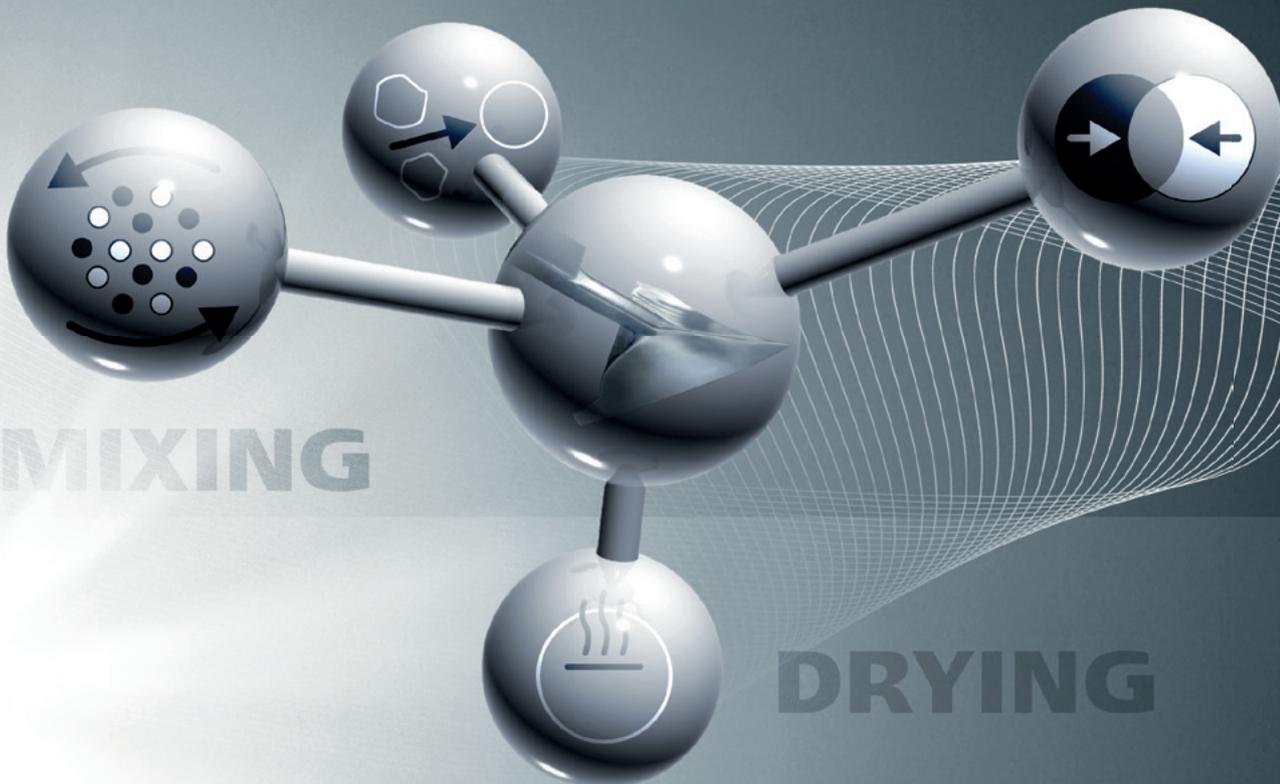


GRANULATING

REACTING



MIXING

DRYING

Drying and Reacting Systems

**We work for all brands
in all industrial fields.**



Lödige DRUVATHERM® Dryers and Reactors for Suspensions, Pastes, Bulk Solids and Powders.

Drying is defined by removing or reducing liquid components (moisture) from or in bulk solids by thermal processing while the moisture is evaporated and removed.



Applications

General applications:

- Reaction processes at high heating temperatures (up to 700°C), at normal pressure up to high pressures (up to 50 bar)
- Drying process at normal pressure, under vacuum up to high vacuum (10^{-5} mbar)

Specific applications:

- Synthesis of aramid fibers
- Cellulose derivatives
- Catalyst mixture
- Battery pastes
- Friction lining materials
- Oil- and solvent-containing sludges
- Pyrolysis of plastics, used tyres and car fluff
- Metal soap (stearates) and other plastic stabilizers
- Dyestuffs and pigments
- Pharmaceutical active agents and intermediate products
- Food like pectins, vitamins, xanthan, carrageen, cocoa mass

Certified process steps guarantee the quality of our service and products.

The issued certification is a reflection of our customer and quality orientated thinking. The Quality Management System of Lödige is certified according to DIN ISO 9001. We are in the possession of pressure vessel manufacturer certification according to AD 2000 (HP0) and to the ASME Codes ("U" stamp), are certified to register pressure vessels with the National Board, USA, as well as having the certification for ML registration from the Chinese and South Korean "Centre of Boiler and Pressure Vessel Inspection". Likewise, we are in possession of the certification "Japanese Industrial Standards" for the supply of pressure vessels.

Drying and Reacting Processes

At Lödige, consultancy, machine, process and service all come from one source. The individual, project specific technical specification and the precise adaptation to the process task due to the availability of a multitude of standard options and technical solutions are our strength – and hence your advantage.

Drying

During the drying process, the liquid components are separated from the solid components with the introduction of energy. The aim of such an operation is to either gain the dried component as a valuable product, or to recover the solvent for re-use in the process. In the latter case, even the selective recovery of solvents is possible.

Whether low speed or high speed shovel dryers are utilised, there will always be a gentle but effective mixing of product particles, ensuring optimum heat exchange conditions. In doing so, temperature gradients and hot spots are avoided. Temperature sensitive products are preferably dried under vacuum, as a reduction in the vaporisation temperature is then achieved. Drying processes under normal atmospheric pressure can be accelerated by injecting either hot air or superheated steam directly into the product bed. Warm water, steam or thermal oil can be used as a heating medium for the heating jacket. Depending on the project, further heating energy sources can also be used according to the state of the art.

Reacting

We can carry our chemical reactions (synthesis) of one or more components (educts, reactants) to one or more products having new chemical and/or physical characteristics. Horizontal vessels, having superb particle interaction generated by the mechanical fluid bed, are thus well suited for chemical reaction processes. For this reason, for example, organic pigment synthesis can be carried out directly without the need to create an initial suspension. Horizontal mixer/reactors are also well suited for polymerisation processes, gaining an advantage over, for example, vertical units due to their insensitivity towards product phase changes.



Lödige DRUVATHERM® Dryers and Reactors provide a wide range of advantages.

“All-in-One Process”

This we understand to be the ability to carry out all steps of a complete process in one single Lödige unit. The universal nature of Lödige reactors allow for complex process steps like mixing, liquid addition, heating, evaporative concentration, reacting, drying, cooling, granulating and coating steps to be carried out in a single unit.

For example: liquid reactants are initially mixed and then brought to a reaction upon introduction of additives. Subsequent evaporative crystallisation, drying, cooling and granulation yield the final solid product. These process steps are performed without intermediate storage, transportation or cleaning.



Batch Operation

Most drying processes are carried out in a batch manner. The product is dried under specific pressure and temperature conditions until the desired final characteristics are achieved. In many instances, the process parameters are adapted to accommodate the changing product consistency with time.

Continuous Drying

The product is introduced near the endplate on one side of the dryer, then transported by the mixing elements to the other end of the dryer. A specifically designed internal weir ensures a controlled discharge of product and thus the adherence to a defined retention time. By selecting a project-specific mixing shaft, retention times of several hours are achievable. The introduction of thermal energy is effected via the heating jacket (contact drying) or additionally using pre-warmed air (convection drying).

Steady State

When products display certain characteristics, it is sometimes not recommended to carry out drying in a purely batch manner. In this case, already dried product is initially introduced into the dryer, followed by the continuous addition of moist raw product over time. The process has to be controlled such that the moisture introduction rate due to fresh product equals the evaporation rate. The drying process is then in Steady-State.

When the maximum filling level of the dryer has been reached, the dryer is discharged. A certain amount of dried product is retained inside the dryer for the next batch.

Technical Features

- Both modes of operation: high speed / low speed operation
- Compliance to ATEX
- Flame-proofing according to international requirements
- High efficiency due to filling degree related heat exchange surface area
- Operating pressures up to 50 bar
- High durability against load alternation
- Compliance with various welding regulations
- International certification for pressure vessels and shaft seals
- Mechanical seals having air and liquid lubrication
- Wide selection of materials of construction
- High temperature range up to those for pyrolysis processes

Lödige DRUVATHERM® Versions VT, VTE, VTA

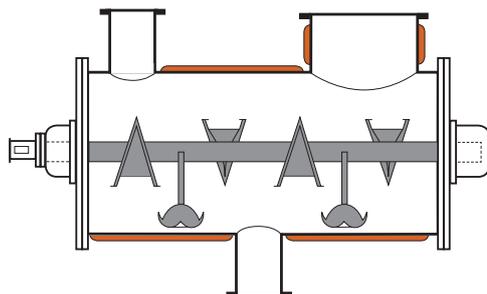
Lödige provides vacuum dryers for batch operation in three versions with different shaft bearing designs. This has influence on the accessibility for cleaning and inspection. A classical batch mixer of type FKM appropriately modified can also be used for drying processes under normal atmospheric conditions.



VT Version

VT 300 - VT 40000

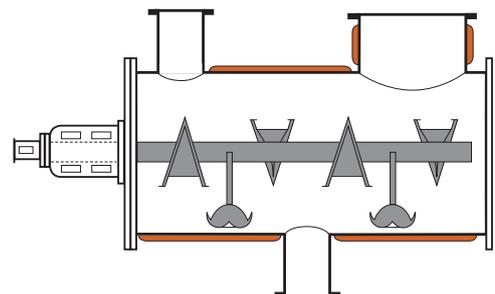
The VT with bearings at each end of the dryer shaft is the classical version. An inspection door or manhole provides access to the inside of the drum. This version is particularly suitable for repetitive identical drying processes and to accommodate high drive power requirements.



VTE Version

VTE 5 - VTE 2000

The VTE is equipped with a bearing at one end of the dryer shaft. The endplate at the non-drive end of the machine is hinged and can be opened for access to the dryer drum, thus providing easy inspection and cleaning. As the shaft is held in a bearing at one end only, the bearing has to be suitably designed for the task.

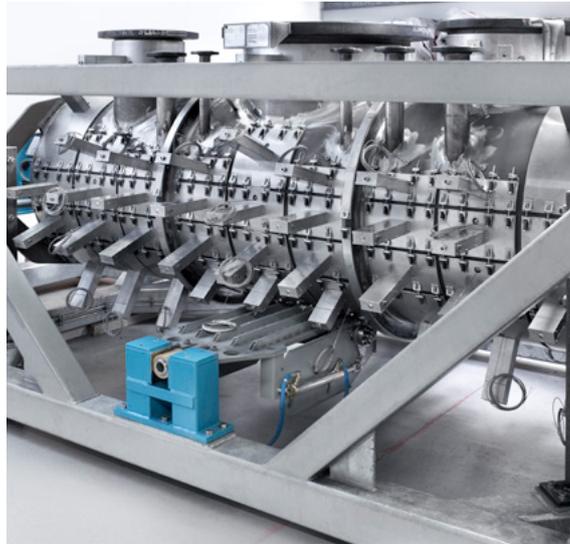


**Operation parameters of the DRUVATHERM®
Vacuum Dryers and Reactors**

The Vacuum Dryers operate under the following parameters:

- Drum pressure 10^{-8} / 50 bar
- Jacket pressure 0 / 30 bar
- Drum temperature -80 / 700°C

Construction materials like normal steels, stainless steels and special materials (for example INCONEL® or Hastelloy®) are used.



VTA Version

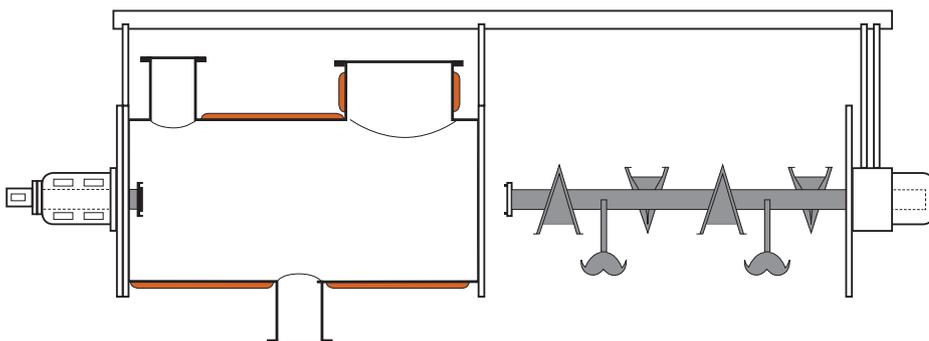
VTA 300 - VTA 6000

The VTA is equipped with a fully extractable shaft giving access to the complete inside of the dryer. In this way cleaning and inspection is made even simpler. The pull-out mechanism is either motor driven or mechanically actuated.

HTR High Temperature Reactor

HTR 1200 - HTR 14000

The HTR is a special development of this version which is specifically dedicated to applications at high temperatures. The detailed technical features are especially adapted to the thermal and process conditions.



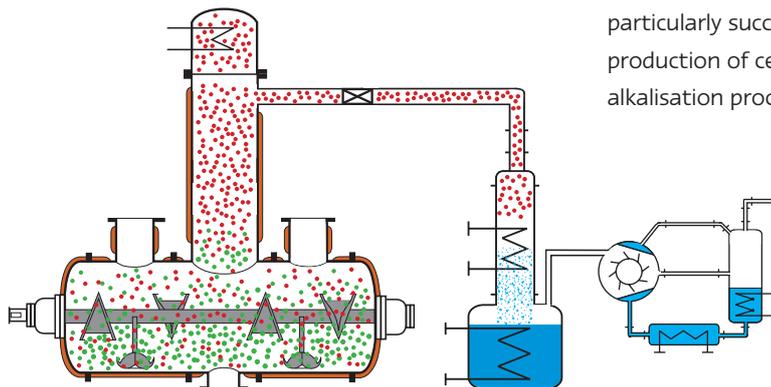
Lödige DRUVATHERM® Versions DVT, CGT

The DRUVATHERM® DVT Reactor is used for drying processes and reactions with up to 50 bar gauge pressure.



DVT Reactor

The DRUVATHERM® DVT Reactor provides both drying and reacting processes at overpressures up to 50 bar. In this type of machine the excellent mixing of solids by the mechanical generation of a fluid bed is put to good use. In cooperation with partners, Lödige has developed special shaft seals and shutt-off devices for use under vacuum and at overpressure. With conventional reaction processes, solid materials frequently require dispersion in liquids to ensure contact between reaction partners.



The separation and downstream treatment of the liquids after the reaction involves additional, costly process steps. The intensive, mechanical mixing in Lödige Reactors means that the liquid phase can be minimized. Downstream treatment is reduced or can be dispensed with completely. The same benefits can be implemented in liquid reactions in which solid material is produced (e.g. precipitation, polymerisation, crystallization). In this case solid concentration can be increased and the following steps, e.g. filtration or centrifuging, dispensed with. Drying is carried out straight away in the same machine.

Practice-proven Lödige Druvatherm® Reactors are particularly successful in the chemical industry for production of cellulose and starch ethers as well as for alkalisations processes.



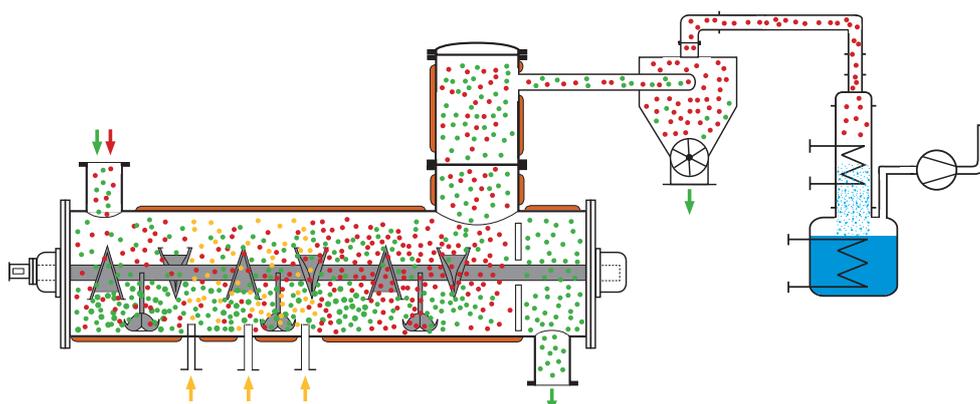
- DRUVATHERM® CGT Granulator Dryer**
- ⋆ Long slim design
 - ⋆ Volumes between 300 and 10,000 liters
 - ⋆ Variable retention times
 - ⋆ Completely heated
 - ⋆ Contact and convection drying
 - ⋆ Drum pressure -1 / +1 bar
 - ⋆ Jacket pressure 0 / 5 bar
 - ⋆ Temperature up to 160°C



Continuous Granulator Dryer CGT

The DRUVATHERM® CGT Dryer is designed for continuous operation. The special feature of this dryer is, in addition to the continuous operation, the possibility to combine convection and contact drying (aeration drying). Due to the extended residence time, products can be dried at low temperatures to protect them. At the same time excellent granulation can be obtained. By using two CGT dryers, a combined stripping/drying process can be run.

During stripping in the first dryer, product moisture (solvent) is removed by steam. The resultant water moisture is removed in the second machine by convection drying. In this way the residual solvent is kept to a minimum and the high-cost of inert gas/circulation drying is avoided. This process is often used in the field of polysaccharides.



Efficient Systems – beyond the machine

The right peripheral equipment makes a dryer or reactor into an efficient system. Lödige supplies complete systems with all peripheral equipment necessary for operation:

- ∴ Condenser
- ∴ Vacuum pump
- ∴ Controls
- ∴ Piping and wiring
- ∴ Installation
- ∴ Start-up

Lödige not only supplies the actual dryer or reactor, but complete systems with all peripheral equipment necessary for operation of drying and reacting processes. The required items are defined by the drying process and the equipment already available on site. Contact drying systems allow for simple recovery of evaporated product moisture by condensation and return of this to the production process ("closed system"). There is no exhaust air problem which is inevitable in convection drying due to the large quantities of drying gas used. This is especially important if product moistures are hazardous or environmentally dangerous, as contact dryers finally emit the vapours in the form of condensed liquid. Systems intended for multi-step reaction processes are made suitable for process requirements by consistent process design, comprehensive basic engineering and specific design of the reactor.

1 Condenser

Vapours have to be condensed as they cannot be exhausted into the environment. This is carried out by a condenser which is usually operated with cooling water. In many drying processes the condensate is not disposed of, but recovered to be used again in the production process. In some cases the recovered condensate can be used as a valuable raw material.

2 Condensate Receiver

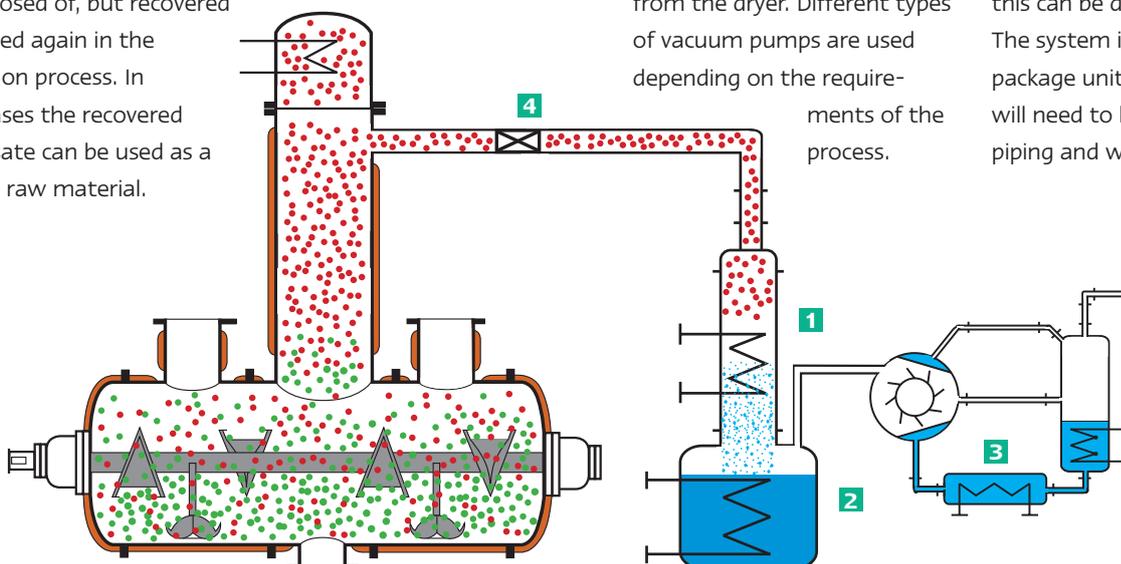
Condensate collects on surfaces of the condenser and drips into the receiver. The progress of the drying can be checked via level measurement.

3 Vacuum Pump

To reduce vapour pressure and thus product temperature the drying process is operated under vacuum. This reduces the boiling temperature of the product moisture and supports the removal of the vapours from the dryer. Different types of vacuum pumps are used depending on the requirements of the process.

4 Piping and Wiring

After installation all peripheral equipment must be connected by piping and equipped with the necessary fittings. Extensive wiring is frequently required for automatic controls. In the case of smaller machines this can be done in the factory. The system is delivered as a package unit. Larger machines will need to be equipped with piping and wiring on site.





Lödige Test Centres

Having more than 700 m² of floor space, the Lödige Test Centres provide trial capacity for more than 30 machines. Trials for mixing, granulating, reacting, drying and coating, representing the full range of the Lödige product line, can be carried out here.

For the development of safe and reproducible drying and reacting processes, Lödige provides you with two state-of-the-art test centres for a wide range of testing and analyzing.

During trials with your raw materials, all data relevant to the process and scale-up are measured and documented. Trials supply necessary data for correct specification of the dryer or reactor and peripheral equipment. A laboratory is available for initial physical analysis e.g. moisture content and particle size.

After-Sales

The aim of our after-sales service is to maintain the high quality of the system we have supplied and to support the customer at all times by quick response in order to solve any problems.

In addition to installation and startup, Lödige also offers professional advice regarding inspections, intervals between inspections and the number of spare parts to be held in stock.

Furthermore, we provide support and advice for validation and any measures necessary for maintaining the validated condition.

Lödige offers you not only the best solution to your process task but also competent service to safeguard your investment and the long term high quality of your system.

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Lödige supplies high-grade components, sub-systems and systems for technical processing applications in a wide range of industries. We are specialized in the field of mixing, granulating, coating, drying and reaction. Our profound knowledge of processes, development and production enables us to contribute to the success of our partners throughout the world.

Lödige, which was founded in 1938, is a family-run business in its third generation now.

With the invention of the Ploughshare Mixer, Lödige created a mixing unit that can cover a wide range of different processing tasks. This unit forms the basis for numerous innovations in the area of mixing and processing technology.

Industrial mixing and processing technology has been significantly influenced by Lödige and will continue to be so in the future.

Over 500 patents and more than 30,000 machines and systems demonstrate our experience with customer-oriented system solutions. Lödige operates with more than 300 employees worldwide and supports its customers with a network of subsidiaries, technical offices and agencies.