



48⁺ Years
Of experience

TYPES OF INDUSTRIAL DRYERS AND THEIR SELECTION



In Association with SVCH-Technologii, Moscow (Russia)

ISO 9001:2015 | ISO 14001:2015 | ISO 45001:2018

ABOUT US

KERONE is now renowned for serving the specialized needs of customers with the best quality and economical process of application engineering solutions and industrial heating products manufactured in a high-quality environment by a trained and qualified workforce (special purpose machinery)



KERONE is a pioneer in application and implementation engineering with its vast experience and team of professionals.



KERONE is devoted to serve the industry to optimize its operations both economically and environmentally with its specialized process engineering solutions.



KERONE is having immense expertise in manufacturing and implementing various types of engineering solutions.



KERONE is possessing employee strength of more than 280+ experts continuously putting efforts for happy industrial engineering solutions



48+ Years Manufacturing Excellence



Great Sale Support



Highly Customized Product



Adherence to Standards



Sound Infrastructure



Team of experts Delivering Quality



Timely Delivery



Cost Effective Solutions



WHY CHOOSE US

"Choose Kerone for innovative solutions tailored to your unique product needs, ensuring efficiency, reliability, and unmatched quality."

With decades of expertise, cutting-edge technology, and a customer-centric approach, Kerone Engineering offers tailor-made Applications Engineering solutions that prioritize quality, flexibility, and cost-effectiveness. Benefit from our commitment to excellence, post-sales support, and innovative solutions for your unique Applications Engineering needs. Choose Kerone Engineering for reliability, performance, and unmatched value.

MISSION



To enhance the value of customer operation through our customer need centric engineering solution.



We are committed to providing our customers with unique and best-in-class products in the industrial thermal processing segments. Through strategic tie-ups for technical know-how with renowned leaders in industry-specific segments, we ensure that our offerings meet the highest standards of quality and innovation.

VISION



Turn into a world leader in providing specialized, top-notch quality and ecological industrial heating, cooling, and drying solutions across the globe.



To attain global recognition as the best of quality and environment-friendly engineering solution company.



Enhance the value of customer operation through our customer need centric engineering solution.



TRUSTED PARTNERS





Introduction

Drying is a process where moisture is removed from a wet material or a gas to make it dry. This technique is often used in different industrial operations like sugar production, milk powder production, soap bar production, etc. The energy for drying is supplied by external means like hot gas or air.

Types of Pipes

Vacuum drying is a process where heat-sensitive material is dried by reducing its pressure as we know by reducing pressure moisture can be removed easily at relatively lower temperatures. Because characteristics of heat-sensitive materials can be degraded on exposure to hot air or gas.

Drying Mechanism

Drying is dependent on the principles of mass & heat transfer. Moisture vaporizes at the solid surface while the solid is heated to a sufficient temperature. The heat required (Sensible heat & heat of vaporization) for drying is usually supplied by hot air or gas. After the vaporization of surface moisture, more moisture is transported from inside the solid to its surface. The different types of mechanisms may be classified into:

- ▮ Liquid diffusion
- ▮ Vapor diffusion
- ▮ Capillary force
- ▮ Pressure-induced transport

Different Types of Moistures

- **Moisture content:** It is the quantity of moisture in wet material. It is generally expressed in mass ratio units (kg moisture/kg of dry solid).
- **Bound Moisture:** The amount of moisture in a solid that causes a vapor pressure less than the normal vapor pressure of water at the given temperature is called bound moisture.
- **Unbound Moisture:** The amount of moisture in a wet solid in excess of the bound moisture is called unbound moisture.
- **Equilibrium moisture:** It is the moisture content in a solid that is in equilibrium with the drying medium of a given temperature & relative humidity.
- **Free moisture:** It is the moisture content in a solid in excess of the equilibrium moisture. Only free moisture can be removed by drying under a given set of conditions.

The Drying Rate Curve

The time taken by drying operation of a moist solid to final moisture content can be determined from the rate of drying under certain conditions. The drying rate is a function of the temperature, humidity, flow, and transport properties of drying gas. The drying rate (N) is determined by the experiment method. Refer to the equation given in Fig. 1 below

$$N = - \frac{W_s}{a} \times \frac{dx}{dt} \quad \text{Kg moisture/m}^2.\text{s}$$

Where, N=rate of drying

W_s = mass of dried solid

a = drying area

X = moisture content at any time t.

Fig. 1: Equation for Drying rate

Types of Dryers

There are several types of dryers available to suit specific needs as a wide variety of wet solids, slurries, and solutions are required to be dried on an industrial scale. The performance of a dryer depends on how good the contact between the wet solid and the drying gas is.

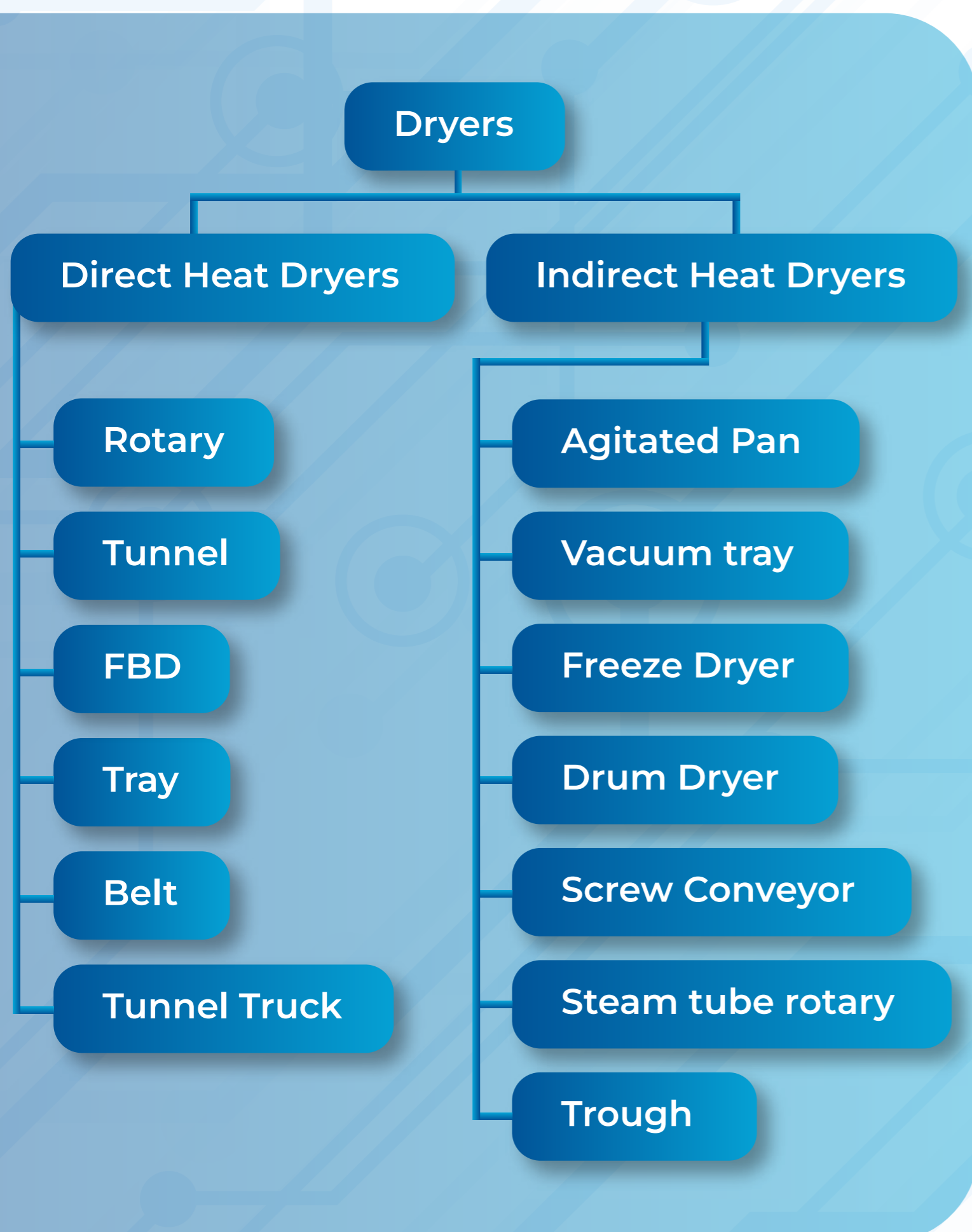


Fig. 2: Classification of Dryers

Tray Dryer

A tray dryer is the most common type of dryer generally used in industries where cross-circulation drying occurs. The moist solid is taken in a number of trays; the trays are stacked in the drying chamber providing a gap so that drying gas may be passed over the exposed top surface of the solid spread on a tray. The drying gas (usually air) is heated in contact with steam coils. A blower fitted inside the cabinet forces the hot air over the trays. A portion of the air is circulated inside the cabinet and the rest leaves the chamber carrying evaporated moisture. The temperature, humidity, and velocity of air may be regulated by adjusting the gas flow rate.

Advantages of Tray Dryer

- ▮ Each batch is dried & handled separately
- ▮ It's more feasible in consumption of fuel
- ▮ Easy to clean, accessible, and control
- ▮ Less space requirement
- ▮ It's operated batch-wise
- ▮ It provided a tendency to over-dry the lower trays.
- ▮ It requires small labor costs for loading & unloading trays.

Rotary Dryer

Rotary dryers are often called the 'workhorse of chemical dryers' and fall in the most widely used class of continuous dryers in process industries. It consists of a slowly rotating slightly inclined cylindrical shell fed with moist solid at the upper end. The material inside a rotary dryer flows along with the rotating shell, gets dried, and leaves the dryer at the lower end. The heat for drying is provided by a hot flue flowing outside and heat is transferred through the shell.

Countercurrent flow in a rotary dryer ensures a more uniform distribution of the temperature-driving force along with the shell.

What is a rotary dryer used for?

This type of dryer is suitable for relatively free-flowing, non-sticky, and granular materials e.g. almost all types of crystals after crystallization and washing such as table salt, sodium sulfate, ammonium sulfate, minerals, and organic salts. Also, it is used for dehydrating waste materials, and animal feed-stuffs.

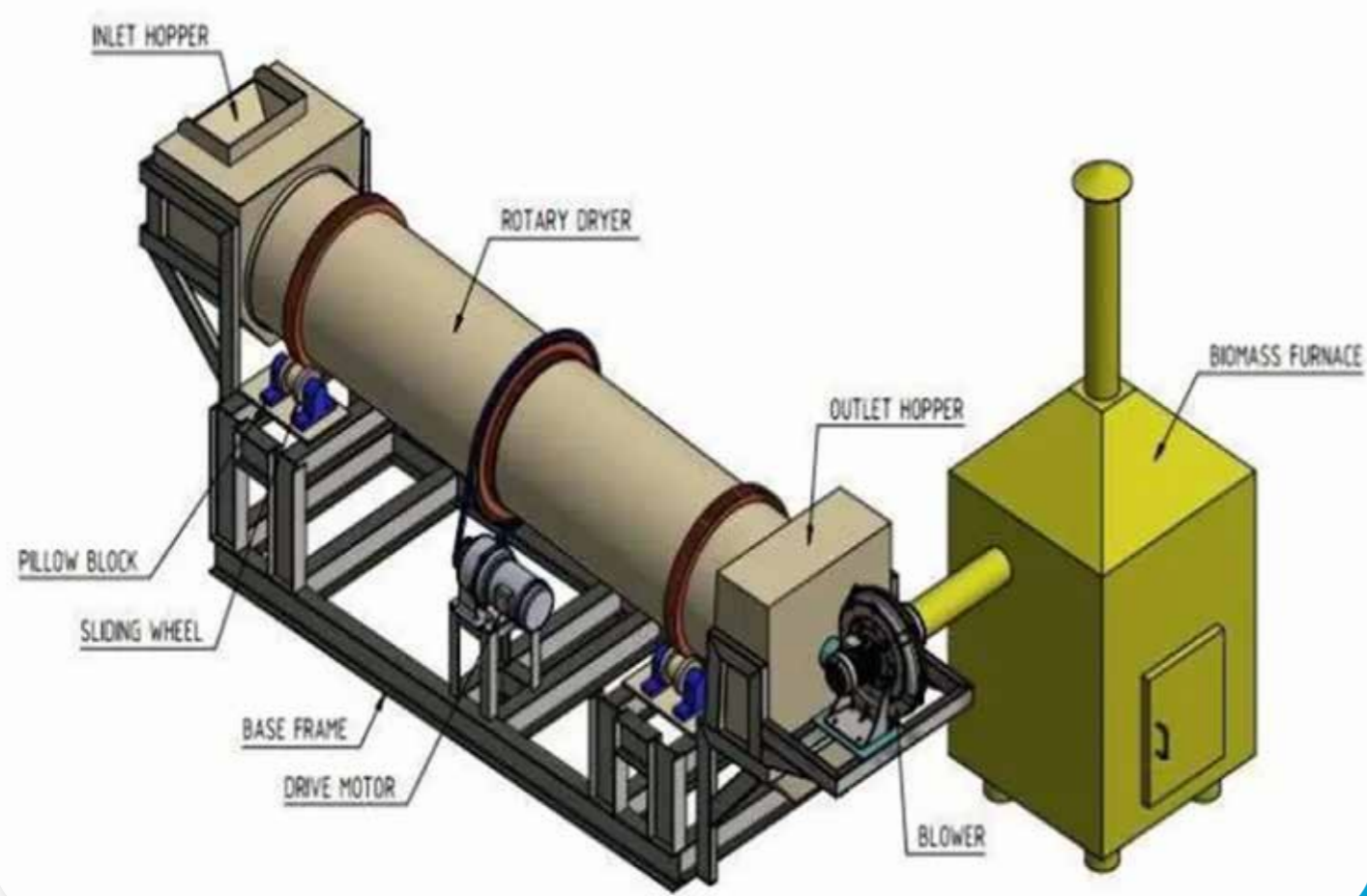


Fig. 3: A Typical Rotary Dryer

Vacuum Dryer

The vacuum dryer is provided with a heating jacket and slow-moving agitator for wet material. A moderate vacuum usually not below 10 mm Hg is used. The vapor drawn by the vacuum device may be condensed if recovery is desired. The conical shape allows faster discharge of the dry product through the bottom. This type of dryer is used for drying powders, dyes, chemicals & pharmaceuticals.



Fig. 4: Typical Vacuum Dryer

How does a vacuum dryer work?

It is a batch operation where the pressure and humidity are reduced by means of vacuum pumps in an air-tight vessel. Thus, by lowering the atmospheric pressure in the chamber the materials inside the vessel dry more rapidly through contact with heated walls indirectly.

Advantages of Vacuum drying

- Vacuum drying is a process, where heat-sensitive, toxic powders and hygroscopic & granules have been dried by avoiding exposure of excess heat as well as certain nutrients, which can break down on exposure to excess heat. Taste, appearance, and other properties may degrade under too much heat.
- Vacuum drying employs a safe & highly effective technique for drying large volumes of heat-sensitive granules or powders. The temperature is usually very low compared to what will be required in a common industrial dryer.

Fluidized-bed Dryer

This type of dryer is used for drying free-flowing moist solids. The working principle is very simple. The moist solid is fed continuously into the dryer by a screw feeder and is kept fluidized by a stream of hot drying gas. The dry product is also continuously removed through a nozzle at an appropriate location. The fines carried over by the gas are separated in a cyclone separator or bag filter. A fluid-bed dryer is widely used to dry a variety of materials such as minerals, pharmaceuticals, seeds, cereals, spices, fish meals, waste materials, etc.

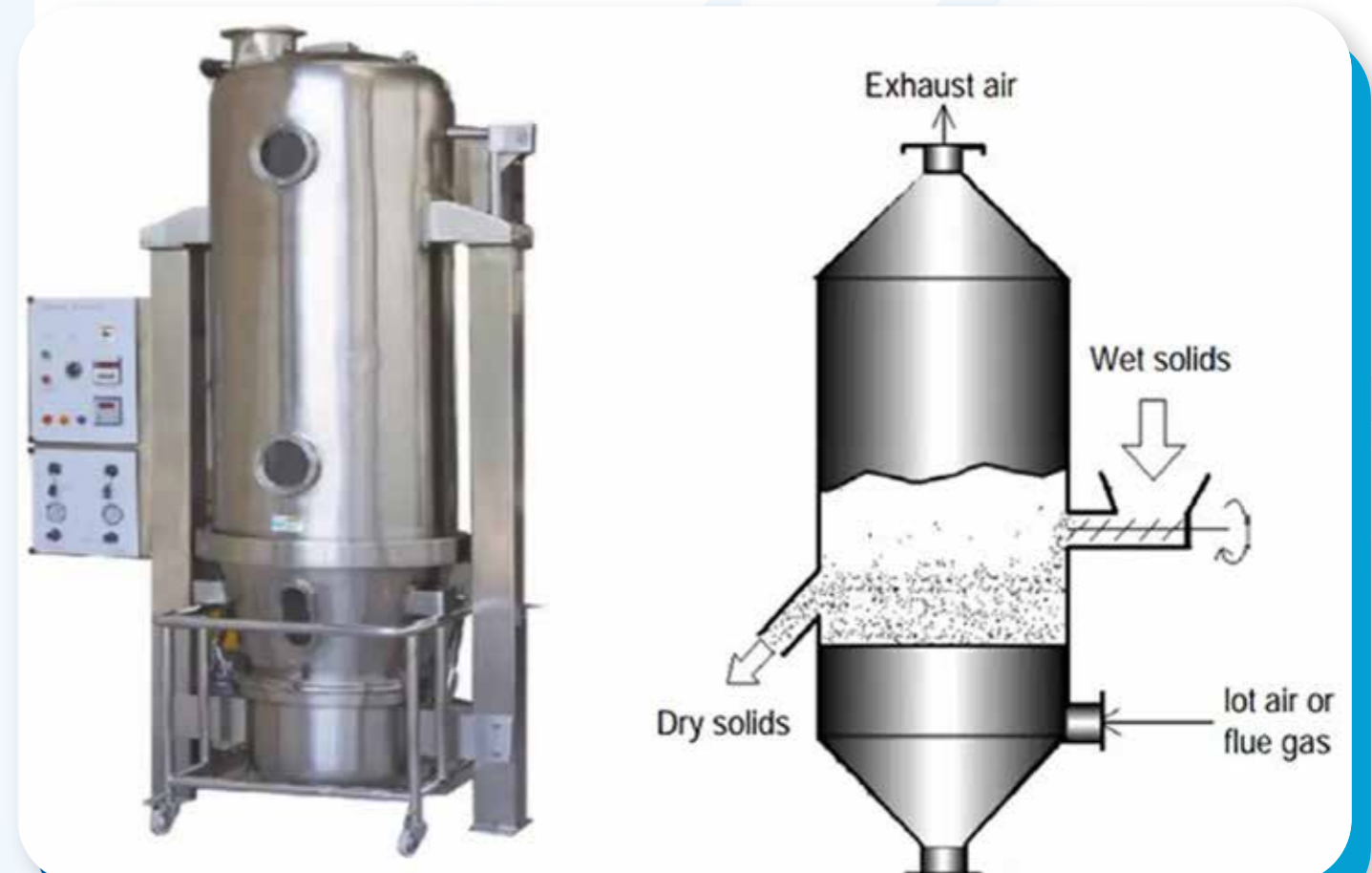


Fig. 5: Typical Fluidized bed dryer

Spray Dryers

A spray dryer is installed to dry the atomized droplets contained in the feed that may be a solution or slurry of fine particles. It consists of a big drying chamber which may be 15m in diameter and 35 m tall.

How does a spray dryer work?

The feed is fed through an atomizer located at the top. The hot gas is introduced either at the top or at the bottom (concurrently or counter currently). The hot gas temperature may be as high as 700°C but normally is kept within 250-280°C. Drying of the droplets dispersed in the hot gas occurs in a very short contact time of a few seconds. The process of atomization of the feed is performed by a rotating disk and a high-pressure nozzle. The liquid or slurry is fed onto the disk at the center which is centrifugally accelerated and then ejected from the periphery of the disk at a speed of 80-200 m/s. The angular velocity of the disk is 3000-20000 rpm.

Advantages of Spray dryer

- The spray dryer can atomize handle abrasive slurry or paste using a whirling disk without erosion.
- It is also considerably flexible with respect to feeding rate and properties.
- The size of the atomized droplet is 10-20 microns
- Due to its conical bottom shape small dried particle is removed through a product conveying line.
- Because of the very short contact time between droplets and the drying gas. A spray dryer is suitable for drying heat-sensitive materials.
- A spray dryer is also used to dry a variety of other liquids, e.g. milk, egg, coffee, tea, tannin some polymeric resins, pharmaceuticals, organic and inorganic activated pharmaceuticals ingredients, detergents, etc.



Fig. 6: Spray Dryer

Selection of Industrial Dryers

The following data need to be collected before the selection of dryers.

- The physical form of feed – Liquid, slurry, pasty, free-flowing powders, granular, crystalline, continuous sheet, discontinuous sheet.
- Dryer throughput (Kg/hr).
- Upstream/Downstream equipment – batch or continuous.
- For particulate feed products, mean particle size and size distribution.
- Inlet/outlet moisture content of the product.
- Maximum allowable product temperature.
- Drying curve.
- Feed cohesiveness. Product fragility. Contamination by drying gas.
- Explosion characteristics (vapor/air and dust/air).
- Toxicological properties.
- Corrosion aspects.
- Product value.
- Experience already gained.

A typical decision tree diagram is provided in Fig. 7 and Fig. 8 below for the selection of batch dryers and continuous dryers.

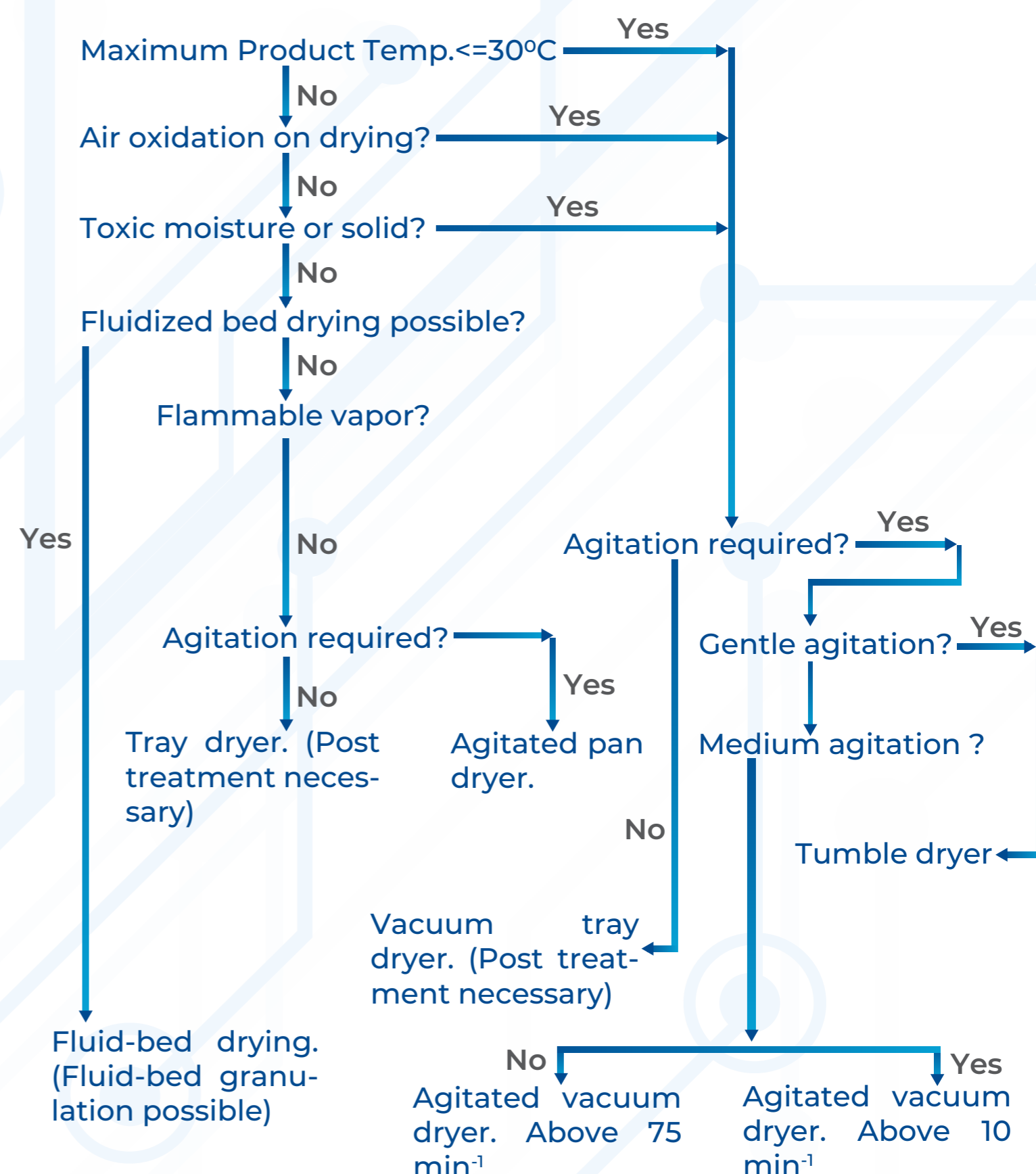


Fig. 7: Decision Tree for batch dryer selection.

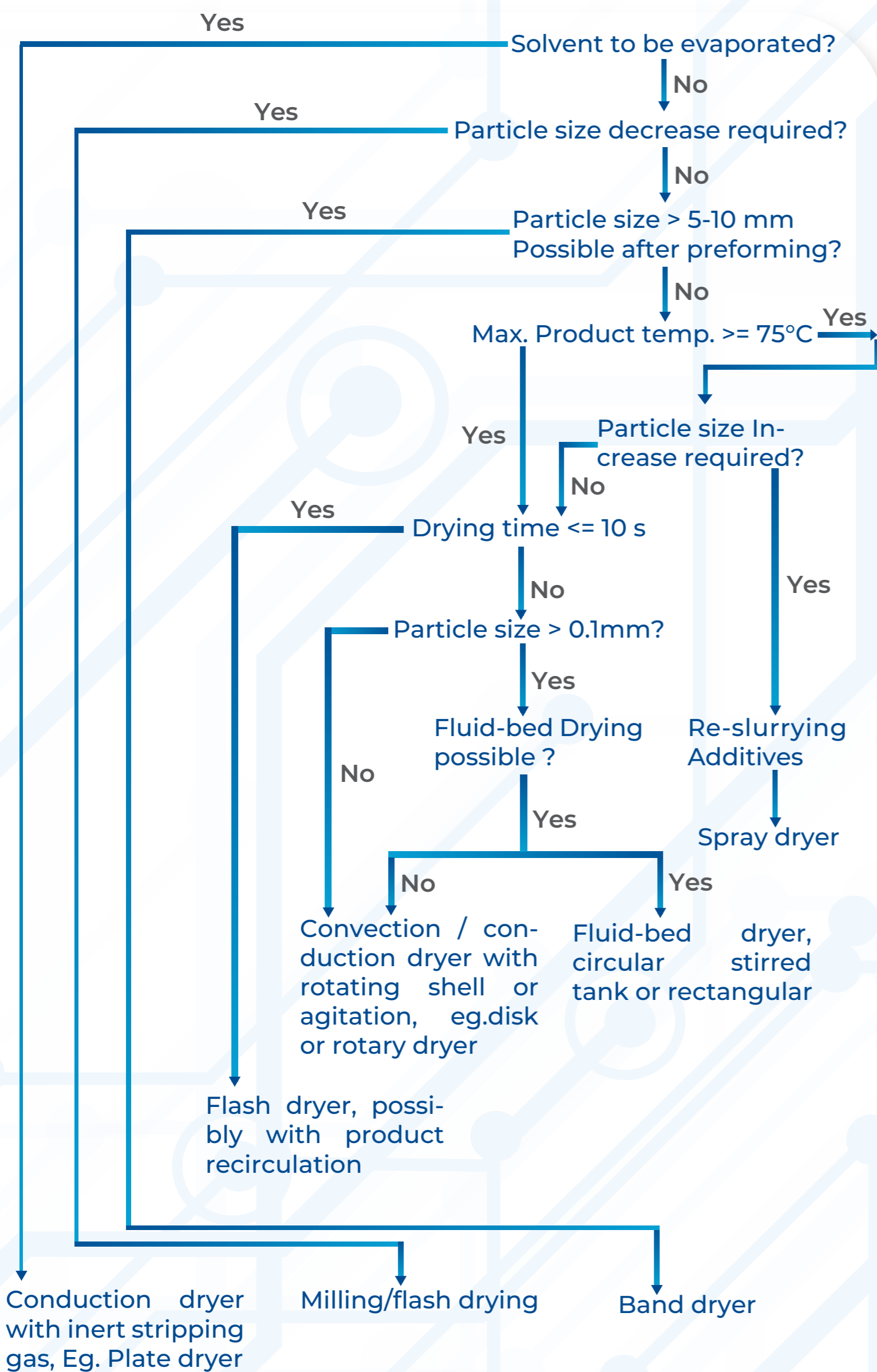


Fig. 8: Decision Tree for continuous dryer selection

Proper dryer selection is a challenging issue and has a significant impact on the economic growth of a plant, it is not at all recommended to fully depend on the vendors' information & recommendation but users should come up with preliminary criteria for dryer selection prior to contacting any vendor. The above decision trees for the selecting batch and continuous dryers can be used during the initial assortment of a large number of dryers.

Future Developments in Industrial Drying Technology

As technology continues to advance, there are several emerging trends in industrial drying that are worth noting. One of these is the use of renewable energy sources, such as solar power or biomass, to heat industrial dryers. Another trend is the development of more efficient and environmentally friendly drying methods, such as superheated steam drying or microwave drying. These methods can help to reduce energy consumption and minimize the environmental impact of industrial drying processes.



Imperial and Band Dryer

Conveyor belts are stacked one on top of the other to create Imperial and Band dryers. Long residence times and several passes are made possible on constrained floor space by multilayer. Band dryers are built using a number of modular components, each with its own heating and air circulation system.

Industry Applications

- Energy saving due to gas recycling
- Highly homogeneous treatment
- Adjustment of temperature, gas velocity and direction in each section
- Multiple processing in one single equipment
- Versatility of processes and applications
- Accurate adjustment of residence time
- Possibility to add accessories for mechanical action on product

Features

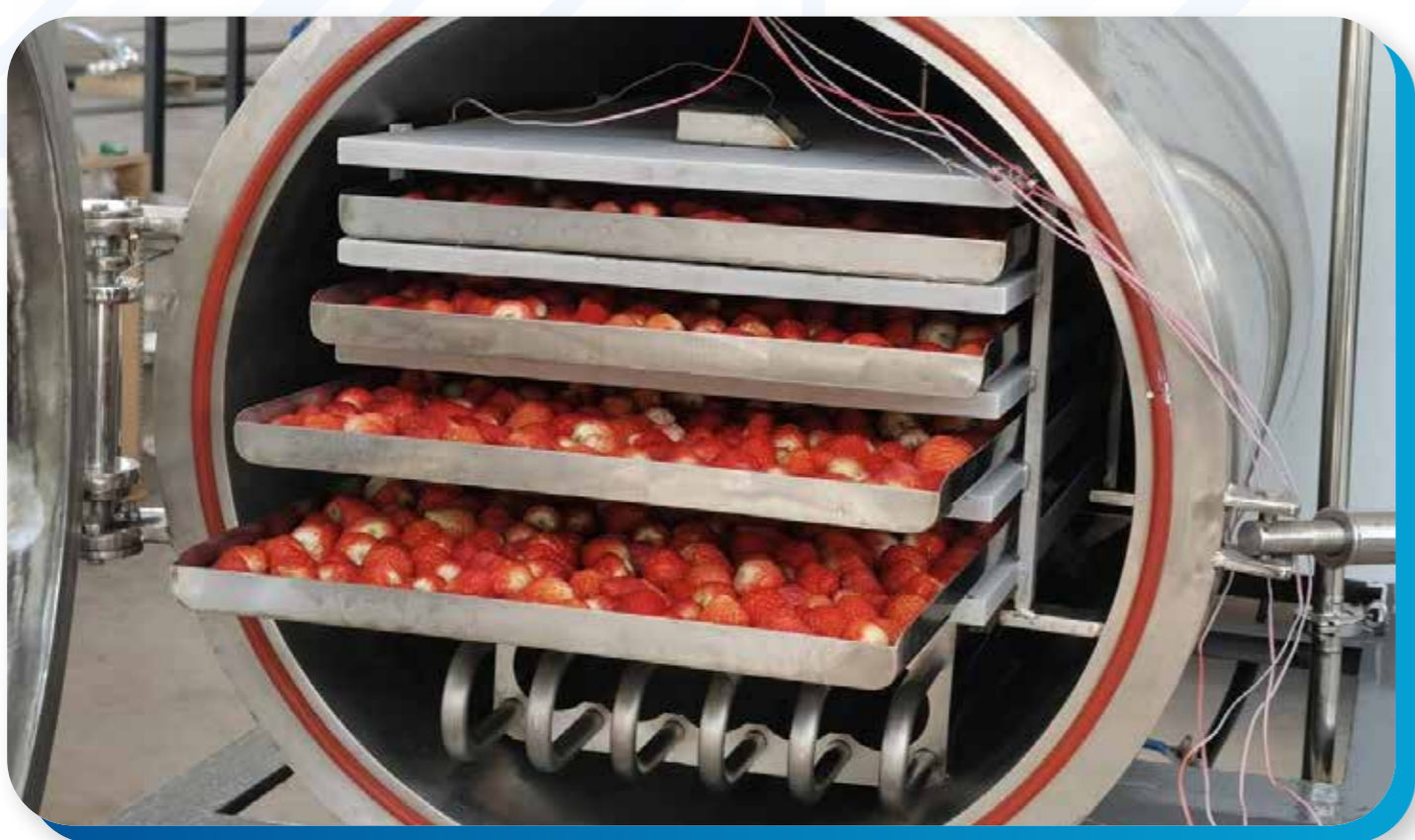
- **Easy zoning:** The temperature, humidity and airflow speed can be easily set and controlled for each zon
- **Uniform Drying:** The drying time can be easily attuned to achieve consistent heat progress, results in evenness of drying across product.
- **Clean Drying:** Materials are dried with in the band dryer's chamber with uniform moving speed this results in minimum damage and dust sprinkle.
- **Product suitability:** Band dryer allows grinding and shaping of sludge or irregularly shaped materials.

- **Multi Staging:** Band dryers can be made with single stage or multi stage with capability to handle both high volume or low volume.
- **Customisable:** Imperial and band dryers can be made with different configurations such as heat source (Hot Air, Oil, electric etc.), humidity (humidifier, dehumidifier etc.) and air circulation (from top, down, vertical, horizontal etc.)



Microwave Drying System

Microwave drying systems use electromagnetic waves to heat the product and remove the water. This process is faster than traditional drying methods and can reduce the energy consumption by up to 50%. Microwave drying systems are commonly used in the chemical industry to dry powders and granules. They are also used in the food industry to dry fruits and vegetables.

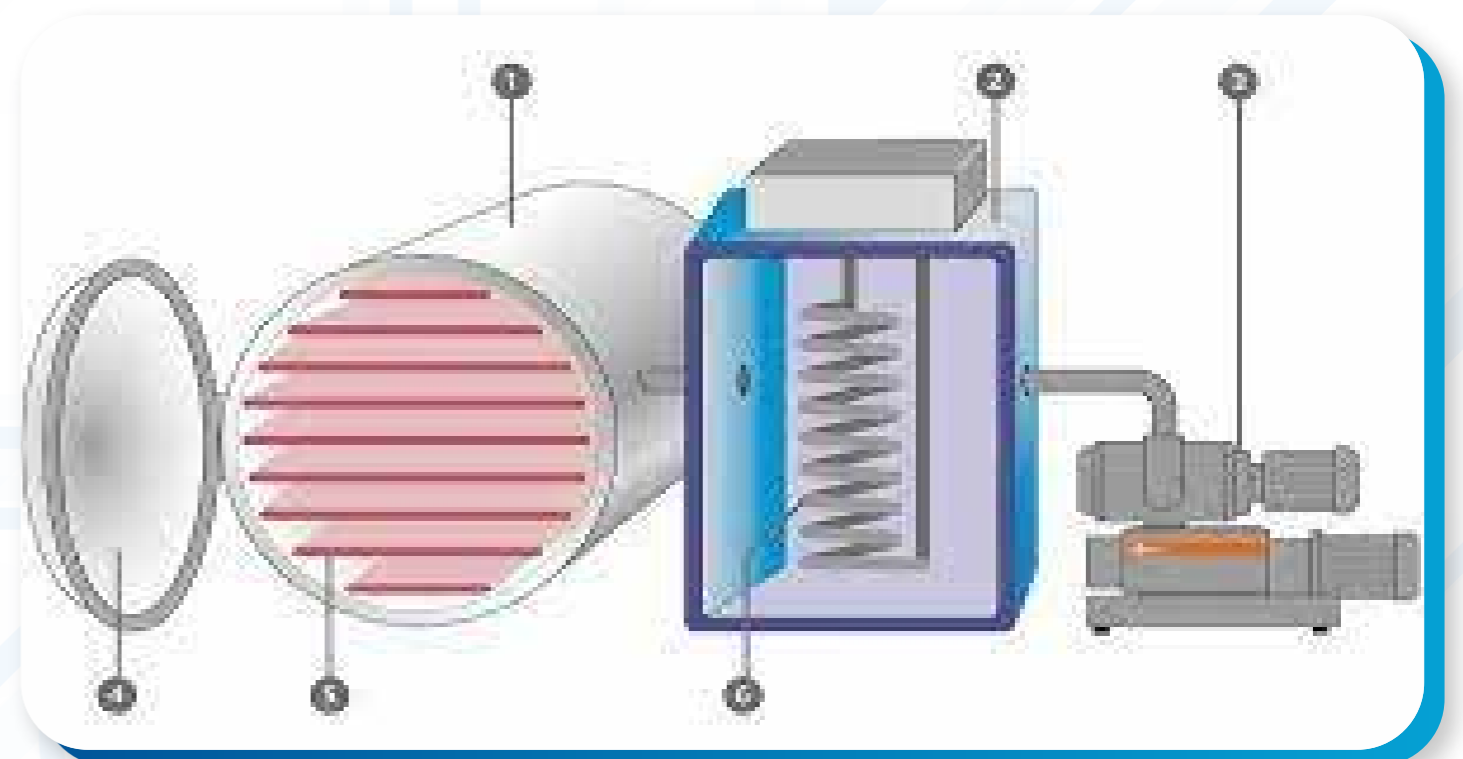


Freeze Drying System

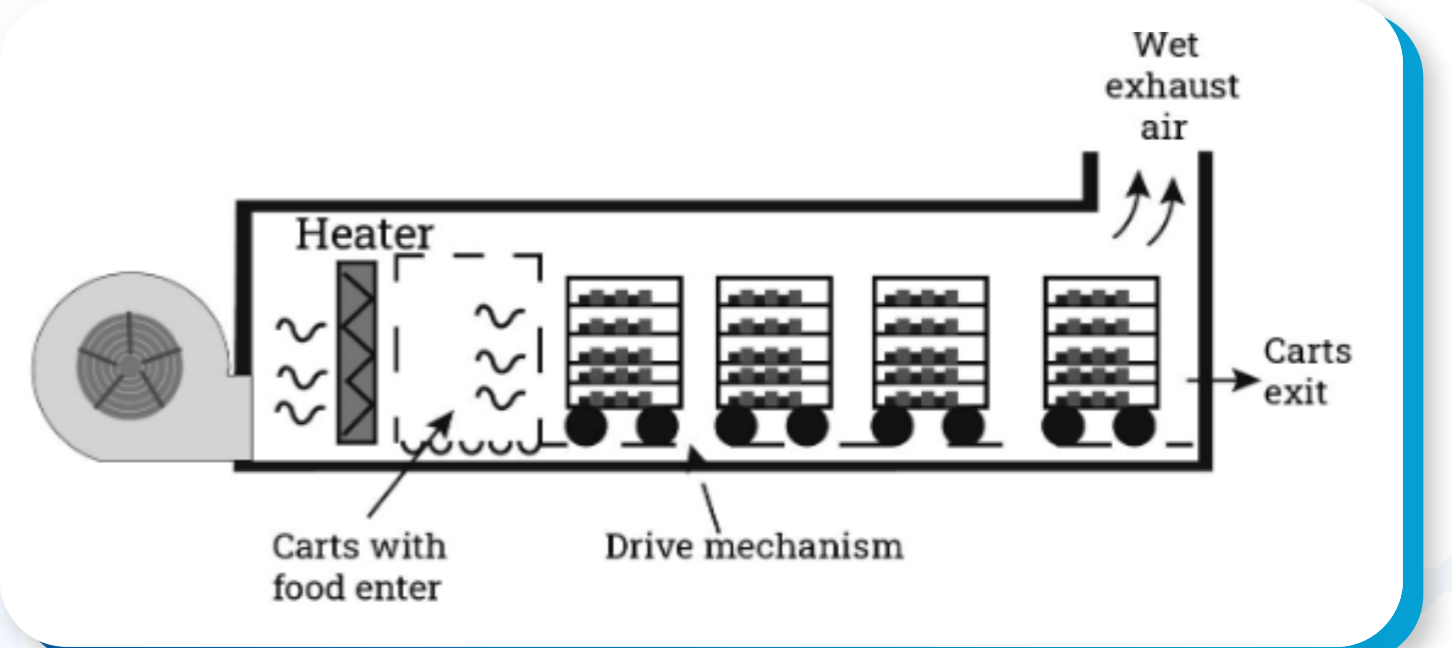
Another popular advanced technology drying system is the freeze-drying system. This process involves freezing the product and then removing the water by sublimation, which means converting ice directly into vapor without going through the liquid phase. Freeze drying systems are commonly used in the pharmaceutical industry to produce vaccines and other medicines. They are also used in the food industry to produce freeze-dried fruits and vegetables.

Characteristics of the Freeze-Drying Process

- ▮ The phase transition of the water contained in the product into ice.
- ▮ The ice to vapor phase transition.
- ▮ The desorption of water molecules from material structures.
- ▮ The obtainment of a sufficiently low pressure.
- ▮ The re-sublimation of water vapor removed from the material on the surface of the condenser.
- ▮ The removal of a layer of ice from the surface of the capacitor.



Tunnel Dryer



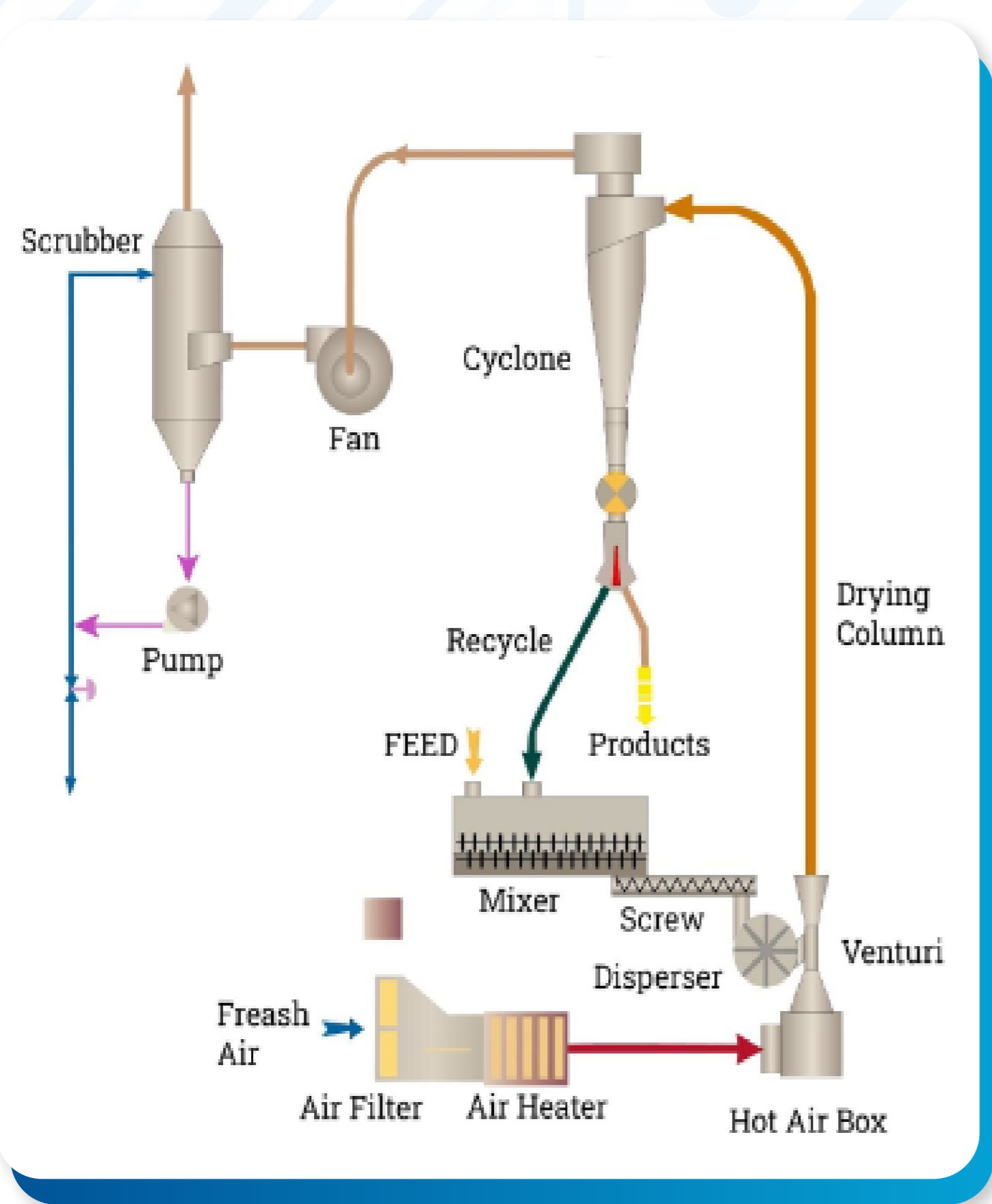
In tunnel dryers, the materials to be dried are loaded in trays attached to a trolley. The trolleys enter at one end and move slowly through the drying tunnel, wherein a stream of hot air or gas is blown. The material dries as it moves through the tunnel. The trays may move in either of the following directions with the air stream:

- **Concurrent Configuration:** The material movement and the airflow are in the same parallel direction. This configuration is the least efficient.
- **Countercurrent Configuration:** The material movement and the airflow are in opposite parallel directions. It is the most efficient configuration as the temperature gradient across the chamber is more uniform — the hottest and driest air contacts with the materials with the highest moisture content.

● **Cross-Flow Configuration:** The airflow is perpendicular to the material movement, thereby maximizing contact. The screen conveyor dryer is a type of tunnel dryer that utilizes this configuration. The materials are placed in a perforated screen through which hot air is vertically blown. Moisture is removed from the materials as it passes through the tunnel.

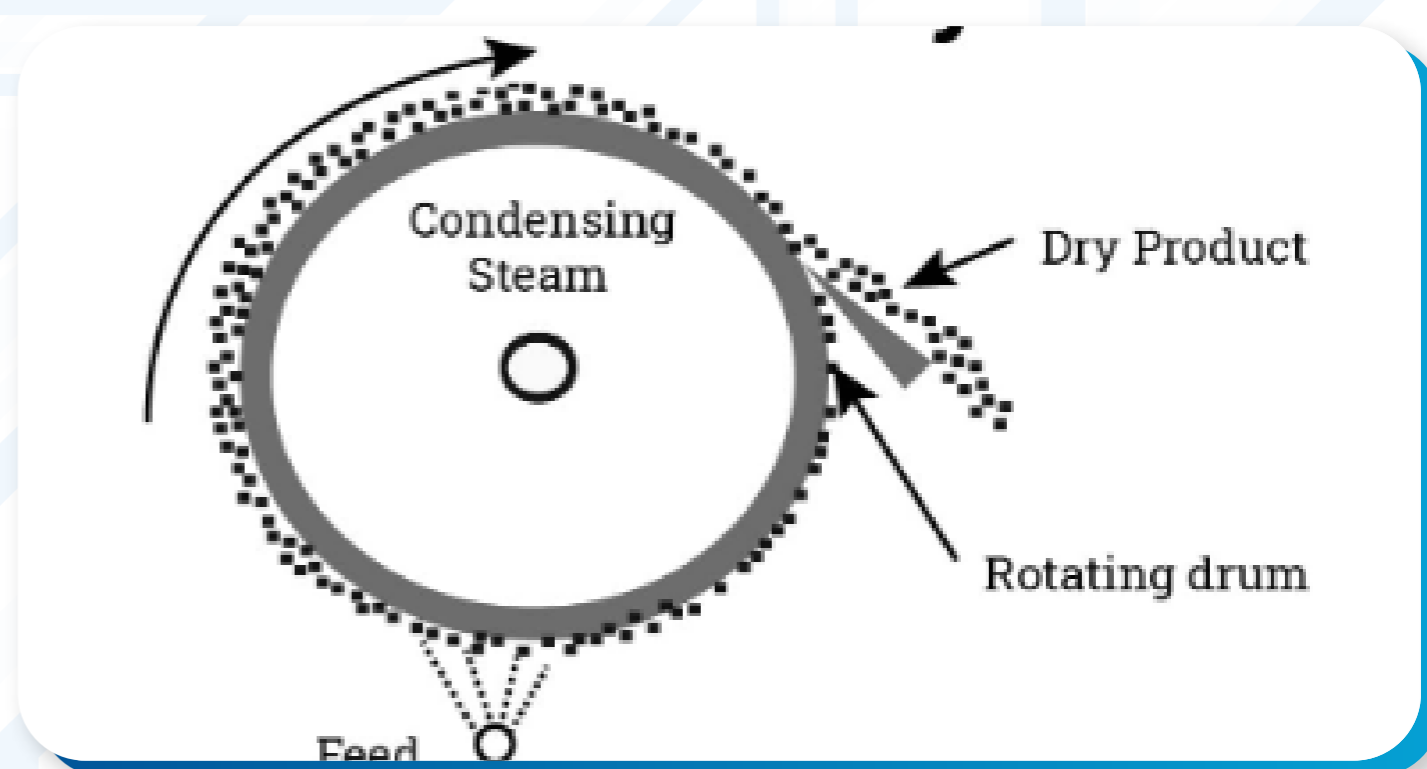
Flash Dryers

Flash dryers dehydrate wet granular materials by conveying them across a drying duct. A high velocity hot gas stream flows through the duct that keeps the particles suspended. The heat from the gas stream removes the moisture or solvent from the product. After passing through the duct, the particles are separated from the gaseous stream by a cyclone and a bag filter. A portion of the exhaust gas is recirculated to the duct in order to increase energy efficiency. Flash dryers are used in drying minerals, salts, starches, dyes, and other granular products. To improve energy efficiency, flash dryers recirculate part of the exhaust gas, reducing heating needs and operational costs. These dryers are ideal for drying heat-sensitive or fine granular materials and are widely used in industries like mining, chemical processing, and food production. They handle products such as minerals, salts, starches, and dyes, offering rapid and energy-efficient drying, making them essential in modern industrial applications.

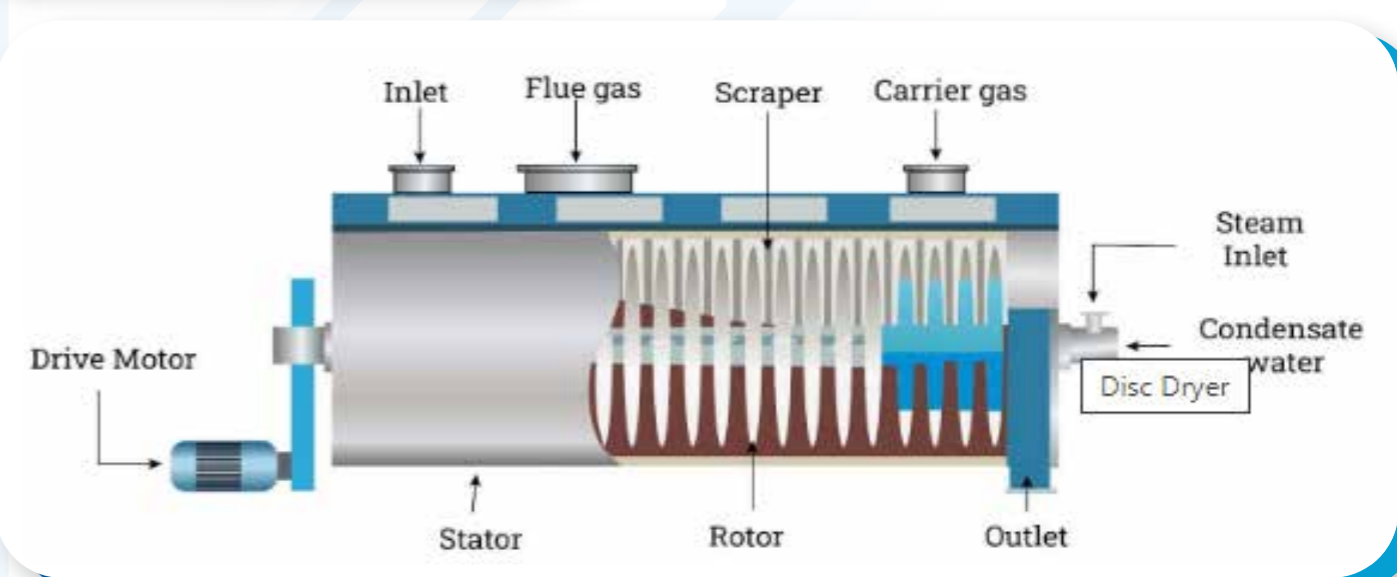


Drum Dryers

Drum dryers or roller dryers dehydrate liquid feed in order to produce powders, flakes, or granular materials. They consist of one or two internally heated drums that rotate about their axis. Steam is flowing inside the drum, and heat is conducted through the walls. The feed is sprayed onto the surface of the rotating drum or between the two rotating drums. A thin film of the liquid feed sticks and dries on the hot surface. The product's initial and final moisture contents determine its residence time on the drum surface. A scraper removes the dried particles once the desired moisture content is obtained. In vacuum drum dryers, the drums are placed in a chamber with vacuum pressure. The low pressure inside the chamber decreases the boiling point of the moisture or solvent, causing it to evaporate at a lower temperature. Hence, vacuum drum dryers are suitable for drying heat-sensitive products.



Disc Dryers



Disc dryers consist of multiple vertical discs mounted on a shaft, which are all contained in a horizontal cylinder. The shaft is internally heated by steam or hot oil; heat is conducted from the shaft to the mounted discs. The discs provide the area for indirect drying. The wet feed in the form of slurry or sludge enters on one side of the cylinder. Moisture or solvent from the feed evaporates as it touches the discs. The materials are transported axially throughout the cylinder. Scrapers are installed inside the cylinder to ensure uniform mixing and prevent the materials from sticking onto the discs. Finally, the products are collected at the bottom of the other cylinder end.

Different Types of Kerone Industrial Dryer

Hot Air Dryer



A hot air dryer uses heated air to remove moisture from materials, typically by blowing hot air through or around them. It's commonly used in industries like food processing, pharmaceuticals, and plastics to dry products efficiently. The hot air evaporates moisture, and the system may include fans or blowers to enhance airflow and drying speed. Hot air dryers are simple, cost-effective, and widely used for drying solid materials.

Conveyorized Infrared Dryer



A conveyorized infrared dryer uses infrared heat and a moving conveyor belt to dry materials efficiently. It's commonly used in industries like printing, textiles, and coatings. As materials pass through, infrared heat quickly evaporates moisture or cures coatings, offering fast, uniform drying. This system is ideal for continuous, high-speed production processes.

Radio Frequency Dryer



The heat is generated within the material hence there is no losses in terms of conduction of heat in surrounding, radio frequency (RF) industrial dryers are highly controllable as the rate of heat production is proportion of radio frequency energy supplied to the materials.

Box Convection Dryer



A box convection dryer uses heated air circulated within a closed chamber to dry materials. Items are placed inside, and the hot air evenly removes moisture through convection. Commonly used in industries like food processing and chemicals, this dryer is ideal for batch drying and handling a variety of materials. It offers efficient, uniform drying in a controlled environment.

Microwave Dryer



Microwave is not a type of heat, rather it's a form of energy that are exhibited as heat by the means of their interaction with the material. It results in material to heat themselves, the mechanism of energy conversion used is dipole rotation.

Rotary Drum Dryer



A rotary drum dryer dries materials by rotating them inside a large drum while hot air flows through it. Commonly used in industries like mining, agriculture, and chemicals, it efficiently dries bulk materials such as minerals, fertilizers, and biomass. The rotating drum ensures uniform exposure to heat, enabling consistent and effective moisture removal.

Batch Dehydrators



Batch dehydrators are used to dry materials in controlled quantities, processing one batch at a time. They use heated air or other drying methods to remove moisture from food, chemicals, or other products. Ideal for small to medium-scale operations, these dehydrators provide efficient, uniform drying, making them common in food processing and agricultural industries.

Tunnel Hybrid Dryer



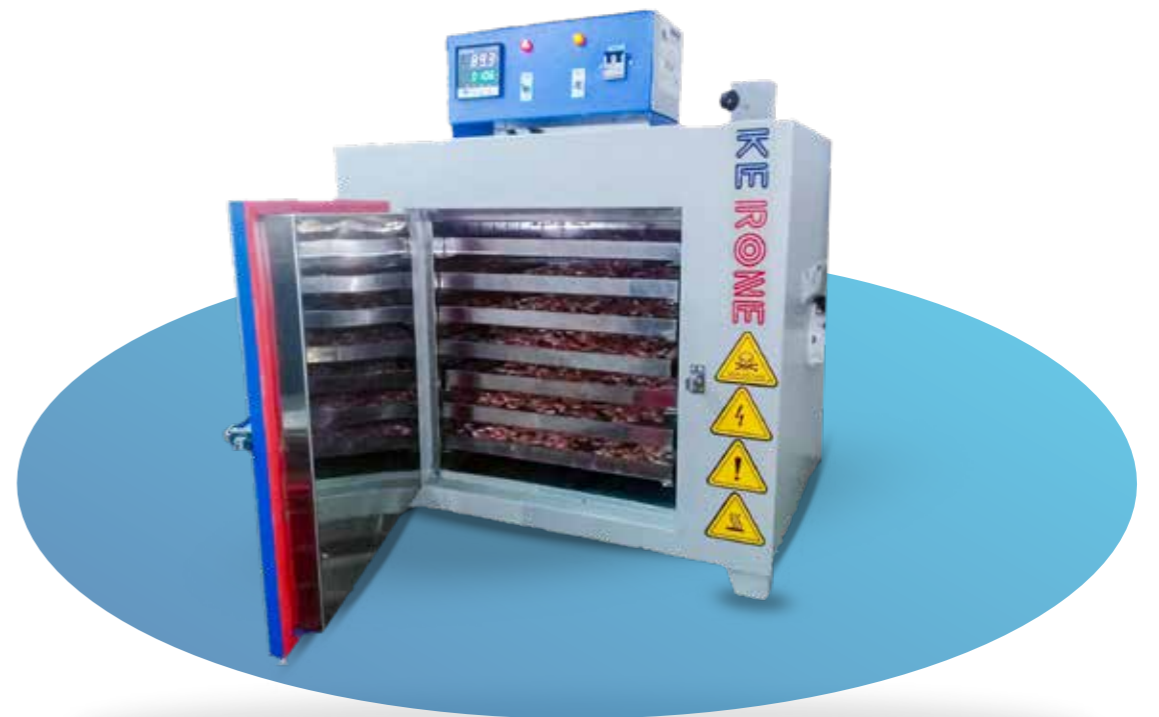
Tunnel dryer commonly used to get manufactured with the hot air for drying of material, however the advancement in the heating technology has enabled the tunnel dryer with advanced and faster drying techniques such as microwave/ RF/ Infrared.

Food dryer



A food dryer removes moisture from food using heated air or other drying methods, preserving it for longer storage. Common in food processing, it helps retain nutritional value while preventing spoilage. Food dryers are used for drying fruits, vegetables, herbs, and more, offering an efficient way to extend shelf life.

Fish dryer



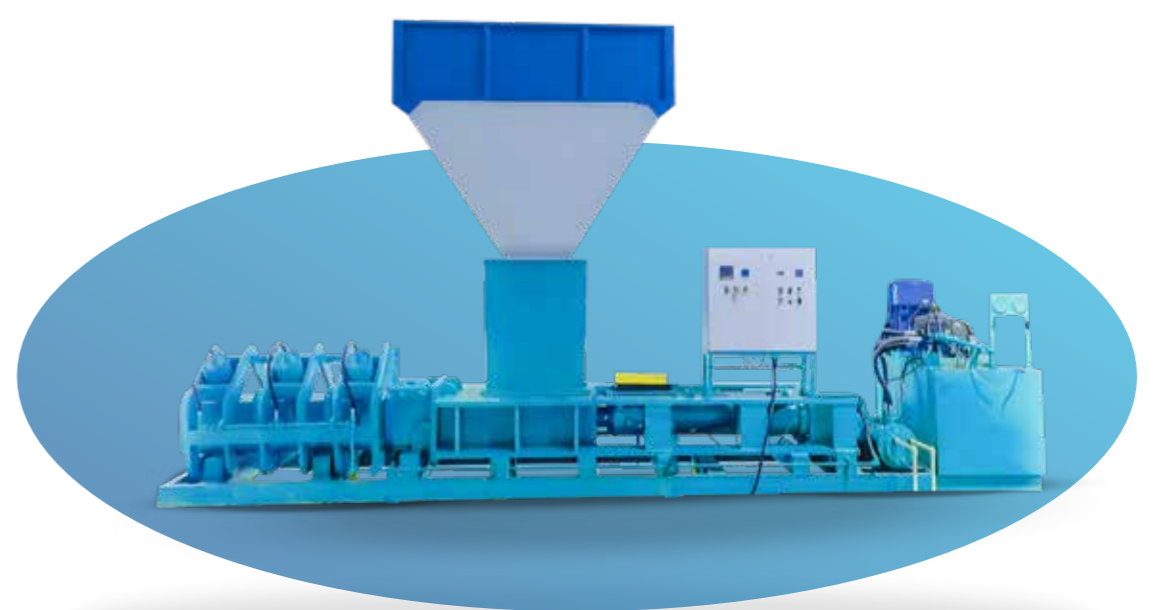
A fish dryer is a specialized machine designed to remove moisture from fish, preserving its quality and extending shelf life. Using methods such as hot air circulation, solar energy, or smoke, fish dryers ensure even drying while maintaining flavor and nutritional value. Commonly used in seafood processing, these dryers are essential for producing dried fish products for both domestic and international markets.

Grain dryer



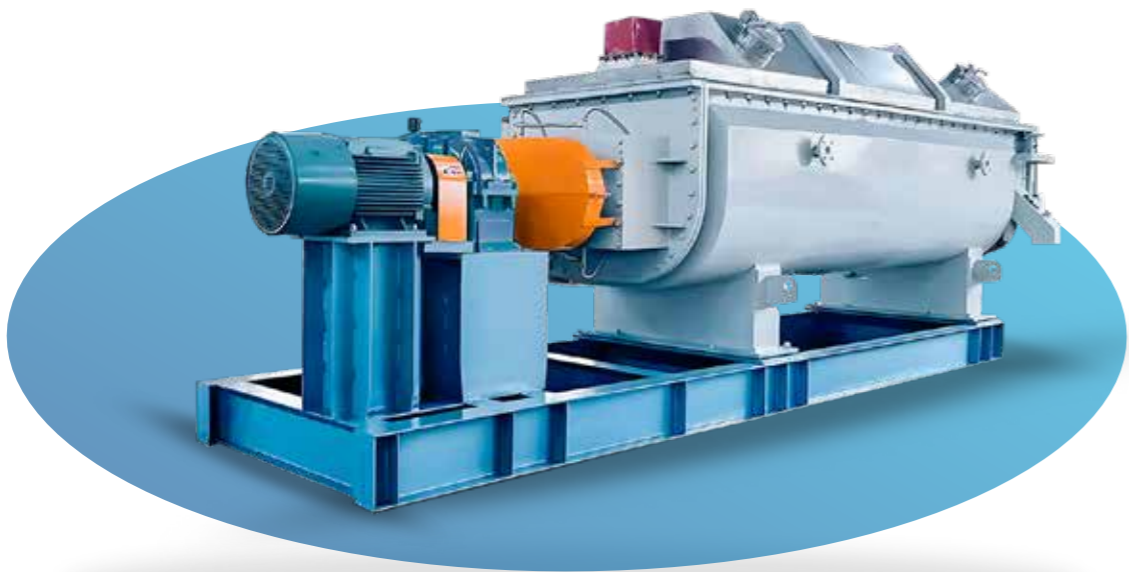
A grain dryer is an essential agricultural device designed to remove moisture from harvested grains to prevent spoilage and maintain quality. Utilizing heated air or other drying methods, it ensures uniform drying while preserving the integrity of the grains. Commonly used in farming and grain storage operations, grain dryers help improve the shelf life and marketability of crops by reducing moisture levels to safe storage conditions.

Coir Pith Dryer



A coir pith dryer is specifically designed to remove moisture from coir pith, a byproduct of coconut processing. Utilizing hot air or other drying methods, these dryers efficiently reduce moisture content to improve the material's shelf life and usability in horticulture and agriculture. Coir pith dryers are essential for enhancing the quality and marketability of this versatile organic product.

Sludge dryer



Sludge dryers are designed to dewater sludge, effectively reducing its volume while recovering valuable materials. By promoting circular economy practices, these dryers play a crucial role in waste-to-energy solutions, transforming waste into reusable resources. This process supports sustainable waste management efforts and significantly reduces environmental impact, making sludge dryers essential tools in modern waste treatment facilities.

Coal dryer



A coal dryer is designed to efficiently remove moisture from coal, enhancing its combustion efficiency and reducing transportation costs. By using heated air or gas, the dryer improves the coal's energy content and ensures more complete combustion, resulting in higher heating values and reduced emissions. This process not only improves the overall quality of the coal but also lowers shipping costs by minimizing weight, making it more economically viable for power generation and industrial applications.

Flash Dryer



Flash dryers are efficient direct drying units classified as convective dryers. In a pneumatic flash drying system, particulate solids are conveyed through a drying duct suspended in a stream of hot air. As the materials travel, they are rapidly dried by the hot gas, allowing for continuous operation and significantly reduced drying times. This process ensures uniform heat distribution, making flash dryers ideal for industries handling granular materials while preserving product quality.

Spray Dryer



Spray drying is a method for converting fluids, solutions, and thin slurries into powder form. The process atomizes the liquid into fine droplets, which are then exposed to a hot airstream, rapidly evaporating moisture and forming dry powder particles. Widely used in industries like food, pharmaceuticals, and chemicals, spray drying produces uniform powders with controlled moisture content while preserving the quality of heat-sensitive materials.

Microwave Dryer



Microwave dryers utilize electromagnetic waves that fall within the microwave region (300 MHz to 300 GHz). Microwave radiation can penetrate beyond the surface of the material. Hence, these dryers are used to dry the material from within (i.e., volumetric drying). The moisture or solvent evaporates from the pores of the material. Microwave dryers are used to process food and agricultural products.

Infrared Dryer



Infrared dryers utilize electromagnetic waves that fall within the infrared region (300 GHz to 400 THz). This region falls just below the visible light spectrum. These dryers emit energy to heat the material's outer surface, and heat is conducted from the outer surface to the inner portion of the material. Infrared dryers are usually equipped with forced convection equipment to increase efficiency.

OUR CLIENTS









THANK YOU

UNIT 1

4 & 5, Marudhar Industrial Estate, Gas Godown Lane, Goddev Fatak Road, Bhayander (E), Dist. Thane - 401105. (India)

Contact Us
+91-22 48255071,
48255072

UNIT 2

Plot No. B-47, Addl. Midc Anandnagar, Ambernath (E), Dist. Thane (India)- 421506

Contact Us
+91(0251)26205
42/43/44/45/46

KRDC

Plot No K2, Industrial Gala F4A, D- Wing, MGN Properties, Opposite Godrej Co., Addl MIDC Anand Nagar, Ambernath (E)- 421506 (India)

Contact Us
+91-2512620543/44

UNIT 4 (EUROPE)

Kerone Engineering Solutions LTD. (EMitech) Viale della Palma, 7, 70033 Corato BA, Italy (Europe)

UNIT 5 (THAILAND)

Thailand Representative:
163 Rajapark Building,
18th floor, Sukhumvit 21
Road (Asoke), Wattana,
Bangkok - 10110, Thailand

Contact Person
G.Vivekanand
+6689 500 9821

Uzbekistan / Kazakhstan (Office)

TIT Company LLC: 100060,
2, A. Kahhar, Tashkent,
Uzbekistan

Contact Person
Mr. Slava
+998 903540963

Israel (Office)

Ornatus Industrial Tech
Ltd: Dam Hamac bim 36,
7178602 Modiin, Israel

Contact Person
Omri Fabian
+972 584844887

Australia & New Zealand (Office)

Linotech Pty Ltd:
Po Box 3046, Browns
Plains, Qld 4118. Australia

Contact Person
Eric Quevauvilliers
+61 (0)418 871 005

Bangladesh (Office)

House-10, Road-5 Priyanka
City, Sector-12, Uttara,
Dhaka-1230, Bangladesh

Contact Person
Md. Emtiaz Morshed
+8801747762200



SCAN HERE

Our Mails

info@kerone.com
sales@kerone.com
marketing@kerone.com

Website

www.kerone.com
www.kerone.net
www.keroneindia.com