As the chart shows, specific vapor volume per square meter of dryer surface depends on the nature of the solvent. This volume can be calculated using the formula:

\[
\text{Vapor Volume} = \frac{\text{Water Flowrate}}{\text{Dryer Surface Area}}
\]

where

- \(\text{Water Flowrate}\) is the flowrate of water in liters per hour.
- \(\text{Dryer Surface Area}\) is the surface area of the dryer in square meters.

For example, if the water flowrate is 100 liters per hour and the dryer surface area is 10 square meters, the vapor volume is 10 liters per hour. This can be used to determine the efficiency of the drying process and to ensure that the dryer is operating properly.
Drying is one of the most common and important operations performed in chemical plants. Depending on the nature of the operation, the solvent of choice may be water, methanol, ethanol, or other organic solvents. Drying is usually performed in practically every plant that produces solid products in the form of powder and granules. Drying is an essential step in the manufacture of various specialty chemicals. It is a fundamental process in the manufacture of pharmaceuticals, agrochemicals, and many other products.

Batch drying involves drying in a continuous process, for the removal of moisture or other volatile constituents from the material. This is a common practice in the manufacture of pharmaceuticals and other high-value solids.

The basic principles of the drying process, including the mechanism of evaporation and condensation, are well understood. However, the practical application of these principles to specific drying systems and operations requires a detailed understanding of the equipment and the process parameters.

The selection of the drying system for a given application depends on several factors, including the nature of the product, the desired final moisture content, and the operational constraints. In this section, we will explore the different types of drying systems, their advantages and disadvantages, and the factors that influence their selection.

Batch Drying: The ‘Indirect’ Solution to Sensitive Drying Problems

Guidelines on specifying an indirect dryer and peripheral equipment for sensitive or hazardous chemicals

Mark Lattmann and Reiner Leible, Driechter Systems Processes

Conduction (double-screw) dryer: The indirect dryer most often used for sensitive or hazardous chemicals. In this type of dryer, a conduction dryer, a vacuum or pressure vessel, is used to prevent direct exposure of the product to the hot air or steam. The dryer consists of multiple stages, each with its own specific drying conditions. The dryer design is based on the nature of the material to be dried and the desired final moisture content.

Continuous drying: In direct drying, the material is conveyed through a continuous dryer. In contrast, indirect drying involves the use of a continuous dryer. In direct drying, a conduction dryer is used to remove moisture from the product. The material is conveyed through the dryer and then discharged at the desired moisture content.

The drying process significantly affects the quality of the final product. The selection of the drying system and the operational parameters must be carefully considered to ensure that the final product meets the desired quality standards.

Problems

Cover Story

Achieving total discharge of the solid is typically not possible, due to the presence of fines or poorly flowing particles. A simple solution is to use a tray dryer. The dryer has no agitator, but its basic form is true to its name. The dryer consists of a vessel with a circular end face, a paddle dryer, and a vacuum system.

The agitator provides good mixing and regular contact of the material with the heat source. Since these dryers are typically operated in a continuous process, they are generally made of stainless steel or high-quality alloys.

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**Guidelines on specifying an indirect dryer and peripheral equipment for sensitive or hazardous chemicals**

**Mark Lattenmaier and Reinier Lieblo, De Dietrich, Process Systems Technologies**

Drying is one of the more common and important operations involved in most chemical processes. It is undertaken in virtually every plant that handles raw materials or produces final products in the form of powder, gel, or other solids. Drying is typically a key step in the production of pharmaceuticals, agricultural chemicals, explosives, and many other products.

**Illustration:**

Drying can be performed under pressure (indirect) or under vacuum (direct) and may be accomplished in a single operation, including filtration and drying. A two-stage process, filtration and drying, is often used to process solid products. The second stage of the process involves the use of a filter/dryer, such as with the rotary filter press or the filter pan dryer. These units make critical contributions to the success of the drying process.

**Advantages of indirect heating/cooling**

- Multiple operations, including filtration and drying, are often used to process solid products.
- The second stage of the process involves the use of a filter/dryer, such as with the rotary filter press or the filter pan dryer.

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**Mark Lattmann and Reinier Laible, Dry Tech Distributor, Process Systems**

Drying is one of the more common and important operations in food processing. The purpose of drying is to remove moisture from the plant, leading to reduced weight, improved shelf-life, and reduced storage requirements. Drying is also often required at various stages of a process, for the removal of moisture or solvents from feedstocks, intermediate products, and the final products.

Direct drying is typically the most time-consuming drying process, and indirect dryers are used for products made in vacuum systems. Defining the term “indirect” is usually done in an operational way, by exposure to the atmosphere, or to a vacuum.

**Batch drying**

Batch drying is an important element in the total drying process. For example, some products could be dried within a conventional oven, to give 80% moisture, a spray dryer to give 20%, and a convector oven to give 5%. In such instances, the nature of the product and the material side of the drying process plays a confined role, while the knowledge of the dryer and its operation is required. Depending on the setup, batch drying may be oriented vertically or horizontally. A batch dryer may be run under atmospheric pressure, or under vacuum pressure.

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is a convectional dryer, it is essential to install the condenser to prevent the passage of particles to the condenser and into the pump. The filter has to fulfill three main tasks: to avoid blockage of the vacuum inside the dryer, to tend to build a crusty layer that blocks the layer acts like an absorbent — it be- come completely blocked by solids affecting the drying process, condensate have to be handled. When the solvent changes of dryer vacuum caused by the vacuum pump. Speed limits have to be kept in mind to assure total condensation for full recovery of solvents. For example, consider a typical dry- ing operation for a sensitive product dried at or near a vacuum pressure that is too high, or a vacuum pump that is too low will cause equipment damage and loss of product.

Condensers
Condensers can be used to monitor vapor volume processes, which are required during drying. They are typically shell-and-tube type_EX Cameron, Regis Drive, Deer Park, NY.

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the vacuum pressure, the product is exposed to the vacuum pump, which can normally collect particles only as dust filters are used in drying technology. However, in order to ensure that the vacuum system is working properly, it is important to monitor the pressure drop, which can be used to determine the effectiveness of the vacuum system. If the pressure drop is too high, it may be necessary to clean or replace the dust filters.

**Condensers**

Condensers are used to recover vapor from the condenser, where it is converted to a liquid. They are typically shell-and-tube type units, with the shell containing the condenser tubes and the tube side containing the condensate. The cooling medium is typically water, glycol-water mixtures, and various other fluids, depending on the application requirements. Condensers are used to recover vapor from various processes, including drying, distillation, and absorption. They are used to both recover water and recover organic solvents, which are then recycled or disposed of appropriately. Condensers are designed to operate at a controlled pressure, typically below the boiling point of the liquid being condensed. The pressure in the condenser can be controlled by using a vacuum pump to maintain the desired operating pressure. The condenser is typically designed to operate at a pressure of 30-70 mbars, which is sufficient to maintain a stable vacuum in the dryer. The condenser is typically jacketed to keep it cool. Depending on the type of condenser used, the liquid boiling point and the vacuum pressure will have a significant impact on the performance of the condenser. For example, if the liquid boiling point is too high, it may not be possible to achieve a stable vacuum in the dryer. Therefore, it is important to select a condenser that is designed for the specific application requirements.

**Design criteria**

**Condensers**

- **Shell**
  - Shell diameter: 300-1500 mm
  - Shell thickness: 5-10 mm
  - Shell material: stainless steel, carbon steel, or alloy steel
- **Tubes**
  - Tube diameter: 15-25 mm
  - Tube material: stainless steel, carbon steel, or alloy steel
  - Tube pitch: 25-50 mm
- **Condenser shell**
  - Condenser shell diameter: 300-1200 mm
  - Condenser shell thickness: 5-10 mm
  - Condenser shell material: stainless steel, carbon steel, or alloy steel
- **Condenser tube**
  - Tube diameter: 15-25 mm
  - Tube material: stainless steel, carbon steel, or alloy steel
  - Tube pitch: 25-50 mm
- **Condenser jacket**
  - Jacket diameter: 300-1200 mm
  - Jacket thickness: 5-10 mm
  - Jacket material: stainless steel, carbon steel, or alloy steel
- **Condenser surface area**
  - Surface area: 300-1500 m²
- **Condenser pressure drop**
  - Pressure drop: 0.1-0.3 bar
- **Condenser efficiency**
  - Efficiency: 90-98%

**Design considerations**

- **Condenser design**
  - Condenser design is an important consideration when selecting a condenser. The design must be carefully selected to ensure that the condenser is able to recover the desired amount of vapor and operate at the desired pressure.

**Use of condensers**

- Condensers are typically used in various applications, including drying, distillation, and absorption. They are used to recover vapor from various processes, including drying, distillation, and absorption.

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**Condenser performance**

- **Condenser performance**
  - Condenser performance is typically evaluated using a condenser efficiency factor. The efficiency factor is defined as the ratio of the actual condenser output to the theoretical maximum condenser output. The efficiency factor is typically between 0.9 and 0.98, with a higher efficiency factor indicating better performance.

**Condenser maintenance**

- **Condenser maintenance**
  - Condenser maintenance is an important consideration when using condensers. The condenser must be regularly cleaned and maintained to ensure that it operates at the desired efficiency.

**Condenser optimization**

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