakdown
- Lower cooling capacity requirement

MATERIAL HANDLING EQUIPMENT

In addition to the immediate support equipment, various types of bulk material handling equipment will be required to transport material to and from the dryer. This might include steep incline conveyors, belt conveyors, bucket elevators, feeders, trippers, plows, and more.

Considerations in DRYING

ROTARY VS FLUID BED | CHALLENGES IN PROCESSING | TESTING



Rotary dryer flights

ROTARY DRYER OR FLUID BED DRYER?

When it comes to buying an industrial dryer, buyers are often faced with the decision to choose between a rotary dryer and a fluid bed dryer. Historically, rotary dryers have been used for more industrial applications, such as minerals, fertilizers, and aggregates, while fluid bed dryers have been used more in the pharmaceutical, specialty chemical, and food industries. Despite some industry preferences, the drying capabilities of these two industrial dryers have allowed for a significant amount of overlap in applications, and subsequently, confusion for what is ultimately the best choice when comparing the two.

Though the choice between a rotary and fluid bed dryer can be material or industry specific, ultimately, each dryer has its own advantages and disadvantages. With comparable capital costs, the decision often comes down to customer preference and what will best suit the processing conditions, with a few considerations to keep in mind….

MATERIAL CONSIDERATIONS

Rotary dryers have been called the "workhorse" of the industrial drying industry, due to their heavy-duty construction, their high-capacity capabilities, and most of all, their ability to accept significant variance in feedstock. Because of this, rotary dryers are better suited for heavy-duty materials where a lot of variety in feedstock is a given, such as in the case of various minerals. Rotary dryers are known for their ability to take what is given, big or small, wet or dry, lumpy or uniform, and produce a quality product.

Conversely, fluid bed dryers have a very tight window when it comes to variability in feedstock, requiring as much uniformity in particle size distribution and moisture content as possible. Where a rotary dryer will just keep running with little to no process upset, variability in feedstock with a fluid bed dryer has the potential to leave an operation at a standstill. Feedstock with lumps or inconsistencies in moisture content can cause serious problems when processed in a fluid bed dryer.

Additionally, rotary dryers are better suited for heavy-duty processing loads, such as those found in the mining industry. Because it takes significant energy to fluidize large or heavy materials, it may not be practical to process these types of materials in a fluid bed dryer. Fluid bed dryers are best reserved for applications processing lighter-duty materials.

Materials that must not suffer degradation are better served in a fluid bed dryer. Rotary dryers often result in some, albeit little, degradation to material, because of the fact that the material is being picked up and dropped. This is not an issue with all materials, but can be an issue with some.

Rotary dryers do offer the advantage of "polishing" granules; because of the rolling action on the bed of material, loose edges are knocked off, and granules are further rounded, or "polished."

CAPACITY & SPATIAL FOOTPRINT

Rotary dryers are typically larger than fluid bed dryers, and therefore require a larger spatial footprint in the processing plant. Fluid bed dryers are smaller, and have the advantage of being modular, allowing them to be added on to, and making them ideal for situations where there is a likelihood for operational growth.

However, rotary dryers are capable of processing a much higher throughput - up to 300 TPH in a single unit depending on the requirements of the system. Fluid bed dryers handle closer to 100 - 150 TPH per unit.

OPERATIONAL CONSIDERATIONS

Rotary dryers require significantly less supervision than their fluid bed counterparts. Rotary dryers are largely unaffected by fluctuations in feedstock and other processing conditions, such as reduced feed. They offer a consistently reliable solution in settings where inconsistencies in feedstock and instabilities in processing are to be expected.

Fluid bed dryers are much less suited for these types of situations, requiring a very consistent processing environment.

ELECTRICAL ENERGY CONSUMPTION

The choice between a rotary dryer or fluid bed dryer is also a matter of energy. Fluid bed dryers work by fluidizing the material, which requires a high magnitude of air. Additionally, because it takes a certain amount of energy to fluidize a material, energy is not reduced when running at lower capacities. Rotary dryers require less electrical energy to dry material, and energy consumption is reduced when running at decreased capacities.

Fluid beds also often require a much more extensive and costly air handling system as a result of the magnitude of air required for fluidization.

MAINTENANCE & LIFESPAN

In terms of maintenance and lifespan, rotary dryers and fluid bed dryers are comparable.

TABLE: **ROTARY VS. FLUID BED SUMMARY**

The chart below summarizes some of the most important considerations to examine when choosing between a rotary and fluid bed dryer.

	Rotary Dryer	Fluid Bed Dryer
ELECTRICAL ENERGY CONSUMPTION	Requires less energy	Requires more energy
THERMAL EFFICIENCY	Comparable	
CAPITAL COSTS	Comparable	
CAPACITY & SPATIAL FOOTPRINT	Up to 300 TPH per unit Large footprint	100 - 150 TPH per unit Small footprint Modular design allows for easy operational growth
MAINTENANCE	Comparable	
FEEDSTOCK VARIANCE	Insensitive to variance	Highly sensitive to variance
INDUSTRY	Minerals Fertilizers Raw Materials	Pharmaceuticals Specialty Chemicals Foodstuffs

CHALLENGES IN ROTARY DRYER PROCESSING

Rotary dryers may be the workhorse of the industrial drying industry, but that does not mean they are without challenge. Different materials can present unique challenges, and will require careful preparation in many cases, and routine maintenance in others, in order to prolong the life of the rotary dryer and ensure processing efficiency is maintained. The most common challenges faced in rotary dryer operation include: buildup, abrasion, and corrosion.

BUILDUP

While rubber, ceramic, or even stainless steel liners offer an effective solution to preventing buildup in other rotary drum applications, where heat is used, such as in the case of a rotary dryer, liners are typically not an option. Because heat causes materials to expand, and different materials expand at differing rates, installing a liner into a rotary dryer would more than likely result in problems. For this reason, knocking systems are the most common way to address buildup when it comes to rotary dryers.

There are two predominant designs for knocking systems: ball & tube knockers and pneumatic hammer knockers. Each design serves to "knock off" potential buildup as the drum rotates. No matter which design is chosen, a wear plate or band is also installed to protect the shell of the drum from the knocking, while still allowing the vibration from the knock to dislodge any potential buildup within the drum.

Although there are many ways to keep buildup under control, the best way to control it is to prevent it from the start. There are a couple of ways to approach this.

One way to prevent buildup is to adjust the feedstock through what is called back-mixing. Back-mixing takes place when dry material is added to the wet, raw material in order to make it less sticky. However, this is not always an option, as some materials remain sticky for a wide range of moisture levels. In cases such as this, a heated screw could be a more efficient choice over a rotary dryer.

Another way to prevent buildup is to design a less aggressive internal flight. Because buildup tends to occur in sharp corners, a less aggressive flight can reduce the propensity for buildup to occur. In this situation, some efficiency is lost, but the decline in buildup can be a compensating factor. Additionally, adding a bald section in the beginning of the drum allows the feedstock to dry a little before it hits the flights, also lessening the chances for buildup to occur.

ABRASION & CORROSION

Aside from buildup, abrasion and corrosion are also common challenges faced by many rotary dryer owners. Though abrasion and corrosion can wreak severe havoc on a dryer if left unattended, there are ways to help prevent the potential for abrasion and corrosion, as well as ways to minimize damage.

Abrasion and corrosion can have similar effects, but they are very different in nature. While corrosion is chemical in nature, abrasion is physical in nature. Many materials processed in a rotary dryer are abrasive, including limestone, potash, and sand.

FEECO INTERNATIONAL

Flights corroded away in a rotary dryer

As material rubs on the shell, the metal gets worn down from the abrasive material.

Corrosion, on the other hand, is purely based on chemical reactions. Acid, for example, will erode a metal shell over time, because the carbon in the metal reacts with the acid, leading to premature wear.

In order to protect against abrasion or corrosion, it's important to choose materials of construction that are more resistant to such phenomena. The correlation between the material of construction and the material to be processed is particularly important to understand in preventing corrosion. Since corrosion is a chemical action, one must understand how the material being processed will react with the materials of construction. Choosing stainless steel or alloys when fabricating a rotary dryer will help to minimize corrosion. Protective coatings can also be an option to protect the shell of a rotary dryer, with a variety of choices available.

When processing a material that is corrosive or abrasive, careful monitoring is integral to preventing major damage. Routinely inspecting surface areas for any sign of damage goes a long way in avoiding major problems; catching potential problems early can mean the difference between a minor repair and equipment replacement. Particularly with corrosion, cracks, crevices, and rough surfaces all increase the opportunity for corrosion and should be carefully inspected and repaired if necessary. Also when working with corrosive materials, material should not be allowed to build up, or sit for long periods of time. Again, this promotes corrosion and should be prevented in order to prolong the life of the dryer.

DRYING TEST STUDIES

Testing for drying processes offers valuable information when designing an industrial drying system. Testing offers the opportunity to confirm the viability of your intended process, as well as to work out process variables and other unknown data points, helping to define a recipe for success, and reduce the opportunity for surprises after process scale-up.

There are many reasons why it may be desirable to test a material prior to purchasing equipment or investing in a full-scale production facility:

TO TEST PRECONDITIONING

Material is often dried prior to further processing in order to prevent upset conditions in subsequent processing equipment. Preconditioning a material also helps to improve the end product. Most processes require a material feedstock within a specific range of moisture. Testing will help to determine what drying parameters are required to reach the target moisture range. If that moisture range is not known, testing can help to determine the ideal moisture range.

TO CONFIRM END PRODUCT CHARACTERISTICS

Most often, manufacturers and processers are looking to create a product with very specific characteristics. Testing can ensure that characteristics such as attrition, crush strength, compression, bulk density, and moisture content are all met. Here again, testing also defines the processing variables required to reach this specific matrix of parameters.

TO OPTIMIZE AN EXISTING PROCESS

Test studies are also valuable to improve an existing process. This might include testing a recycle loop, adding in a back-mixing process prior to the rotary dryer, or simply optimizing the operating parameters of the dryer from a process and/or energy standpoint.

TO DESIGN A NEW DRYING SYSTEM

Testing is particularly valuable when looking to design a new industrial drying system. This will help define process variables, ensuring the dryer will meet the exact needs of the material to be processed.

This is especially true when working with a process that is not well established, or a material that is not often (or ever) processed. Testing will not only help to work out process variables, but will also provide a starting point for scaling up the process, essentially offering a recipe for full-scale production.

WHAT CAN BE TESTED?

During testing, a variety of characteristics can be measured, depending on the needs of the process and end product. Typically, the following points of data are tracked and analyzed during testing:

- Inlet moisture content of material
- Outlet moisture content of material
- Inlet material temperature
- Outlet material temperature
- Material feed rate
- Residence time
- Inlet process air temperature
- Outlet gas parameters

All of these parameters can be adjusted throughout processing to reach ideal end product characteristics, including crush strength, compression, bulk density, and moisture content.

When it comes to measuring moisture during testing, FEECO process engineers use a specialized device, called a moisture analyzer, to record the amount of free moisture present in agglomerates. With most materials, reaching a target moisture range, or even an exact percentage, is required for the final product. This ensures agglomerates perform as desired, and do not result in clumping or breakdown issues.

FEECO Rotary Dryer with combustion chamber

While manual moisture analysis testing is still widely practiced, the Innovation Center uses a highly advanced, in-line moisture analysis device. Manual moisture testing can still be carried out, but this new tool allows for real-time measurement and analysis without destructive sampling or disruption of the process.

In addition to measuring these standard parameters, the FEECO Innovation Center has the capability to test various flight designs and patterns. Optimizing the design of the flight itself, as well as the pattern of the flights in the drum, helps to maximize drying efficiency. More information on the FEECO Flight Simulator can be found on page 29.

The Innovation Center can also test the impact of residence times by adjusting speed and through the insertion of dams in the dryer.

Testing can be carried out in the dryer alone, or as part of a larger agglomeration/granulation process.

AUTOMATION

We have partnered with Rockwell Automation to bring our customers the best in process automation, both as part of testing in our Innovation Center, and as part of a system purchase. A variety of data points can be tracked and adjusted from a single interface, in real time during testing. This includes:

- Horsepower
- Amps
- Feed rate
- Hertz
- Temperature
- Flow Rates
- Torque
- Gas Sampling & Analysis

In addition, data points can be selected, trended, and reported on, allowing users to select only the data they need, from the exact time frame desired.

Testing is a valuable component to designing a new drying system, or optimizing an existing one. Whatever the reason for testing, testing can provide the valuable information needed to reach the ideal drying solution.

AVAILABLE **TEST UNITS**

- 3’ (0.91m) Diameter x 20’ (6.1m) long rotary dryer
- Flight/Lifter Simulator (for testing flight design and pattern)

The FEECO Innovation Center offers a variety of testing options to simulate the conditions in continuous, commercial-size rotary dryers. Testing offers a host of invaluable information, allowing you to gain critical data on your material, work out process variables, and develop a recipe for process scale-up.

Our flexible setup, combined with the expertise of our process engineers and our experience with hundreds of materials allows a variety of thermal tests to be expertly conducted. We can run tests in the dryer alone, or test your material as part of a continuous process loop as part of a larger agglomeration or granulation process. Samples can be gathered throughout testing to assess particle characteristics.

In general, testing is typically carried out in two phases:

1. Proof of Process - A continuous testing phase that aims to establish the equipment setup and parameters required for continuous production of your specific material.

2. Process/Product Optimization - An in-depth study to optimize your specific material’s characteristics and/or production parameters in an industrial setting.

OPTIONAL TESTING CONDITIONS & EQUIPMENT:

- Baghouse
- Data Collection & Trending System
- Direct or Indirect
- Parallel (Co-Current) Flow
- Removable Flights, Dams, and Bed Disturbers
- Thermal Oxidizer
- Water Quench Tower
- Wet Scrubber

COMMONLY TARGETED PARTICLE CHARACTERISTICS:

- Attrition
- Baghouse Efficiency
- Bulk Density
- Compression
- Crush Strength
- Flowability
- Moisture Content
- Particle Size Distribution
- Solubility
- Temperatures

REPORTING & DATA IN REAL TIME

A variety of data points can be gathered during testing, many of which can be viewed, trended, and even adjusted in real time from a single user interface for optimal process transparency. Data collected during dryer testing may include:

- Current (Amps)[RT]
- Burner Fuel Usage
- Drum Slope
- Fan Speed [RT]
- Feed & Product Rates [RT]
- Temperature (Feed end, Internal, Thermal Oxidizer, Product, & Exhaust Gas) [RT]
- Residence Time
- Rotational Speed
- Particle Size Analysis of Feed & Product
- System Pressures [RT]
- Gas Sampling & Analysis (Oxygen, Carbon Monoxide, Nitric Oxide, Nitrogen Dioxide, Sulfur Dioxide, and combustibles discharged from various thermal processes)* [RT]

Automated with Rockwell Automation
Allen-Bradley · Rockwell Software

([RT]) Indicates that the data can be tracked in real-time.
(*) Gas sampling & analysis is available at an added cost

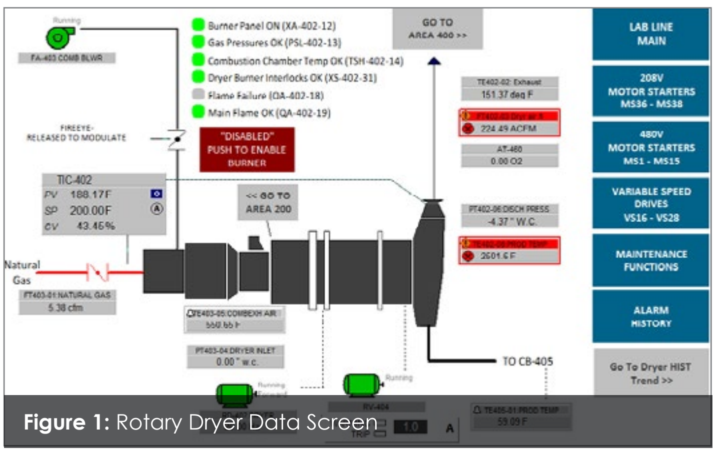


Figure 1: Rotary Dryer Data Screen

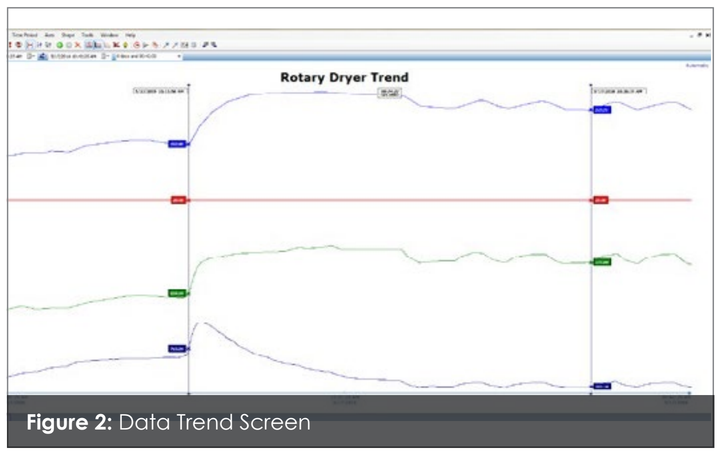


Figure 2: Data Trend Screen

FEECO can integrate third party equipment into your control system, giving you complete process tracking and visualization. Secure remote access to the system by a Rockwell Automation expert provides unparalleled troubleshooting capabilities.

MATERIAL **TRANSFORMATIONS**

Completed through testing in the Innovation Center

BEGINNING MATERIAL	FINAL END PRODUCT	Agglomeration	Drying	Blending	Thermal	Compaction
Ammonium Sulfate	Granular Fertilizer					●
Ash (Wood, Fly)	Granular Fertilizer	●	●			
Bentonite Clay	Cat Litter Granules	●	●			●
Biomass	Biochar, Activated Carbon		●		●	
Bone Meal	Granular Fertilizer	●	●			
Calcium Carbonate	Granular Fertilizer	●	●			
Calcium Chloride	Ice Melt Pellets	●	●			
Calcium Sulfate	Granular Fertilizer	●	●		●	
Carbon Black Dust	De-dusted Pellets	●	●			
Cell Phone Batteries	Lithium, Zinc Metal Recovery				●	
Cement Kiln Dust	Granular Calcium Fertilizer	●	●			
Ceramic/Aluminum	Refractory	●	●			
Clay	Proppants				●	
Clay	Cat Litter, Oil Dry Granules, Encapsulate Seeds	●	●	●		
Coal Dust	De-dusted Coal Pellets	●	●			●
Composts(Yard Waste)	Granular Fertilizer	●	●	●		
Copper Dust	Metal Recovery Pellets	●	●	●		
Corn Cobs	Cat Litter, Oil Dry Pellets	●	●	●		
Diatomaceous Earth	Filter Agent	●	●			
Dredge Sludges	Non-leaching Granules	●	●	●		
Electric Arc Furnace(EAF) Dusts	Metal Recovery	●	●	●		
Ethanol Plant Waste(DDG)	Animal Feed	●	●	●		
Foundry Dust	Metal Recovery	●	●	●		
Glass Batch	Glass Blend	●	●	●		
Gold Ore Dust	Precious Metal Recovery	●	●	●		
Grain Dust	Non-explosive Pellets	●	●	●		
Gypsum	Granular Fertilizer	●	●			
Gypsum Wallboard Waste	Granular Fertilizer, Cat Litter Pellets	●	●	●		
Humate	Granular Fertilizer	●	●	●		
Iron Ore	Metal Recovery Pellets	●	●			
Iron Oxide	Metal Recovery Pellets	●	●	●		
Kaolin Clay	Paper Coating	●	●			
Lime (Wastewater Treatment Sludge)	Granular Calcium Fertilizer	●	●	●		
Limestone	Granular Calcium Fertilizer	●	●	●		
Manure – Cattle/Chicken/Hog	Granular Fertilizer	●	●	●		
MAP Fertilizers	Granular Fertilizer	●	●	●		
Mined Frac Sand	Dried Frac Sand		●			
Municipal Wastes	Granular Fertilizer, Fuel Pellets	●	●	●		
Nickel Ore	Metal Recovery Pellets	●	●			
Nitrogen Fertilizers	Granular Fertilizer	●	●	●		
NPK Blends	Granular Fertilizer	●	●	●		●
Paper Sludge	Granular Fertilizer, Cat Litter	●	●	●		
Paper Sludge	Bright White Clay				●	
Petroleum Coke Dust	Fuel Pellets	●	●	●		●
Phosphates Powder	Granular Fertilizer	●	●	●		
Potassium Chloride	Granular Fertilizer	●	●	●		●
Raw Coal	Purified Coal				●	
Saw Dust	Cat Litter, Fuel Pellets	●	●	●		●
Soda Bottles	Recycled Plastic				●	
Soy Flour	Animal Feed	●	●	●		
Steel Dusts and Sludges	Metal Recovery Pellets	●	●	●		●
Sugar	Sugar Pellets	●	●	●		
Sulfur Dust	Non-explosive Pellets	●	●	●		
Sulfur Stack Emissions	Granular Fertilizer	●	●			●
Talc Ore	Sterilized Baby Powder				●	
Tar Sands Waste Sludge	Substitute Fuel Pellets	●	●	●		
Titanium Dioxide	Pigment Pellets	●	●			●
Titanium Metal Shavings	Metal Recovery	●	●	●		
Tungsten Oxide	Metal Recovery Pellets	●	●			●
Zinc Oxide	Metal Recovery Pellets	●	●			●

Agglomeration: Drum, Pan Pelletizer, Pin Mixer

Drying: Rotary Drum Dryer, Fluid Bed Dryer

Blending: Pug Mill

Thermal Process: Rotary Kiln

Roll Compaction: Roll Compactor

SCHEDULE A TEST

To discuss your testing needs with one of our process engineers and schedule a test, contact us today at:
FEECO.com/contact

WHY FLIGHT DESIGN MATTERS

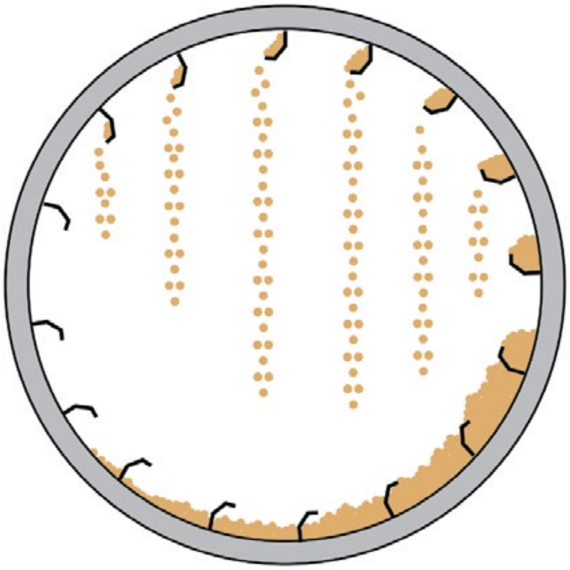
Flights, also known as material lifters, are a key component in the performance of rotary dryers and coolers.

As the unit rotates, flights pick up the material, carry it higher, and drop it through the air stream, creating what is referred to as a curtain - a shower of material spanning the width of the drum's interior.

The optimal curtain will maximize heat transfer between the material and process air. However, all materials behave differently; some may have a high angle of repose; others may tend to stick or cause build-up. Flights must be designed to work with the unique characteristics of the material in order to create the ideal curtain.

A variety of factors work together to influence how the material will respond: flight size and geometry, spacing, material of construction, drum speed, loading, and more.

The FEECO flight simulator is a valuable complement to the testing services offered in the FEECO Innovation Center. This versatile tool can provide a wealth of information. Whether you need to determine the best flight design or pattern for a new system, optimize the flights in an existing unit, or test a change in process conditions, the FEECO Innovation Center can help!



The diagram above illustrates how flights create the curtain in a rotary dryer to maximize heat transfer.

HOW THE FLIGHT SIMULATOR WORKS

The 45" diameter x 24" deep rotating drum can simulate process conditions in a commercial size unit.

Lifters are mounted equally spaced along the circumference of the test unit and easily changed for testing various options. Data from existing flight designs can be scaled for comparison.

A variable speed drive is used to adjust the rotational speed of the drum, while a clear plastic cover allows for visual observation throughout the testing process.

The pictures above show the same lifter configuration at two different rotational speeds. In the drum on the right, the rotational speed was increased, improving the distribution of material across the drum's cross section (the open spaces between the falling pellet streams would be filled in by off-setting the lifters along the length of the drum).

DATA GATHERED

The flight simulator tests your specific sample of material to gather a number of data points that will allow process experts to determine the optimal combination of flight design, pattern, drum loading and speed to achieve the best results. This includes:

- Number of flights
- Flight design (radial, single bend, double bend)
- Flight pattern (staggered, in-line, etc.)
- Loading/Percent fill (amount of material in drum at one time)
- Drum speed (RPM)
- Moisture content
- Particle size distribution

The image above shows the testing of a bed disturber (aka a mixing flight) with a talc material. The goal of the test was to determine how well the talc was being mixed as a result of the bed disturber. In a process setting, this would ensure uniform temperature throughout the bed.

A black tracer was added to the simulator as a visual indicator of effectiveness. The black disappeared within 3-4 revolutions of the unit, showing that the disturber was effective.

Various tests are performed to analyze performance of the selected variables, including:

Degradation (Attrition) Tests - Analyzes how the selected variables impact the amount of attrition (the breakdown of granules into fines)

Flight Fillage Tests - Measures the volume of material in a flight at a given point to determine the rate at which material is being discharged

Visual Analysis - To determine the impact of the selected variables on the material behavior; is the material showering or discharging in clumps; is bridging between flights occurring; are the lifters completely emptying?

Once process experts have come to a conclusion, parameters can be tested in our continuous, pilot scale rotary dryer to confirm process success.

The flight simulator is just one of the tools FEECO process experts use to engineer custom equipment suited to your unique process needs. For more information, contact us today!

INSTALL & MAINTENANCE

INSTALLATION TIPS | ALIGNMENT | PREVENTATIVE MAINTENANCE

Installation of a FEECO Rotary Dryer

Installation of a FEECO Rotary Dryer

ENSURING A SMOOTH DRYER INSTALLATION

A rotary dryer is a major investment and integral part of many industrial processing systems. And while a significant amount of time and research is put into finding the right rotary dryer manufacturer and engineering a solution that blends seamlessly into a process, the work is far from done after the purchase. Installation requires just as much planning and attention to ensure proper installation, optimal performance, and equipment longevity.

WHY PROPER DRYER INSTALLATION IS IMPORTANT

A properly installed rotary dryer is the first step in prolonging equipment life and reducing potential downtime and maintenance. Problems that begin at install can quickly turn into serious damage and downtime. A poorly installed rotary dryer can result in a variety of problems, including:

- Damage to wheels/tires from poor alignment
- Damage to drum shell because it was handled improperly
- Re-work needed and/or voided warranties because critical hold points/inspections were not carried out

However, there are a few simple steps you can take that will help to achieve a smooth and successful installation, avoiding the problems mentioned above.

KEY STEPS FOR A SMOOTH ROTARY DRYER INSTALLATION

HAVE A CUSTOMER SERVICE ENGINEER ON-SITE

Having a customer service engineer or service technician from the manufacturer on-site for installation offers many benefits. Customer service engineers are well trained in the exact specifications needed for efficient installment and operation of your specific equipment. They know what to look for, any potential places error can occur, and can oversee installation, assuring that things are done right, and no warranties are voided in the process.

In addition, customer service engineers are a valuable source of knowledge for answering installation and operational questions on the spot. Furthermore, they can train maintenance personnel on the ins and outs of the equipment during their time on-site.

PLAN AHEAD

Contacting the equipment manufacturer well ahead of the installation date to begin planning is vital to carrying out a seamless rotary dryer installation. Ideally, the equipment purchaser, manufacturer, and installation contractor should be in contact with one another prior to installation so that everyone knows what needs to happen before install day arrives. This will help to ensure that on-site customer service engineers and supporting manpower will have everything they need on-site, and won't waste valuable time waiting on things that could have been prepared for. The items listed below should be considered during the planning stages of installation:

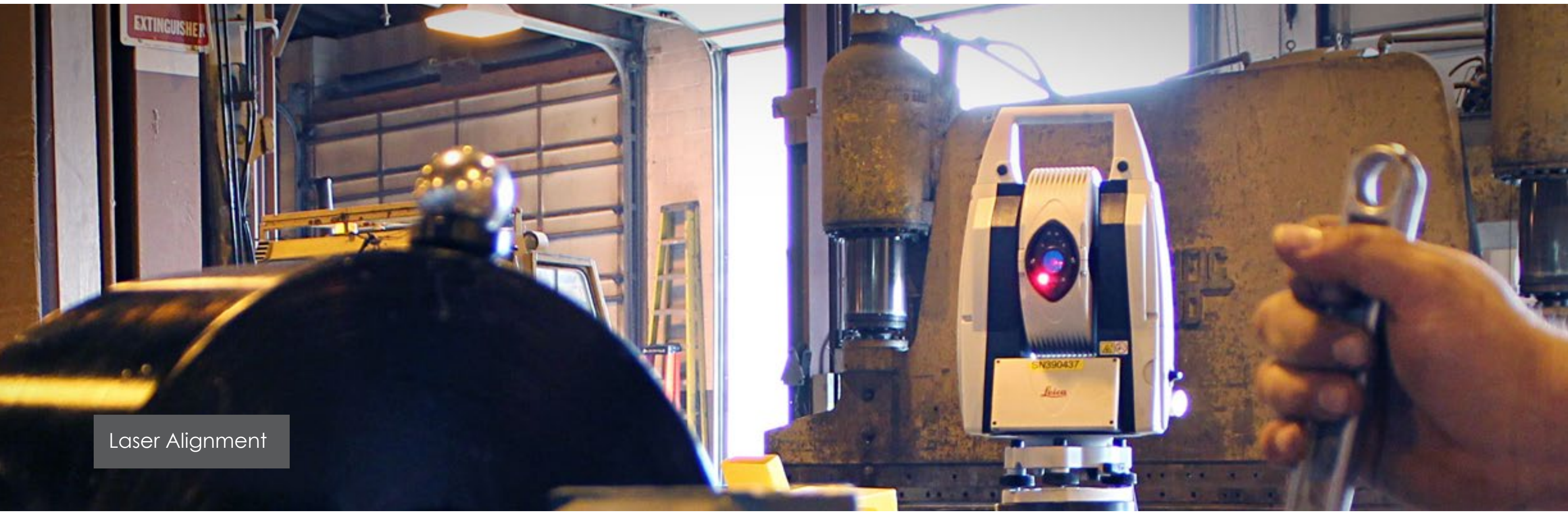
Appropriate equipment staging: In cases where the dryer is a replacement and will need to be fit into place, ensuring all ancillary equipment, such as feed chutes and/or discharge chutes are in place and pre-positioned, will prevent wasted time during install. This is less of a concern when putting together a new process where equipment will be fit around the drum, but can still be prepared for.

Materials & Equipment: Having the right materials and equipment on hand can mean the difference between a smooth install and days wasted. Materials such as grout needed for pouring under bases, or shimming materials used in the alignment process, should all be purchased and prepped for install. It's worth mentioning also, that the proper tools and equipment should be on-site. While most install contractors will have the right tools and equipment at their disposal, the importance of having them on-site and ready for use cannot be emphasized enough. This too, will prevent wasted time waiting for the proper tools or equipment to arrive. An inadequate crane, for example, could mean that technicians have to wait for a new crane to arrive and be mobilized before work can begin.

Pre-Alignment: The contractor should install and pre-align the drum bases prior to installation day. Having the bases installed and pre-aligned will allow engineers to begin their work right away on installation day, instead of waiting a day or two for the pre-alignment to be completed.

The proper installment of a rotary dryer is key to process efficiency, prolonging equipment life, and avoiding unnecessary downtime and maintenance. Adequate planning for installation, such as having the appropriate materials, manpower, and equipment on hand, will go a long way in ensuring a smooth rotary dryer installation.

All of the items above can be planned for through a simple conference between the equipment purchaser, installing contractor, and original manufacturer. Planning for these items will help to ensure that no time is wasted on installation day and progress moves according to plan.


Laser Alignment

THE IMPORTANCE OF PROPER ROTARY DRYER ALIGNMENT

Misalignment is one of the most common problems faced when working with rotary dryers. Though aligning a drum is a simple solution, leaving a drum out of alignment can result in major problems. Routinely having a rotary dryer re-aligned is an important part of preventative maintenance, and the overall longevity of the dryer.

WHAT CAUSES A DRUM TO BE MISALIGNED?

Misalignment is often the result of an improper base installation. Proper drum base installation will help to ensure that the dryer 'floats' as intended between thrust rollers. Misalignment in a base will propagate through the rest of the drum, causing wear and damage to other drum components, such as trunnion wheels, tires, drive components, and thrust rollers.

Misalignment also occurs naturally as a drum experiences normal wear and tear over time, causing the drum to gradually fall out of perfect alignment. For this reason, it is important to routinely have a drum re-aligned.

SIGNS THAT A ROTARY DRUM IS MISALIGNED

Misalignment causes a drum to ride harder against the thrust roller, therefore wearing faster on the tire sides. This excessive riding can result in grooves and/or gouges on the face of the tire. There are several telltale signs that can be a good indication that a rotary drum has fallen out of alignment:

- Excessive tire/wheel wear
- Damage to the tire/wheel
- Excessive wear on the thrust roller
- Damage to the thrust roller
- Pinion/girth gear wear
- Pinion/girth gear damage

In addition to this, watching a drum run can also help to indicate that it is in need of re-alignment. A working drum that is properly aligned should have little to no contact with the thrust rollers. Drive components should run smoothly, without excessive chatter or vibrations.

Ensuring proper alignment of your rotary dryer is an integral part of preventative maintenance, helping to ensure a rotary dryer that stands the test of time.

Regular maintenance and inspection of your rotary dryer will only help in prolonging the life of the drum, ultimately minimizing maintenance costs and down time.

USE A LASER TRACKING SYSTEM FOR OPTIMAL ALIGNMENT

One way to ensure proper alignment is achieved is through the use of a laser tracking system.

While traditional alignment techniques can offer a reliable alignment option, they leave much room for error. New laser tracking systems, however, provide an efficient, and accurate solution to alignment needs, offering fast, precise alignment. In a typical setting, laser alignment can get the bases to within +/- 0.005.

While traditional alignment methods rely on manual measurements and mathematical equations to determine and execute proper alignment, the laser alignment method eliminates the opportunity for human error by utilizing a laser beam to measure 3D coordinates, and recording and analyzing the data on a software program, resulting in faster alignment and extreme precision.

AVOIDING DOWNTIME WITH PROACTIVE MAINTENANCE

Avoiding costly downtime for repairs is a top priority in running a successful operation, no matter what industry you're in, or what equipment you're working with. And while buying high quality equipment will help to avoid downtime, this alone will not prevent it. The same holds true for rotary dryers.

Just like a car, a rotary dryer needs routine maintenance in order to continue running properly. Though this routine maintenance cannot prevent downtime altogether, it is a step you can take to help keep your equipment running in good shape for a long time.

For maintenance guidelines on your rotary dryer, consult the service manual provided to you by the original equipment manufacturer. This will outline some of the routine maintenance you can perform on-site, such as lubricating bearings, changing the oil on the gear box, and rechecking backlash, as well as some of the more major items that will require a customer service engineer, such as retraining the dryer.

Working with your rotary dryer manufacturer to develop an ongoing maintenance plan will provide the best prescription for preventative maintenance, tailored to your specific process. Depending on the manufacturer you work with, a variety of field services will likely be available to help in keeping your dryer running smoothly. This might include:

- Tire & trunnion wheel grinding
- Alignments
- Gear replacements
- Spare part installations
- Routine maintenance checks
- Re-alignment
- 24-hour emergency services
- Annual inspections
- Training programs

All of this routine maintenance will go a long way in helping you to avoid unnecessary downtime and costly repairs resulting from improper care. It's also a good idea to ask the dryer manufacturer what spare parts they recommend having on-hand. Having spare parts on-hand is a good way to prevent unnecessary downtime due to waiting on parts that could have been ordered from the start.

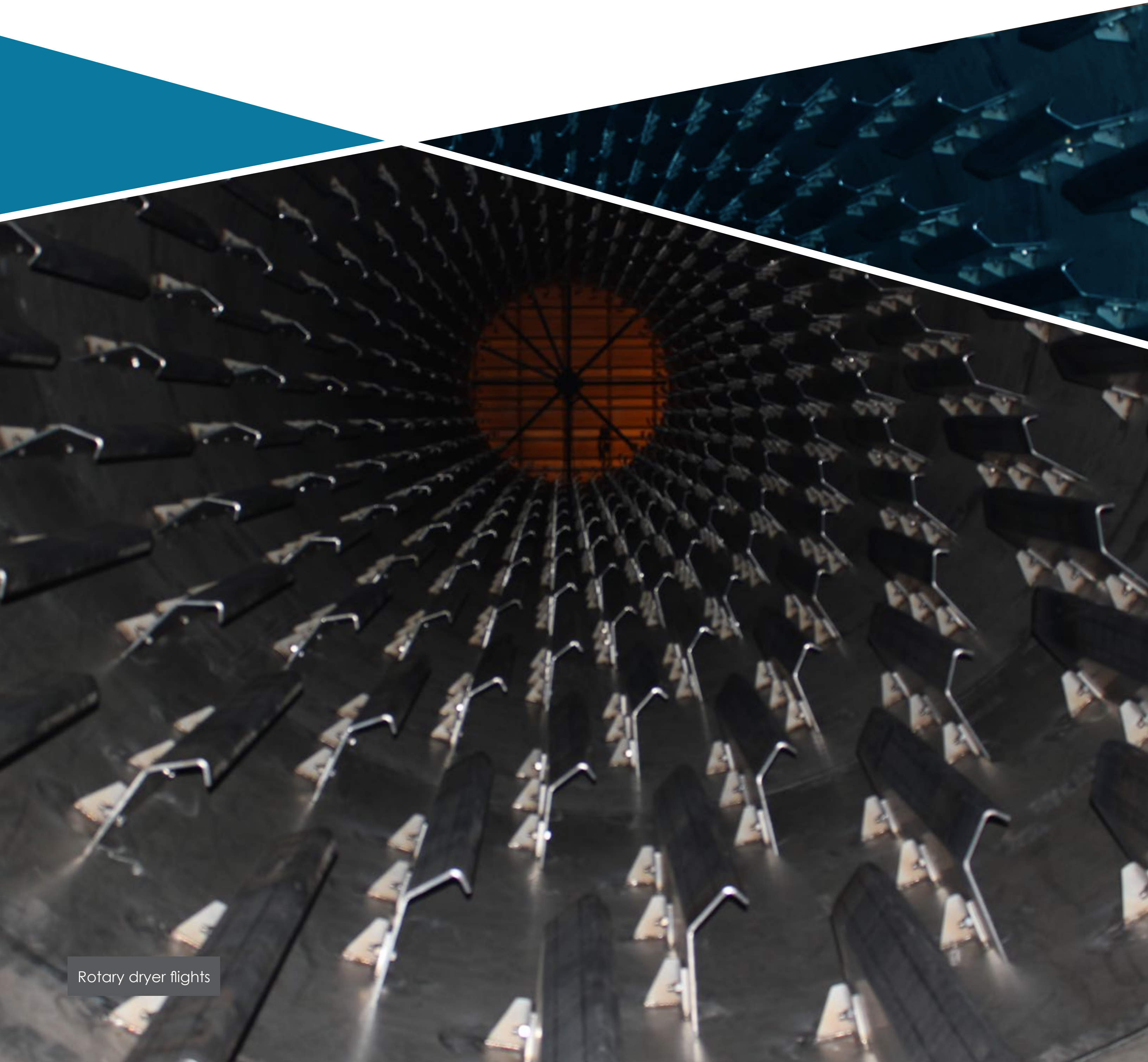
Training programs can also be a valuable tool in preventing catastrophes. Training your operators will help them get to know the equipment, and teach them how to spot potential problems before they have a chance to turn serious.

The FEECO Customer Service Team offers a range of services to assist you with all of your parts and service needs, from start-up and installation support, to process and equipment audits, and even field services and custom retrofits.

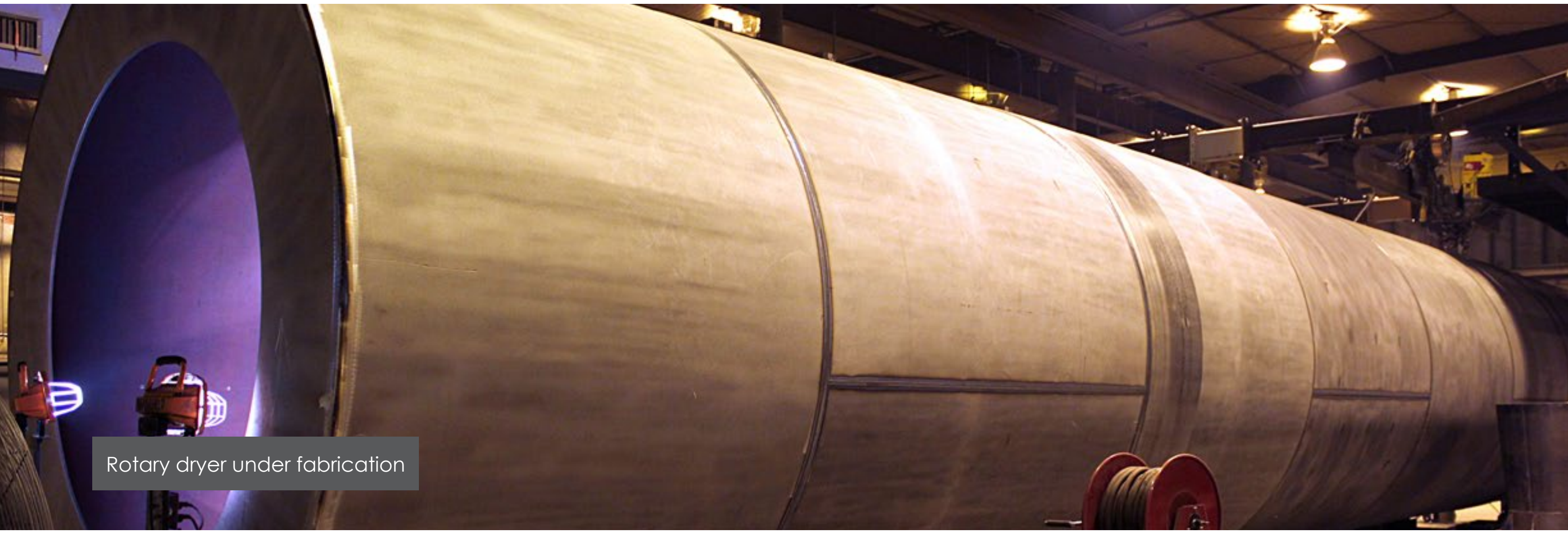

Tire Grinding

CONCLUSION

WHAT MAKES AN INDUSTRY LEADING ROTARY DRYER MANUFACTURER?



Rotary dryer flights



Rotary dryer under fabrication

WHAT MAKES AN INDUSTRY LEADING ROTARY DRYER MANUFACTURER?

Rotary dryers are an essential component in a variety of industrial process settings. As the backbone of many industrial processes, efficiency, reliability, and longevity are key to a successful operation. For these reasons, when looking to purchase a rotary dryer, it is of the utmost importance to select an industry leader. But what makes an industry leading rotary dryer manufacturer? Below are some of the key elements to consider when choosing where to put your trust when it comes to an industrial dryer manufacturer.

FLEXIBILITY IN CUSTOMIZATION

A one-size-fits-all approach may seem like an attractive, cost-effective solution, but this catch-all method does not consider a variety of factors that can make a rotary dryer operate as effectively as possible.

Material characteristics, the processing environment, and desired end product characteristics are all factors that can make a big difference in designing the best possible drying solution for a specific process. There are innumerable factors that can be adjusted to maximize drying efficiency, including length, diameter, inlet temperatures, air flow, flight design and pattern, slope, and many others.

Flexibility in design and customization is a fundamental aspect in choosing a manufacturer that can meet the needs of your unique processing requirements.

MATERIAL KNOWLEDGE

Material knowledge and experience play an integral role in the design and efficient operation of a rotary dryer as well. Several material characteristics, such as bulk density, percent moisture, specific heat, and more, will affect material behavior during processing. For this reason, it is important to select a rotary dryer manufacturer that is experienced in processing a variety of materials, and ideally, with a working familiarity of the material you are looking to process.

Manufacturers offering a testing facility are of particular value, as they can test material characteristics throughout the process. In addition, they can test various configurations of equipment to achieve desired results, testing material throughout the development process to aid in the design of a commercial-scale unit.

HIGH-QUALITY FABRICATION

Choosing a manufacturer that will plan for the rigors of processing material in a rotary dryer during the design and fabrication phases is vital. Rotary dryers should be built using high quality materials so they can provide years of reliable processing. Attention to details, such as a corrosive material, can be the difference between a dryer that lasts a few years, and a dryer that lasts for decades.

ONGOING SUPPORT

An industry-leading rotary dryer manufacturer does not just build rotary dryers; they service them too. Choosing an equipment supplier that will provide ongoing support in the way of install services, training, maintenance, parts, and emergency services is crucial to the life of your industrial drying system.

While they may be relatively low-maintenance, rotary dryers still require routine maintenance to prolong the life of the drum and continue efficient operation. Routine maintenance such as oil changes, re-alignment, and tire grinding will help to keep your rotary dryer in operation for years to come. A leader in rotary dryer manufacturing should have a solid service department, staffed by experienced technicians.

FEECO has been designing and building custom rotary dryers since 1951. Our vast material processing knowledge, combined with our testing facility, allows us to offer our customers the best possible drying solution for their needs. In addition, our experienced Customer Service Engineers can service your rotary dryer to help keep it running its best.

FEECO INTERNATIONAL

ABOUT FEECO

FEECO International, Inc. was founded in 1951 as an engineering and equipment manufacturer. We are recognized globally as an expert in industry-leading process design, engineering capabilities (including everything from process development and sample generation, to feasibility studies and detailed plant engineering), custom equipment manufacturing, and parts and service. We serve a range of industries, including fertilizer and agriculture, mining and minerals, power/utility, paper, chemical processing, forest products, and more. As the leading manufacturer of processing and handling equipment in North America, no company in the world can move or enhance a concept from process development to production like FEECO International, Inc.

The choice to work with FEECO means a well-rounded commitment to quality. From initial feasibility testing, to engineering, manufacturing, and parts and service, we bring our passion for quality into everything we do.

For more information on rotary dryers, material testing, custom equipment, or for help with your process or problem material, contact FEECO International today!

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