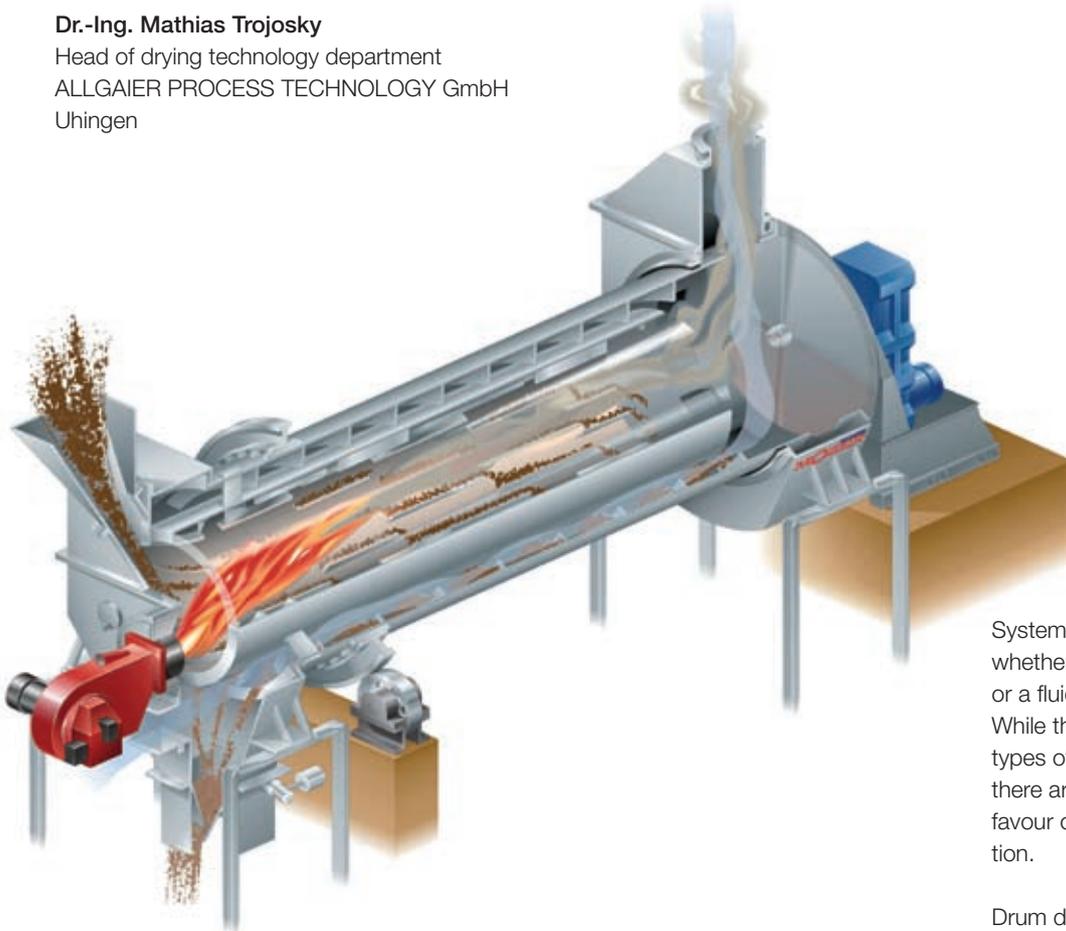


Rotary Drum or Fluid Bed?

Selection criteria for the use of dryers in the process industry

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It can often be difficult to make the right choice. This also applies to the users of drying systems. Each supplier of such systems naturally advertises the technology of his product range as the best, and the users are faced with the problem of deciding which system is really the best for the intended application. This article could perhaps help to solve the problem.

System users frequently have to decide whether to use a drum dryer (rotary dryer) or a fluidised-bed dryer (vibratory dryer). While the application areas of these two types of dryers overlap to a certain degree, there are various selection criteria which favour one or the other for a given application.

Drum dryers have been used for decades for drying many different types of goods and are widely used in the building, minerals and raw-materials industry. Fluidised-bed dryers, on the other hand, are widely used in the manufacture of chemicals, foodstuffs and pharmaceuticals. Various special applications, such as spray-granulation dryers, suspension and paste dryers, fluidised-bed dryers/coolers with heat exchangers integrated into the fluidised bed, have been developed for fluidised-bed dryers. In the last twenty years fluidised-bed dryers have also been installed in the building-material and minerals industry. At the same time, however, drum dryers have been improved further and permit energy-efficient applications, particularly in the minerals industry, and very robust and hard-wearing solutions.

Drum dryers: energy-efficient and particularly robust

In drum dryers, the material to be dried is moved by the rotation of the drum and by the effects of vanes and blades mounted inside the drum. In the past, drum dryers were in most cases constructed with a slight downward inclination in order to support the movement of the material. Today, the drums are almost always mounted horizontally. Lifting blades lift the moist material from the base of the drum and then allow it to fall, thus ensuring good contact between the moist material and the hot air.

In most drying applications, the material and the hot air flow parallel in the same direction through the drum. The solid to be dried is transported through the drum by means of vanes. The material thus moves both in the same direction as the hot air and also at cross flow to the air.

In the minerals industry, the drying air is in most cases heated with the aid of a gas or light-oil burner. The combustion gases are then mixed with a certain amount of ambient air to achieve average drying-air temperatures between 600 and 900 °C. For materials which are not easily damaged by high temperatures, such as quartz sand, the flame can be allowed to burn inside the rotating drum. For drying more sensitive materials such as limestone, clay, bentonite, recycled plastics or organic waste materials, combustion chambers are used to ensure that the combustion gases are mixed with ambient air before they enter the drum, in order to achieve the desired average drying-air temperature.

All in all, the technical outlay for the heating of drum dryers is relatively low. Modern burners have only relatively small fans for the combustion air. In most cases, it is not necessary to use fans to blow the drying air into the dryer or to install costly piping.

The moist drying air leaving the dryer is extracted with an exhaust fan, filtered in the bag filter to remove dust and exhausted via a chimney into the open air. The piping for the exhaust air is also relatively simple, since the air needs to be extracted only at a single point from the dryer housing. Drum dryers are constructed for solid-material throughputs of 5 to 150 t/h. A further advantage of drum dryers is that they are almost unaffected by variations in the moisture content of the materials to be dried, in the throughput or in the grain size of the material or by lumps or coarse



Drum dryer „System Mozer“ for drying limestone and diabase

grains in the incoming material. Even in the event of a power failure, operations can in most cases be resumed immediately when the power returns.

Drum dryers can be used for even fine solids, but are particularly suitable for coarse and very coarse bulk goods, and it is not absolutely necessary to adjust the amount of air when products are changed. Even if the supply of drying air fails, the material is still moved reliably through the drum. Drum dryers are particularly resistant to the effects of incorrect operation, which means that they are ideal for use in less well developed regions. The dryer controller can be automated relatively easily.

Hardwearing drum dryers for abrasive substances

The drum and the blades and vanes inside it are made from thick-walled steel. If the blades and vanes are designed correctly, even very abrasive materials can be dried in drum dryers. Care must be taken that the material to be dried slides as little as possible on the blades and vanes and that it falls onto a bed of material in the bottom of the drum. In general, dryers have a low specific heating-energy consumption if the process can be run with a high inlet-air temperature. High hot-gas temperatures result in low amounts of drying air and less heat losses with the exhaust air. For this reason, drum dryers which operate with the hot-gas temperatures of up to 900 °C which are commonly used in the minerals industry are very efficient, even though the exhaust-air temperatures of drum dryers are generally higher than those of

fluidised-bed dryers.

A special advantage of drum dryers is that it is possible to adjust both the hot-gas inlet temperature and the amount of drying air in periods when a drying system designed for a specific throughput is operated for a long time at a significantly reduced performance. This reduction of the amount of air makes it possible to keep the hot-gas temperature high, close to design value. As described above, this means that the low specific fuel consumption is maintained even when the dryer is not operating at its full rated power.

This cannot be done with fluidised-bed dryers, since the full amount of drying air must be provided, even when the dryer is operating at a reduced load, in order to fluidise the material being dried.

In fluidised-bed dryers, good fluidisation of the material to be dried is a prerequisite for reliable transport of the material through the dryer and for good ventilation of this material. Drum dryers, in contrast, transport the material to be dried with the aid of the vanes and blades in the rotating drum.

The material to be dried in drum dryers does not need to be fluidised by the drying air. The air flows relatively freely through the drying drum. In contrast, the fans which blow air into a fluidised-bed dryer not only have to fluidise the material to be dried; they must also overcome the pressure loss in the gas distribution plate, which must be high enough to ensure uniform distribution of the drying air over the entire cross-section of the dryer. The specific electricity consumption of a drum dryer is thus relatively low and is about two thirds of the value for fluidised-bed dryers.



Fluidised-bed dryer for drying sand, limestone and marble

Saving energy during drying

In cases where the material to be dried has to be cooled immediately, the use of a double-shell dryer for drying and cooling in a single unit is recommended. In such dryers, the material is dried in the inner tube of the drum. The dry and warm material then flows from the inner tube into the outer shell, where it is moved in the opposite direction by suitably designed vanes and blades and is cooled by the incoming, cold ambient air. With the System Mozer-TK, the dried goods can be cooled to about 55 to 60 °C, which is sufficient for most applications in the building-materials and minerals industry and, in particular in the production of mortar. If even lower temperatures are required, a separate cooling drum, followed by a water-cooled contact cooler or a fluidised-bed cooler can be used.

A particularly energy-efficient drying and cooling drum is the System Mozer-TK_plus, which is used primarily for the drying and cooling of quartz sand. In contrast to the System Mozer-TK, the material is not cooled with ambient air. Instead, a certain amount of moist sand is mixed with the warm sand after this has passed through the inner tube of the drum. The evaporation of the water in the moist sand cools the mixture, and the heat stored in the dry sand helps to dry the moist sand. In the TK_plus, the moist material is fed in from both sides. Depending on the moisture content of the sand to be dried, 10 to 20% of moist sand is mixed with 80 to 90% of dry sand. This system permits the fuel consumption for drying to be reduced by about 15%.

In fluidised-bed dryers energy can be recovered by feeding the warm, filtered exhaust air from the cooling zone back into the drum as pre-heated drying air – particularly in cases where it is possible to achieve a good balance between the amount of drying air and the amount of cooling air. In the ideal case, all of the heat resulting from cooling of the dried material can be used for drying. The energy consumption is then reduced to the amount of fuel which would be needed, without recycling of the exhaust air, to heat the ambient air to the temperature of the exhaust air from the cooler which is recycled. In all variants of combined drying/cooling systems, the initial cooling of the dried material leaving the dryer results from the evaporation of the residual moisture. Further drying in the first part of the cooling zone results from the heat still stored in the dried material – rather like the drum dryer/cooler TK_plus.

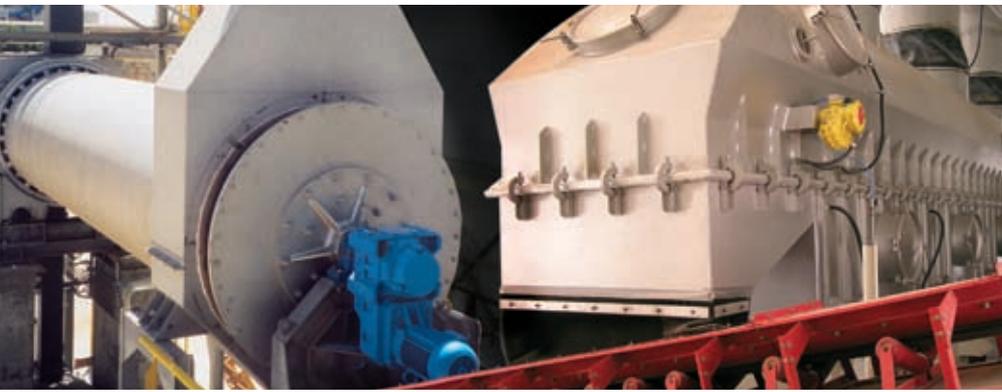
Fluidised-bed dryers: efficient drying of products with uniform grain sizes

In fluidised-bed dryers, the transport of the material to be dried is achieved by fluidising this material with an upward flow of drying air. If this is done correctly, the material assumes a pseudo-fluid state and flows out of the dryer at the same rate as moist material enters the dryer. The solid flows cross flow to the upward flow of drying air.

The outlet of the dryer is equipped with an adjustable weir with which the height of the fluidised bed can be adjusted, and this affects the retention time of the material in the dryer. In the ideal case, all particles in a fluidised bed are continually in contact with the drying air. This results in the best heat transfer conditions and high specific drying rates or relatively small dryer dimensions are possible.

Since this ideal state can often not be achieved in practical applications, fluidised-bed dryers are built as vibratory dryers in order to improve the fluidisation of the material to be dried.

The vibration ensures that even coarse particles which cannot be fluidised by the flow of air are transported better. But there are limits to this. Depending on the range of grain sizes and the apparent density of the material to be dried, the use of fluidised-bed dryers is recommended only up to a grain size of about 6 mm, and at the most 8 mm. If this is not observed, coarse particles can accumulate in the dryer, since they cannot flow over the adjustable weir at the outlet of the dryer. If no adjustable weir is used (in order to prevent the accumulation of coarse particles), it is no longer possible to adjust the retention time of the material being dried by varying the height of the weir or the poorly fluidised solid material is no longer ventilated correctly.



Competent advice guarantees optimal solutions

In general, the air distribution plates should be designed with a sufficiently high pressure loss in order to ensure good distribution of the drying air over the complete area of the dryer. The fans for the drying air must therefore generate a high pressure. Otherwise, the air will take the path of least resistance through the material to be dried and this will result in a poor flow of air, particularly in places where the material is moist. For this reason, fluidised-bed dryers have a higher specific consumption of electrical energy (about 150 % of the energy consumption of a drum dryer).

Wherever possible, fluidised-bed dryers should always be operated with solid materials with fine grains, since they are designed for this. If, for example in the case of a product change, material with a considerably larger grain size enters the dryer, the fluidisation may collapse and efficient drying may no longer be possible. Thanks to the fact that each particle of the material to be dried is continuously surrounded by air, sensitive moist solids or granulates from mixer granulators can be dried without damage in a fluidised bed. Due to the continuous lifting and dropping of the material, drum dryers cause a higher abrasion of the particles.

Just like drum dryers, fluidised-bed dryers are normally regulated such that the temperature of the drying air leaving the dryer remains constant. Depending on the temperature of this air, a control loop adjusts the heat input to the incoming drying air and thus reacts to varying amounts of material or to varying moisture contents. Since the temperature of the exhaust air is closely related to the temperature of the material at the end of the dryer, and

since this determines the residual moisture of the material, it is possible to ensure constant residual moistures of the material being dried.

However, the specific fuel consumption per tonne of material to be dried increases if, due to a continuously low amount of material or low moisture content of the material, the drying system is not operated at the rated parameters for which it is designed.

Since the amount of air entering a fluidised-bed dryer must be kept constant in order to maintain the fluidisation of the material to be dried, the same amount of heat is lost with the exhaust air even if the dryer is operated at a reduced capacity. It is not possible to reduce the amount of air in order to maintain a high temperature of the drying air, as it is possible in drum dryers.

Fluidised-bed dryers are particularly suitable for use in the chemicals industry and for the processing and recycling of materials which are easily damaged by high temperatures.

Selection criteria and aids

Since both drum dryers and fluidised-bed dryers are suitable for many applications, the decision should be made on the basis of criteria such as:

- the expected stability of the production conditions (throughput, moisture content, grain size)
- the prices relation of the energy sources (electricity / gas)
- the infrastructure at the installation location
- the level of training and organisation of the operating personnel
- the services available at site of erection

The investments for a complete drum-dryer or fluidised-bed system, including the electrical control system, are often comparable. In some cases, the criteria are met by both systems. In most cases, therefore, the decision must be made on the basis of two or three main criteria which are of particular importance to the operator or the investor.

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