Monitored Control

Pressure Measurement. Incompletely melted polymer or melt freezing is the most common cause of dangerous overpressure in extrusion lines. These problems can only be reliably recognized with sensor redundancy, since a single sensor with a coating of solid material will not measure the full pressure and is thus "blinded".

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The machinery directive 2006/42/EG that came into force on December 29, 2009 demands that a risk assessment for the entire lifetime of the machine should form part of the development process. In respect of extruders and extrusion lines this assessment has to include hazards that stem from excessive melt pressure. Cases are known where incidents caused by overpressure have resulted not only in damage to machinery and loss of production, but also serious injury to personnel.

The safety requirements for extruders are detailed in the current version of EN1114-1. According to this, excess pressure protection can be provided by mechanical devices such as predetermined break points, rupture discs, stretch bolts, etc. or by pressure sensors. EN1114-1 is currently under review with the objective amongst other things of improving the safety of excess pressure monitoring.

The mechanical solutions mentioned do provide a certain level of failure safety, but particularly in the case of plants with higher throughputs they have their limits. On the one hand material emerging from a predetermined break point can itself be a hazard to man and machine and on the other the melt released has to be captured if it is not to lead to long cleaning times and machine downtime. A further serious disadvantage of mechanical solutions is that it is difficult to adjust the maximum pressure for different machinery configurations such as different dies.

Sensors for Pressure Monitoring

Monitoring with pressure sensors offers the necessary flexibility and can, when suitably connected to the machine control system, limit the melt pressure without material discharge.

Melt pressure sensors like most electronic systems have a limited service life particularly in polymer processing equipment where they are subjected to high temperatures and harsh environmental conditions. The new revision of EN1114-1 is also intended to address this problem by placing higher requirements on the pressure measurement failure safety.

EN13849-1 rates safety relevant components in the control system in performance levels (PL) from "a" (low) to "e" (high). The performance level ensures that the likelihood of failure for safety relevant components can be compared, however, it should be noted that the performance level of the entire system should be considered. Thus in the pressure monitoring system all the control elements from the sensors, signal cables and pro-

Translated from Kunststoffe 4/2011, pp. 63–64
Article as PDF-File at www.kunststoffe-international.com; Document Number: PE110734

cessing unit to drive motor contactors have to be included.

The machinery supplier must ensure that all the dangers identified in their risk assessment are reduced to an acceptable level by appropriate measures. It follows therefore that the extruder's pressure monitoring system has to be able to reliably recognize and reduce a dangerous melt pressure.

At the beginning of this analysis there should be the question of how excessive pressure occurs in extrusion lines. Amongst the most common causes are certainly starting up with incompletely melted material as well as freezing of parts of the machine. These faults are particularly dangerous because cold slugs of material can get lodged in front of rupture discs or pressure sensors disrupting their function: Rupture discs do not then experience the necessary force and pressure sensors are "blinded" since the effect of pressure on the membrane is greatly reduced.

For excess pressure protection with pressure sensors this means that a single sensor, even if it has a very high performance level, is not able to react to these dangerous situations.

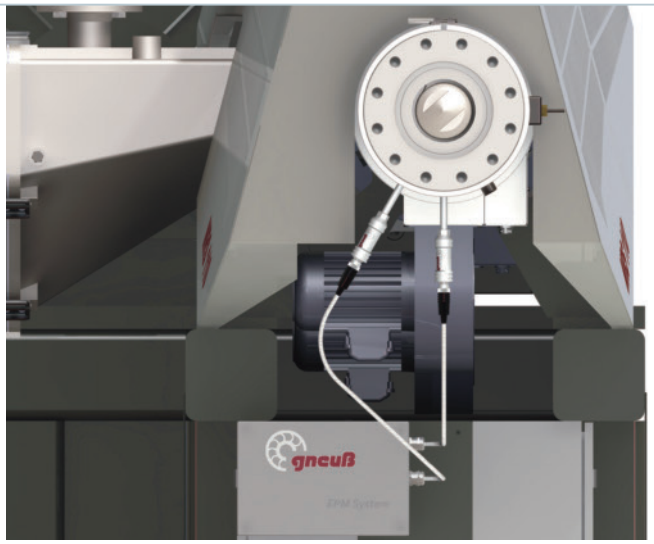

Fig. 1. The Extruder Pressure Monitoring (EPM) system uses two redundant sensors

Reliable Pressure Monitoring

The EPM (Extruder Pressure Monitoring) system from Gneuss Kunststofftechnik GmbH, Bad Oeynhausen, Germany, uses two redundant sensors that are connected to a fail-safe monitoring unit, which checks not only for the maximum pressure but also for discrepancies in the readings between the sensors. Since slugs of cold material will not attenuate the readings at the different measurement points by precisely the same amount, EPM is able to react to this classic error condition **(Fig. 1)**.

The EPM system comprises two pressure sensors and a monitoring unit. The pressure sensors are mounted as close as possible to the pressure generating feature, for example in the connecting flange of the extruder or melt pump. The monitoring unit has fail safe analog inputs for the measurement signals from the sensors. Both measurement signals are monitored against a maximum differential value and a common absolute maximum value. Fail safe relays which can shut down the pressure generating device are provided on the output side.

The pressure measurements are taken with sensors that use tried and trusted DMS technology and the integrated amplifier converts the measurement signal to a 4 to 20 mA output. Isolation amplifiers process the measurement signals so that they can be used by analog inputs to the monitoring unit and at the same time provide galvanic isolation so that they can be used by the process control system.

The EPM monitoring unit is, however, capable of much more: It can serve as a two channel emergency stop relay and can be expanded, for example to provide safety monitoring. This makes the EPM a central safety component in machinery control concepts and means that additional fail safe relays are not required. The system can be optionally equipped with various fieldbus interfaces **(Fig. 2)**.

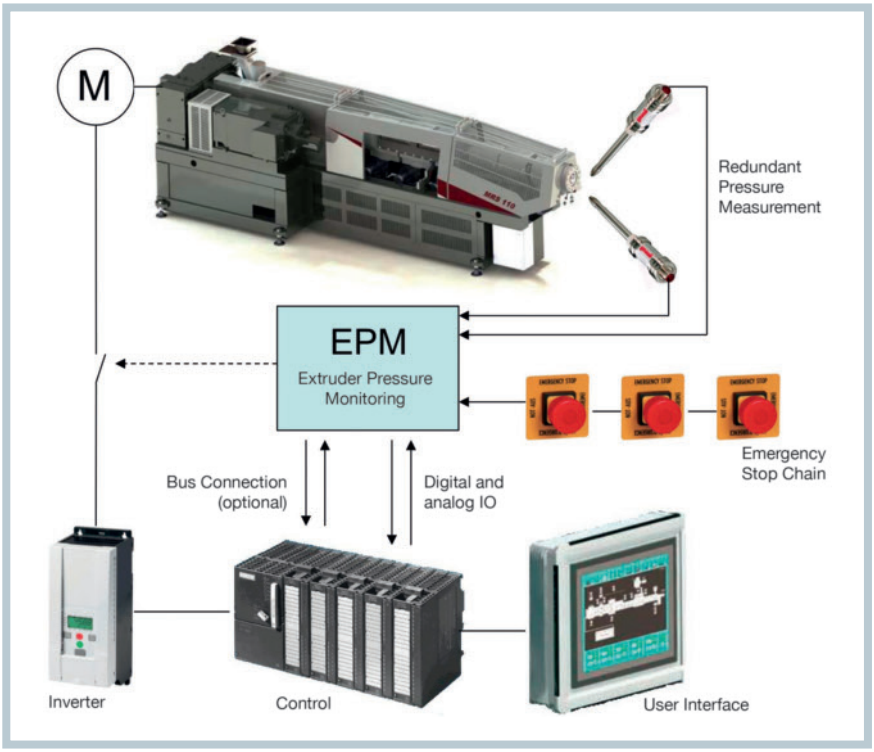

Fig. 2. Integration of the EPM within the machine control system

Conclusion

The EPM from Gneuss offers the highest possible levels of safety in pressure monitoring and due to its flexible configuration options can be a central pillar of machine control systems. It provides support for developers in realizing the risk assessment demanded by the machinery directive. The redundant measurements can react to excess pressure events that cannot be recognized by individual measurement points despite high performance levels. ■

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