VAISALA / APPLICATION NOTE

Continuous Dewpoint Measurement Ensures Product Quality and Enables Optimized Energy Consumption in Plastics Drying

Excess moisture in plastics decreases product strength and causes a poor surface finish. On the other hand, excessive polymer drying wastes energy and lowers productivity as material delay in the dryer is needlessly prolonged. Dryer dewpoint controls help to achieve good product quality with minimal production costs.

Hygroscopic Polymer Materials Require Thorough Drying

Hygroscopic polymers commonly used as engineering plastics, such as polyethylene terephthalate (PET) and polyamides, absorb moisture from the surrounding environment. This absorbed water reacts with the molten polymer at elevated process temperatures of injection and blow molding and extrusion. The reaction is called hydrolysis. It lowers plastic's strength and can also affect its visual appearance. To avoid hydrolysis, hygroscopic polymers require thorough drying prior to processing.

Drying of hygroscopic materials is challenging because moisture is absorbed into pellets' internal structure. Moist PET pellets can contain as much as 0.6 % water by weight. Depending on the applied process, PET must be dried down to as low as 0.003 % (30 ppm) residual moisture level prior to processing. The internal moisture can be removed by heating the raw material and simultaneously exposing it to dry air supplied from desiccant dryers.

Practical Tips for Selecting a Dewpoint Transmitter for Plastics Drying

- Select a transmitter that tolerates the residual chemicals that may evaporate from the plastic materials.
- Select a transmitter with minimal maintenance needs to ensure reliable system optimization.
- Compare transmitters' long-term measurement stability and select one with premium performance to minimize lifetime costs.
- The transmitter should be easily removable for multipoint calibration when needed.
- Select a transmitter with adequate measurement range to meet the dryer specification.
- Check that the permanently installed transmitters can be checked on-site using a reference hand held.

Vaisala's Dewpoint Instruments Suitable for Plastics Drying

- DMT242, a dewpoint transmitter with wide measurement range
- DMT340, a dewpoint transmitter with several options
- DMT143, a compact dewpoint transmitter
- DM70, a hand-held meter for spot-checking

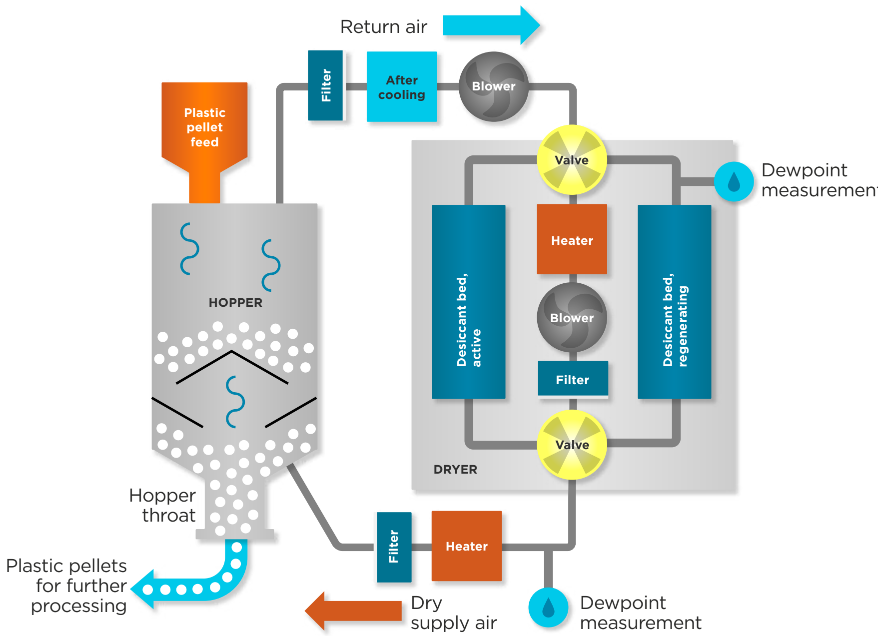

Figure 1: Plastics drying using desiccant dryers.

Optimization of Desiccant Dryer Operation

Desiccant dryers are commonly used for drying hygroscopic materials, as they are capable of producing dry enough air even for the most difficult-to-dry materials. In a desiccant dryer's closed air circulation system air can be dried down to a dewpoint range of -10 to -40 °C T_d, and even down to -60 °C T_d.

Desiccant dryers produce hot dry air, which is blown through a duct to the hopper that contains the plastic pellets. This air removes moisture from the plastic material and the moist air is then circulated back to the dryer, where it is cooled. The desiccant absorbs the removed moisture and the air is reheated and directed back to the hopper.

Dryers typically have two desiccant-filled towers with switching valves that direct the airflow to one tower at a time. One tower dries the air while the other is being regenerated by flushing the collected moisture to the ambient.

A desiccant dryer's regeneration interval can be optimized using continuous dewpoint measurement. Dewpoint measurement also helps detect possible failures in dryer operation. Dewpoint is typically measured at the outlet air duct of the desiccant dryer.

The desiccant-filled towers are set to switch at a set dewpoint value. Dewpoint controlled switching ensures constant drying efficiency and thus consistent product quality. In addition, energy consumption is minimized by the optimal regeneration intervals.

By confirming the required operating performance of the dryer, users can also optimize the drying time and save energy costs without compromising material quality. A much longer drying period under high temperature can also cause a degradation of the material.

Installing a Dewpoint Transmitter to a Desiccant Dryer

Ideally, the dewpoint sensor should be installed before the heater and the hopper to measure and control the dewpoint of the air that is passed over the plastic material. If the transmitter is installed after the heater, a direct process installation is not always possible due to high air temperature, and a sampling system is needed. The sampling system cools and, if needed, filters the air sample before it flows to the sensor. If the process is operating in low or ambient pressure, a pump is required in the sampling system to draw the air sample from the process.

Installing a Dewpoint Transmitter After the Hopper

The temperature inside the hopper may exceed 300 °C for several hours. For this reason, if dewpoint measurement from the hopper is needed, a sample air flow should be extracted and cooled prior to bringing it into contact with the dewpoint sensor. The air in the hopper may contain volatile compounds evaporating from the plastic granules. Typically their molecular size is relatively high so they do not affect the measurement.

Monitoring dewpoint at the hopper outlet in addition to measurement at the dryer allows the operator to optimize the drying time. Once the measured dewpoint has stabilized to a pre-defined low enough level, the cycle is considered complete. Prolonging material delay in the hopper does not improve drying. Monitoring the dewpoint of incoming and outgoing air at the hopper ensures that conditions for the drying process remain optimal for the whole duration of the drying cycle.