Concepts for drying and cooling white sugar

In some sugar factories, a whole variety of problems with drying and cooling white sugar are arising. You would think that these problems would be similar all over the world and that it would be possible to solve them with standard solutions. However, experience shows that the tasks are very complex and that each factory has its own and unique situation.

As a supplier of drying and cooling equipment, it is therefore very important for BMA to be able to offer the best possible solutions for such a variety of requirements.

The simplest, most reliable and most frequently used solution is mostly applied in sugar factories in which campaign operation only takes place during the cold period of the year. In this case, a drying drum is used that is operated with filtered ambient air for drying and cooling. It is, of course, necessary to heat the drying air using steam and/or condensate. Heating is also recommended for the cooling air in order to protect the plant against freezing. If necessary, this heating can also be used to reduce the relative humidity of the cooling air.

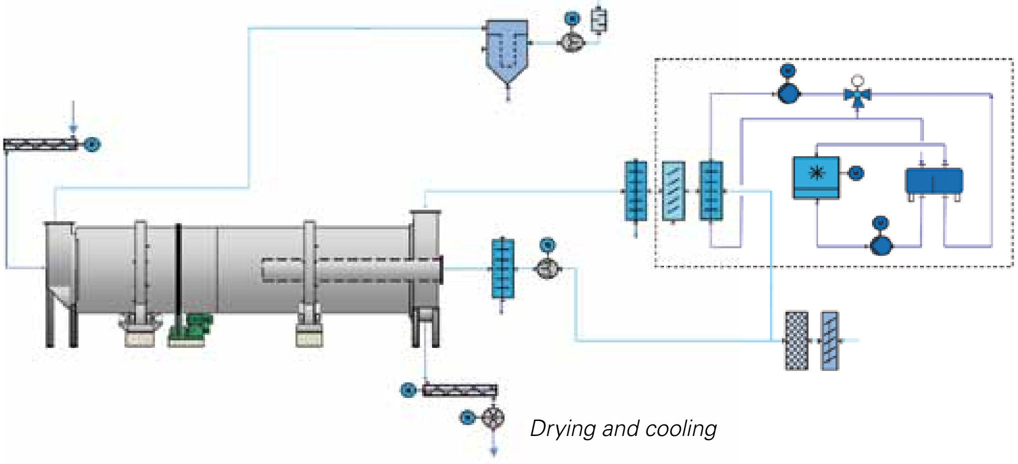
With cooling air temperatures of 15 -20°C it is possible to achieve sugar outlet temperatures ranging between approximately 25 and 35°C – which is dependent on the overall plant design (throughput, drum size, etc.) in any case.

The limits of this drying and cooling concept are reached when the temperatures of the intake air are high, such as when operating a refinery during the summer, or if particularly low sugar outlet temperatures are required. This concept can be applied with throughputs of up to 80t/h, i.e. without the need for additional coolers, while still achieving sufficient cooling results. The drum dryers are, of course, able to process considerably higher throughput quantities – it is only the achievable technological cooling results that are limited.

Usually, desired sugar temperatures range from 30 to 35°C at the outlet of the sugar cooler. It is easy to understand why a sugar temperature of 30°C cannot be obtained using cooling air at 35°C. However, these temperatures may occur during summer; in tropical regions, 35°C is the standard temperature. In such cases, it is necessary to substantially reduce the cooling air temperature using cold water.

Unfortunately, when air is cooled, the relative air humidity increases as a side effect, which may lead to an undesired remoistening of the dried sugar. Therefore, air cooling should be carried out in 3 process steps:

1. Cooling and dehumidifying
2. Separation of the mist produced
3. Relative drying by reheating

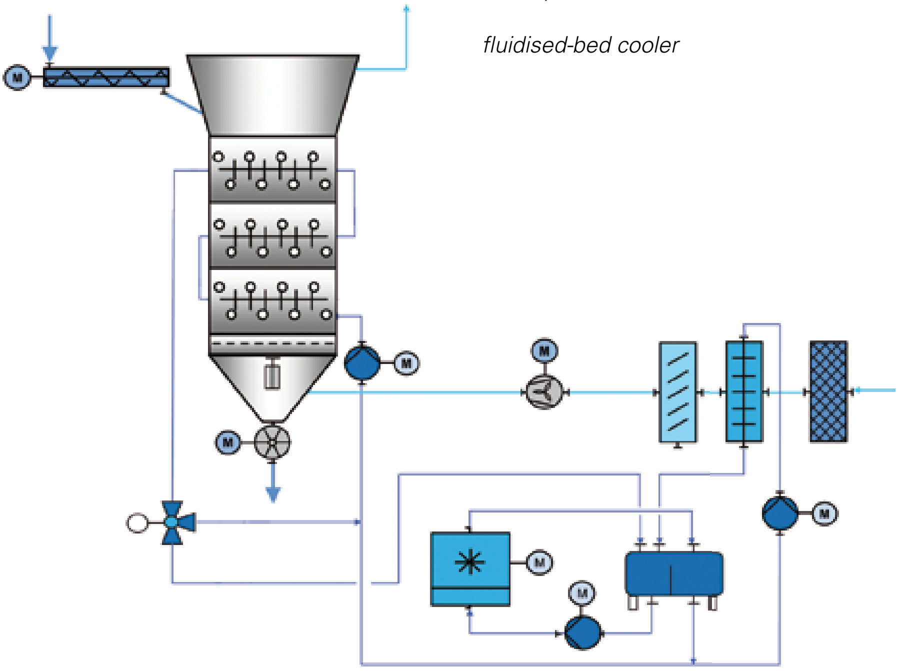


Drying and cooling sugar in the drum dryer

Sugar cooling

in the patented vertical

fluidised-bed cooler



In this way, reliable plant operation can be achieved even with high outside air temperatures.

An important aspect of this method of air conditioning is that it is possible to create constant conditions for the sugar silo that is usually downstream by maintaining the cooling air state independent of weather and time of day. Some plants have been able to minimise their problems with silo operation considerably by slightly reducing the sugar temperature and keeping it constant with no fluctuations.

The unavoidable disadvantage of air conditioning is the energy required for cooling. All-year operating plants that are located in tropical regions and have to cool air of, for example, 35°C with a relative air humidity of 85%, easily require a cooling capacity of about 1 MW to process 50t/h of white sugar. This cooling capacity is used to dehumidify the cooling air by approximately 900kg/h. With a cooling capacity of 1 MW, about 1/3, i.e. about 330 kW of electric energy, is required to generate it.

Such high energy consumption values for air dehumidifying result in minimisation of the air volumes required and the possible multiple use of air. These are the reasons why plants with high sugar throughputs and/or high air intake temperatures are equipped with separated systems for drying and cooling.

For this concept, a drum dryer/cooler is used in the first plant stage. The exhaust air of the downstream fluidised-bed cooler replaces the ambient air usually used for cooling inside the drum. This air already has a typical temperature of 35-45°C when leaving the fluidised-bed cooler, which reduces the cooling effect inside the drum but considerably increases the efficiency of drying without additional energy input.

The sugar is actually cooled in the fluidised-bed cooler. However, here the heat of the sugar is not totally transferred to the cooling air, but the greater part of the heat is removed via water-conveying cooling tubes installed in the fluidised bed. This allows the air volume required for cooling to be reduced considerably. The required air conditioning systems are clearly smaller and better priced in terms of purchase and operation.

For energy removal via the cooling tubes, a chiller can be used for water recooling in a closed loop, as for air conditioning. Alternatively, lower priced cooling waters from rivers or wells are used. However, their temperature should always be below about 18°C.

For cooling-air conditioning, even lower water temperatures are required that cannot normally be provided by well or river water. In this case, the use of a water chiller is unavoidable for air conditioning. Naturally, it is possible to combine both water-cooling variants.

When the separated systems of drum dryer and fluidised-bed cooler are used, the process is almost independent of weather-related external influences and is therefore able to provide a dry sugar temperature that is constant throughout the year.

Many projects aiming for capacity increases normally provide little space for sugar cooling. For this reason and in order to take account of the continuously increasing energy costs, BMA has developed a vertical variant of the fluidised-bed cooler. This vertical cooler elaborates the basic ideas of air volume minimisation and space reduction, while avoiding the considerable technological disadvantages of vertical fixed-bed coolers.

The air volume of the fluidised-bed apparatus can be minimised by reducing the ground area and enlarging the cooling surface installed at the same time. Therefore, the newly developed apparatus is equipped with several heat exchangers arranged one above the other in one fluidised-bed. This results in a reduction of the air volume to approximately 25% of the volume previously required for cooling, which is the technological and economic optimum.

The air volume is reduced so much that a small pipe for feeding and discharge is sufficient, while the apparatus is still able to evaporate the residual moisture from the sugar and discharge it via the air. Since only a small amount of energy is required to dehumidify the cooling air due to the small air volume, the standard version of the vertical fluidised-bed cooler is designed according to this concept. This makes the vertical cooler ideally suitable for use in factories located in tropical and subtropical regions.

As with the horizontal cooler, the exhaust air is supplied to the drying drum as cooling air. If this is not reasonable for reasons of arrangement, the exhaust air can also be discharged via an aspiration system.

The first apparatus applying this new principle will be supplied this summer to Imperial Sugar, USA. It is scheduled to be commissioned with a throughput of about 135 t/h and will be installed downstream of a BMA-supplied drum dryer with Ø 4.0 m x 13.0 m.

In addition to its low energy consumption, the vertical fluidised-bed cooler offers further advantages compared to other concepts:

- Cooling with simultaneous removal of the residual moisture, which ensures there are no sugar agglomerations.
- Reduced storage time of the sugar in curing silos.
- The air is fed through the apparatus exactly against the flow direction of the sugar. This means that the air is utilised to the maximum by applying the countercurrent principle.
- Perpendicular product flow from top to bottom, while utilising gravitation for product conveyance. In an emergency, the apparatus could also be emptied without air supply.

Hartmut Hafemann