Plastics Handling in Extrusion

Product Quality also Depends on Conveying, Metering and Drying Systems

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The handling of plastics pellet stock is extremely important, particularly in the extrusion business. Firstly the material must be fed with the correct composition (following the formulation). Secondly material tearing, for example in film extrusion, can involve a very long and expensive restarting process.

Material supply systems for plastics processing should ensure high availability of all materials and provide prompt warning in the event of material defects. To prevent quality fluctuations, they should allow feeding of materials to an accurate formulation with extreme precision and reproducibility. Furthermore, for some materials, uniform drying is also important.

Taking into account individual requirements, the following solutions are available.

Material Supply

The material can be either fed from a supply point directly next to the extruder or conveyed from a more remote location. Either individual conveyors or centralised conveyors can be used. Werner Koch Maschinentechnik GmbH offers a wide range of vacuum generators from 0.8 to 11 kW. Smaller amounts up to about 50 kg/h are conveyed by means of individual conveyors with 230 volt blowers. For greater distances or higher throughputs, a wide range of three-phase blowers is available. Amounts up to 1500 kg/h and distances up to 200 m are covered by vacuum pumps with line cross-sections and elbows appropriate for stress-free conveying of the material. Eliminating material stress during conveying prevents the formation of "angel hair". Angel hair is the term used in plastics technology for thin filmy strips resulting from deposits in the elbows. These deposits become entrained by the flowing pellet material and may cause downstream blockages, which disrupt the process. However, the main risk is in contamination on material exchange, since these deposits are very difficult to remove Angel hair is produced when the pellets flows at too high a rate through elbows. The problem can be solved by choosing a more suitable vacuum generator or changing the elbow geometry or elbow material.

At a very early stage, Koch-Technik developed conveyors that could convey both virgin material and regrind. Regrind materials can thus be used right from the start.

For multiple delivery points, it is advisable to use the centralised conveyor system (Fig. 1). The necessary conveyors are combined, and a centralised vacuum generator is used instead of multiple individual fans, individual controls and individual filters. A centralised safety filter is installed upstream of this centralised vacuum generator to remove particles bigger than 3 µm from the conveying air before they are discharged to the atmosphere.

All these lines are based on a modular system so that they can be tailored to meet any needs. With this filter system, any conveyor system can meet clean room specifications. The centralised conveyor saves costs, but also has the big advantage that material storage, and if necessary drying and distribution, take place at a centralised location. A clean production hall with no material containers next to the machine and better utilisation of the floor space results in high availability of the individual processing machines (Fig. 2).

Two line layout systems are available:

Material-dedicated conveyors: here, each material has its own line in the form of a closed circular pipeline leading past each extruder. If a different material is required at a delivery point, exchange can be carried out simply by changing the line connection.

Machine-dedicated conveyors: In this system, there is an individual line for each delivery point. This system is ideal

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for cases where a large number of different materials are to be used. Material exchange is carried out by manually reconnecting at a changeover station (Fig. 3), or by means of an automated material system, such as the patented "Navigator" (Fig. 4).

Both systems suck material into a conveyor and empty this into a hopper, which serves as a buffer store. When material is required at the delivery point, this buffer store must be large enough to give the operating personnel enough time to fill the container, and thus ensure continuous material flow.

Glass conveyors and glass elbows are available for dealing with special materials or special requirements. The Koch visualisation system is available for monitoring the control and surveillance of the entire conveyor system.

Metering and Mixing Systems

The pellets conveyed to the processing machines are often mixed with additives such as masterbatches, UV stabilisers and flame retardants, but also regrind. To ensure a high, uniform product quality, they must be precisely metered according to needs. There are two different systems for this: volumetric and gravimetric batch feeders.

For volumetric metering, various metering and mixing hoppers are available for different material throughput rates. A metering roller with a precisely defined chamber volume allows precise volumetric feeding of powders, pellet or regrind to the mixing hopper. Metering accuracies may be as high as ±0.1 % for some material grades.

The feed rate is determined by the variable rotation speed of the metering roll. If more material is required than the roll supplies in the given time, a metering roll with larger chambers can be used. For feeding in the 0.001 % range, special exchangeable metering rolls with extremely small chambers can be used.

The precisely formulated materials are metered into a premixer fitted with a stirrer for the material charged A sensor monitors the level in the mixer. When the level drops, metering is started and a set amount is charged. All hoppers are continually monitored by level sensors. If an incorrect amount is registered, the system must be able to continue running faultlessly. An important aspect is that the throughput of the individual metering line is greater than the consumption of the machines.

The mixing hopper always contains the same amount of material (number of batches). As regards the batch feeders, it is immaterial whether the extruder output is increased or reduced. The composition of the individual batch is not changed.

Since it is increasingly important to provide documentation of adherence to the formulation, and extrusion is no exception, Koch-Technik has developed a new-patented gravimetric metering system (type: Graviko GK, Fig. 5). The new system is characterised by rapid, high precision metering and may be used instead of extremely fine metering with, e.g., cellular wheel feeders.

All the individual components are weighed on a balance with an accuracy of between 0.05 and 0.1 g. A stirrer mixes the components. Depending on the throughput of the processing machinery, four to six different materials can be processed. Four standard models cover the range from 5 to 1500 kg/h. Thanks to quick-release closures, sliding and pivoting devices, the machines can be rapidly modified and assembled without the use of tools.

The balance of the metering system records the actual weight of the individual components and transmits the result to the MCGK control unit. Here, the values are compared with the computed setpoint values. Each filling is weighed several times in succession, with fluctuations compensated out by determining a mean value. If the setpoint and actual weight agree, the bulk material is discharged into the mixer. The optional, extremely accurate chamber-volume metering combined with monitoring and correcting gravimetric metering together form a control loop which ensures absolutely correct metering to an accuracy of 0.1 g, irrespective of the component.

The V2A stainless steel balance pan is particularly lightweight, so that not its weight but that of the substance to be weighed predominates. Therefore, for each component, extremely small amounts of up to 0.3 g, including the balance pan, are registered by the balance, evaluated and documented.

All the basic settings, such as metering values and batch sizes can be entered via the microprocessor control. The management system comprises up to 124 formulations. As standard, the system is equipped with an RS 422 interface and automatic calibration with digital weighing cells and interface. The MCGK control is used in gravimetric metering systems for measuring, controlling, communications, operation, reporting and logging. It is characterised by innovative technology and ease of use. The following data, for example, may be entered in the MCGK control system: the precise formulation, formulation management, batch size and the mixer cut-out delay. The data output provides documentation about the material composition required to comply with ISO 9000. The integrated serial interface allows a log to be printed out or transmitted to a master computer.

Drying

If the plastics to be process must meet a specific residual moisture content, it is possible to dry these materials in advance. This is most suitably performed by means of dry-air dryers, since hot-air dryers do not ensure continuity and may even moisten the pellets, at least in hot and humid summer weather.

The dryers of the EKO series (Fig. 6) generate dry air with a residual moisture content of 0.011 g water/m^3. This corresponds to a dew point of –60 °C. The dew point is the temperature at which the air is saturated with water to 100 %.

The dried air is heated to the temperature required for the material at the drying vessels, flows through the moist material, removing its moisture. At the same time it emits its heat to the pellet stock. This is to the benefit of the subsequent process, since the pellets do not need to be heated from external temperature or room temperature to their melting point, but are already uniformly preheated. The moist air is continually treated, i. e. dried, in dry-air dryers by means of molecular sieves.

For all metering, mixing, conveying and drying systems, Koch-Technik offers a modular system that allows a system to be perfectly tailored to any needs. This has been demonstrated by systems that have been in continuous use for more than 25 years.

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Fig. 1. Centralised vacuum generator with safety filter

Fig. 2. A centralised conveyor allows clean material storage

Fig. 3. Manual material changeover station

Fig. 4. "Navigator" fully automatic material distribution system

Fig. 5. Graviko GK 300 gravimetric metering unit in use on extruders

Fig. 6. EKO 200 dryer