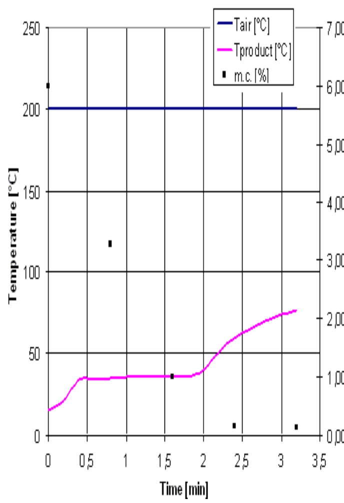
Advancements in Aggregate Drying



Dryer Advancements - Introduction

A continuous fluid bed dryer/cooler is a machine in which a continuous flow of wet granular material is dried and subsequently cooled. Drying of the material occurs because of the direct contact between the material to be dried and the hot drying air that is blown through a layer of the product. The air velocity of the drying air is adjusted in such a way that the layer of product is maintained in a fluidized state. The same principle applies for cooling, only the cooling is with ambient air or with conditioned (cooled) air.

In the 1st stage of drying, the free water is removed from the product. All available energy, supplied as heat in the drying air, is used for evaporation. Both the gas flow and the product attain the adiabatic saturation temperature. The temperature of the drying air reduces while the air absorbs the moisture from the product up to its saturation point i.e. the gas sensible heat is converted in latent heat of evaporation.



Typical Sand Drying Curve

In the 2nd stage of drying, when the free water is evaporated and the product is nearly dry, part of the available energy is used for the evaporation of the last moisture and part is used for heating up the product. There is a relation between the end temperature of the product and the moisture content after drying. If the product temperature at the required moisture content is known, this temperature will be used for controlling the dryer. If there is a change in the moisture content of the feed product or in the product rate, the drying air temperature is automatically adjusted to maintain the product temperature at the end of the dryer.

Dryer Drive Unit

A special design feature of the VENTILEX fluid bed dryers is the shaking movement of the dryer that moves the product forwards, also with low air velocity (sub-fluidization). The shaking movement is a mechanical movement created by a crank-connection rod mechanism. The desired product velocity through the dryer can easily be adjusted by changing the shaking frequency, without changing the amplitude.

Compared to static dryers, the advantage of the shaking movement is that the fluidization is improved and the air load

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VENTILEX USA Inc.
2960 Robertson Ave.
Cincinnati, Ohio 45209

P: 513.366.3950
F: 513.351.5108
E: sales@ventilex.net

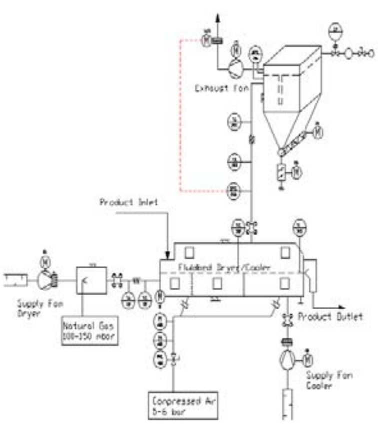
www.ventilex.net

Special points of interest:

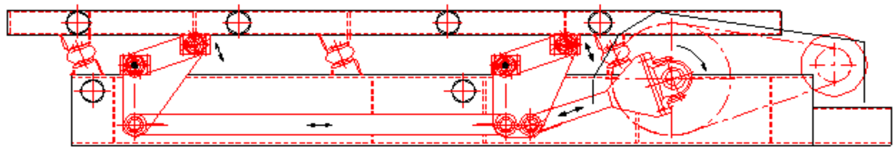
- *Save money with a smaller dryer*
- *Reduce wear with a compact design*
- *Reduce gas consumption with recirculation*
- *Evaporative Cooling can payoff quickly.*

Dry Mortar Plants using VENTILEX Fluid Bed Dryers

“Returning the exhaust gas from the cooler back to the air inlet from the dryer can save energy. “



Typical Dryer Schematic



Drive System, continued...

can be reduced. Because of the lower air load, the amount of fines to the filter will be reduced.

For products that need long resident times (mainly in the food industry), VENTILEX invented sub-fluid bed dryers. The layer thickness of the product with normal continuous fluid bed drying is about 10 - 15 cm [4 - 6 inches]. If the layer thickness is increased, the spread of product residence time is increased excessively due to axial mixing of the product during the drying process.

With sub-fluid bed drying it is possible to run with thicker layers, up to 60 cm [24 inches]. The amount of air is kept to a minimum to keep the mixing to a minimum. Forward movement of the product through the dryer is created by the shaking mechanism.

With sub-fluidization, the product outlet is equipped with a rotating weir that continuously controls the discharge of the dryer. Residence times up to 2 hours are possible without substantial mixing.

Energy Savings

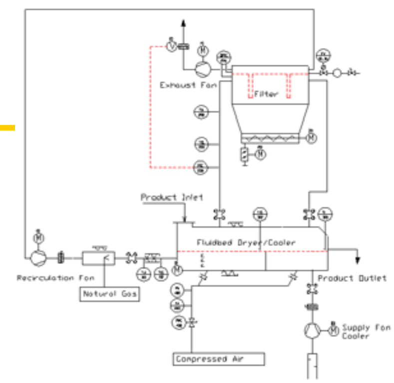
Over the last few years, the maximum drying air temperature used for the VENTILEX fluid bed dryers for sand has increased from 450 - 600 °C [840-1112 °F]. This results in more evaporation per m^2 and thus less energy usage (electrical) per Ton dried sand. Also with higher temperatures the energy efficiency is better.

The burner housing and the undercase of the dryer are built in high temperature resistant steel instead of stainless steel. Also the construction is different than in the past, to avoid problems due to size changes when the temperature of the material changes

Some construction details are the following:

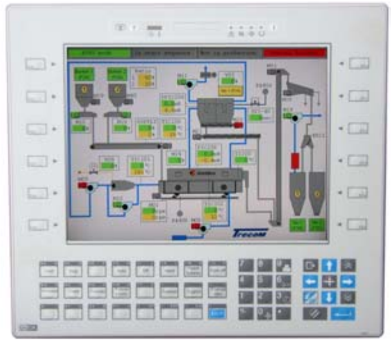
- Hatches are round to avoid cracks
- The bedplate is mounted in such a way that the plate can move freely.
- The undercase [plenum] is mounted with a slide construction to the frame.
- No sharp corners and edges.
- Strengthening stripping are mounted in such way that it can expand.

An example of a flow sheet of a sand dryer is given to the left. The drying air is heated with



natural gas. Another option of heating the drying air is by means of light fuel oil or LPG. The exhaust air from the dryer and from the cooler is combined and exhausted as one air stream.

Returning the exhaust gas from the cooler back to the air inlet from the dryer can save energy. Because the product is cooled, the cooler exhaust air will be ± 50 – 60 °C [122-140 °F]. The amount of energy that is saved by recirculating the cooling air is ± 15 %. In the above figure you can see the flow sheet for a system with recirculation.



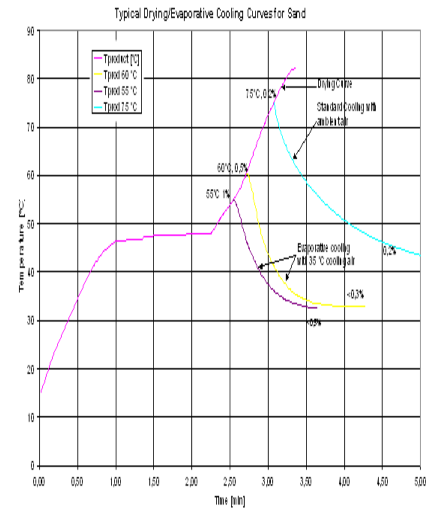
Evaporative Cooling

Some sand products can be dried using evaporative cooling. Evaporative cooling means that the last part of the moisture is evaporated in the cooler, instead of in the dryer. The product is not completely dried to < 0.5 % moisture. Instead of this, it is dried to ± 1 %. The rest of the moisture is dried off in the cooler.

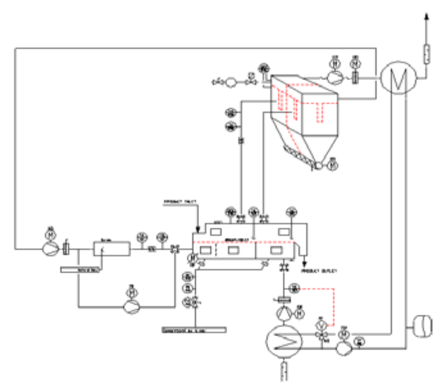
Tests have shown that evaporative cooling works well with temperatures of ± 45 °C [113 °F]. When the cooling air temperatures are too low, the air is not able to evaporate the moisture.

To have efficient evaporative cooling, we can include two heat exchangers in the supply of the installation. The 1st heat exchanger is placed in the exhaust air duct. With this heat exchanger, the latent heat from the exhaust air is used to warm up water to a certain temperature. With a second heat exchanger, the warm water is used for heating the cooling air. The cooling air temperature is controlled at ± 45 °C [113 °F]

The residual moisture in the product is evaporated with the heat in the product. Evaporating the residual moisture in the cooler, with ± 45 °C [113 °F] air temperature means that the product temperature fast drops to the wet bulb temperature. This means that the sand is cooled quicker then normal.



Evaporative Cooling Saves Energy

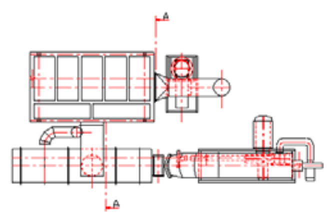


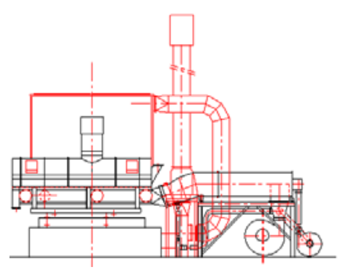
"To have efficient evaporative cooling, we include two heat exchangers in the supply of the drying installation."

Reducing Wear on Ductwork

The lay-out of the drying installations is kept as simple as possible in order to reduce the amount of space required.

Normally the filter installation is placed next to the dryer. This combined with large ducts keeps wear to a minimum. It is also possible to put the filter on a higher level or in the next room, then extra air ducting will be necessary. Special care in design must be taken to reduce wear.





Control System Advancements

Fluid bed drying/cooling system are normally supplied with a PLC based control system. In the VENTILEX control system the following controllers are integrated:

- Sub-pressure controller (pressure in the suction hood, controlled by valve on exhaust fan)
- Product temperature
- Exhaust air temperature
- Supply air temperature
- Product supply control

<u>Sub-pressure control</u>

The amount of exhaust air must be the same amount as the fresh air that is supplied plus the evaporation. A little extra bleed air is exhausted to main-





The sub-pressure in the hood is measured with a Δp- measurement. The set-point of the pressure in the suction hood will be set just below the ambient pressure (± - 0.5 mbar) [0.2 inches H_2O]. When the exhaust air temperature changes or the amount of cooling air is changed, the electric actuated throttle valve behind the exhaust fan will be opened or closed to maintain the proper sub-pressure.

<u>Temperature controllers</u>

For the temperature controllers we have integrated 5 PID controllers in the control system, complete with some extra functions. The control of the VENTILEX dryer/ cooler is based on a 'standard' control system in which the supply air temperature and the exhaust air temperature are controlled (Cascade control). For sand dryers, we have extended the control system with a controller for the product temperature. This is very important for minimizing energy use and not over or under drying the sand or aggregate.

<u>Extension product temperature control system (For sand dryers)</u>

By controlling energy input to the dryer by controlling the product temperature, the energy usage will be kept at a minimum at all conditions, in contrast with the standard control system where only the exhaust air temperature is controlled as described above.

The product temperature control system makes use of the point where product temperature rises quickly when the sand is almost dry. The set-point of the controller is just above this temperature. This maximizes the throughput and always delivers the correct discharged moisture of the sand or aggregate.

The product temperature controller is made in such a way that when the actual product temperature has a certain deviation of the set-point, the set-point of the exhaust air temperature is increased or decreased and in this way the product temperature is controlled back to the set-point. This is all controlled automatically. The actual value of the product temperature will always be at or just above the set-point. This is a very important part of controlling the system and minimizing energy use, while maximizing the product throughput.

The PID controller of the product temperature has three set-points:

- Set-point product temperature for the PID controller.
- Low temperature. This is a set-point with a signal for possible actions by the operator.
- Low/low temperature (this is the temperature when the product is just dry). When the product temperature gets lower then the low/low set-point, the dryer will be shut-off to avoid wet sand going to the screen or to the silo's.

Set-points that can be adjusted by the client are:

- Maximum operation capacity of the product supply system
- Maximum supply air temperature
- Product temperature (this corresponds to % moisture of discharged product)

The set-point of the exhaust air temperature is automatically controlled by the PLC.

To keep all process parameters under control, we have added some extra functions to the PLC-control system. Your VENTILEX engineer will be happy to explain in detail the aspects of advanced control and energy saving possibilities.