

## Introduction

The production of plastic consists of many important process steps, which are needed to generate a homogeneous application specific plastic compound from a number of different raw materials.

## Process

The compounding process is a continuous process. The main steps in the compounding process are:

- > conveying
- > plasticizing/melting
- > mixing
- > homogenizing
- > blending
- > dispersing
- > devolatilizing
- > reacting
- > heating/cooling
- > visc-breaking
- > cooking
- > pressurizing

## Main Ingredients

The main ingredients which must be continuously and very accurately fed are base polymers such as PP and PE.

## Typical Additives

- > Stabilizers, lubricants, plasticizers, colour pigments, fillers, flame retardant, cross linking agents, foam agents, etc.
- > Glass or carbon fibers for reinforcement, base polymer pellets for alloying to new compounds
- > Recycled material

The additives can be in the form of powders or masterbatch pellets

## Key Requirements

One of the key requirements in high speed compounding is to ensure a continuous, uniform infeed with very tight short-term accuracy and repeatability.

## Typical Production Output

Twin screw compounders are equipped with different screw diameters from 25 up to 150 mm in various steps depending on the manufacturer of the compounder. The typical line rates range from 50kg/h up to 6'000 kg/h.

## End-Products

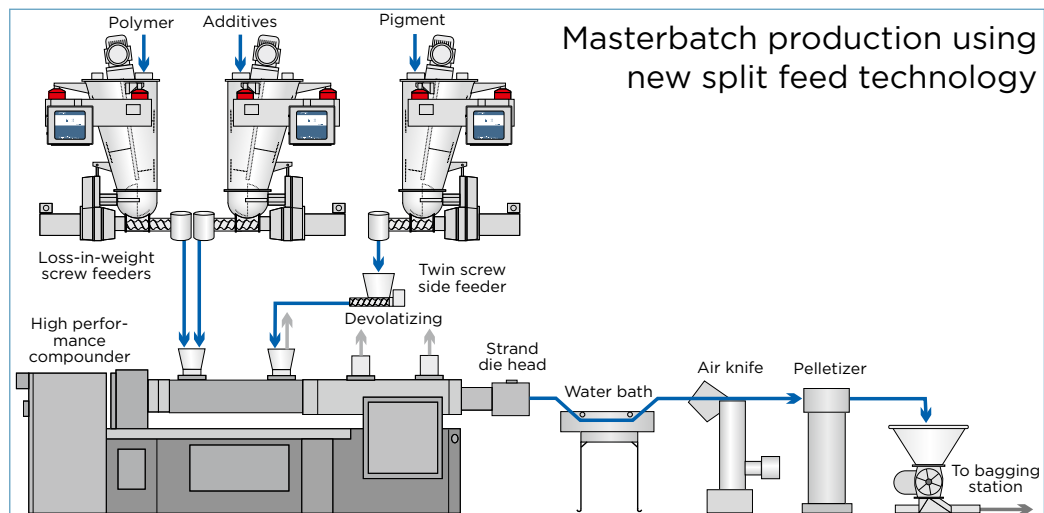
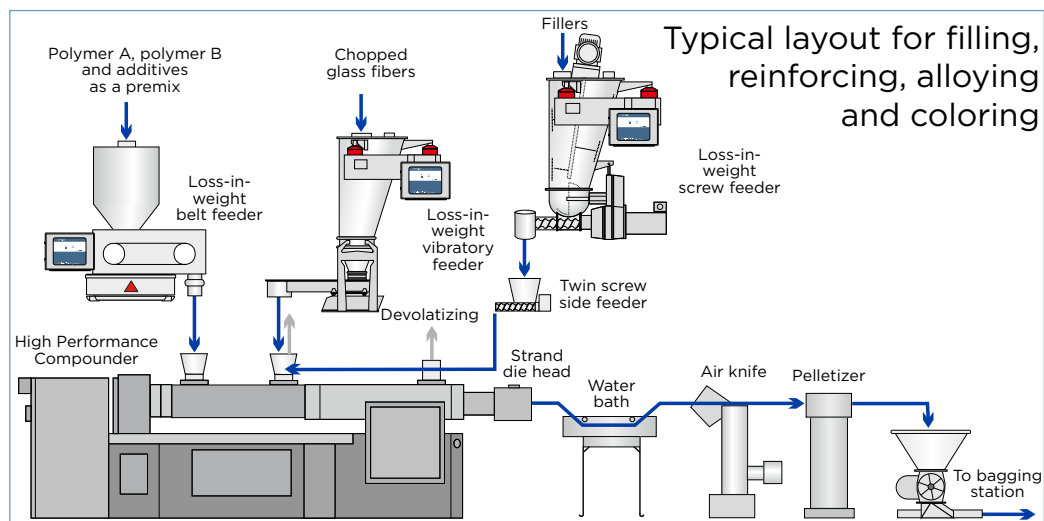
Automotive, building & construction, appliances & housewares, electronics, furniture, health & hygiene, leisure & sport, packaging, pipes, textiles, etc.

## Masterbatch

With high performance compounding technology, the time-consuming step of fine grinding of pellets and premixing in batch quantities can be eliminated. Pigments are fed directly into the melt by means of gravimetric feeders. Pigment concentrations up to 70 percent are possible. Compared with the old premix feeding method, the new process allows formulations with reduced wax content or no wax at all. This means that high performance compounding technology not only benefits productivity and quality but also contributes to reduced raw material costs.

## Engineering Plastics

Compounding and pelletizing of engineering plastics (i.e. filling, reinforcing, alloying, colouring and degassing of PA, PP, PET, ABS, PUR, PC or POM) are the specialty of high performance compounders.



# High Performance Compounding

## Feeding Process

The main polymer and additive masterbatch are fed very accurately with a single screw feeder, e.g. K4G, into the main inlet of the compounder.

Refill is conducted via a Coperion K-Tron vacuum loader system from an octabin station and large storage silos.

A K2-ML-T35 feeds the stabilizer in the form of powder into the main extruder inlet.

The chopped fiberglass is fed via K3-ML-V200 into the side feeder of the second inlet of the extruder. The ratio control is handled via the K-Vision operator interface which in turn controls the feeders via KCM (Coperion K-Tron Control Module), mounted locally at each feeder.

All the recipe handling and line monitoring is done via the factory DCS-System.

## Typical Scope of Supply

The main polymers are normally pellets or powders fed with a single screw feeder type K4G or K2-ML-S60/S100. Alternatively a vibratory feeder can be used.

- The typical feed range for screw feeders is 0.2 - 15'000 dm<sup>3</sup>/h
- The typical feed range for vibratory feeders is 1 - 8'500 dm<sup>3</sup>/h
- The additives are fed by loss-in-weight screw feeders such as K2-ML-T20/T35 at rates of 0.2 - 200 kg/h, depending on the recipe

## Refill

For free flowing products Coperion K-Tron vacuum loaders or receivers can be used to keep the feeders well supplied. Thanks to the dual cyclone technology, most materials can be fed without needing a filter. For sticky additives, such as

Irganox, Tinuvin, or CaCO<sub>3</sub>, etc. Coperion K-Tron P-Series receivers are the ideal solution.

## Control System

The loss-in-weight feeders dose the ingredients in a preset ratio, set in the operator interface or downloaded from the host computer via K-Vision Line controller to the locally mounted KCM.

All the process relevant parameters for each feeder are stored in the appropriate recipe.

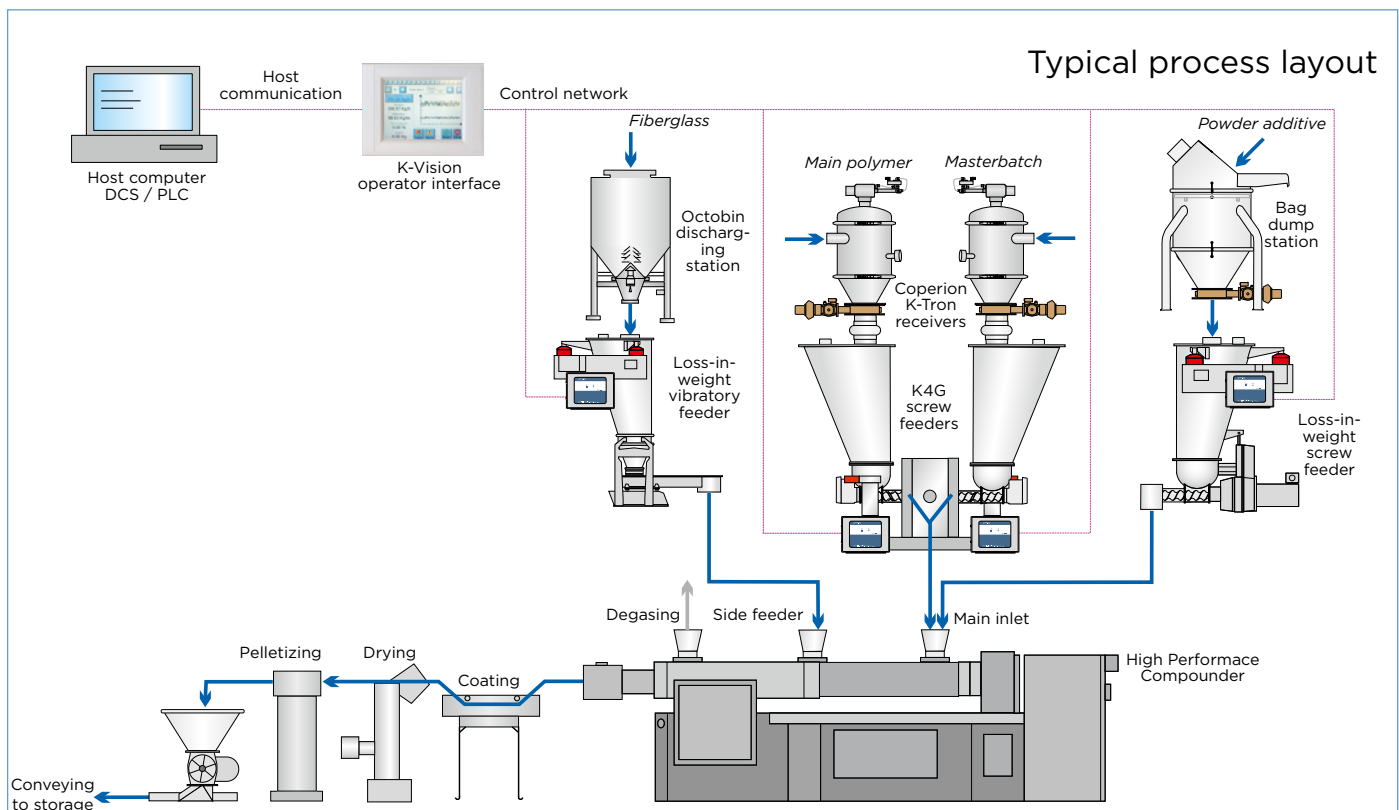
The on-machine KCM combines the function of motor drive and feeder control in a compact package.

In this example the K-Vision provides a single user interface for up to 16 feeders. The integrated K-Link feature allows for communication with the host DCS system via Modbus (Modicon) RTU, Allen Bradley DF1 or Siemens (3964R). Alternatively, a Coperion K-Tron Smart Commander could be used for up to 30 feeders and 8 lines.

## Environmental Conditions

Plastic compounding systems are typically classified as IP55/ NEMA 12. In some processes N<sub>2</sub> blanketing is required. This means that the LWF's are equipped with a well-proven pressure compensation system at the inlets and outlets.

Depending on the process, gas explosion protection may be required, i.e. Zone 1, Temperature class T3 for Europe and Zone 1, Division 2 for USA. In this case standards Coperion K-Tron XP executions must be applied.

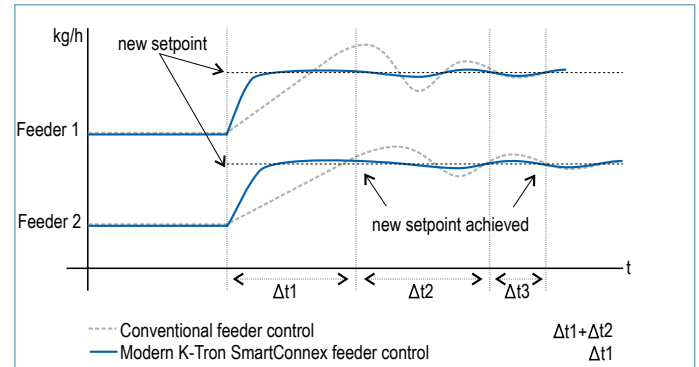


## Advantages of Smart Weighing Technology

The goal of a compounding plant is economical production! Among other things, this means as little waste as possible and minimum reconfiguration time. The Coperion K-Tron feeding system makes this possible. An important factor is the adherence to the recipe during ramping up of the extruder and naturally also during large setpoint changes. The short-term accuracy of a high performance extruder is a key factor for quality of the end product.

In order to even be able to speak of adhering to recipes with changing operating data, one condition must be fulfilled: the mass flow must adapt to the setpoint as quickly as possible. This is only possible with advanced gravimetric control and the high sampling rate and resolution offered by Coperion K-Tron's Smart Force Transducer weighing technology.

## Proven Performance with Coperion K-Tron Smart Technology



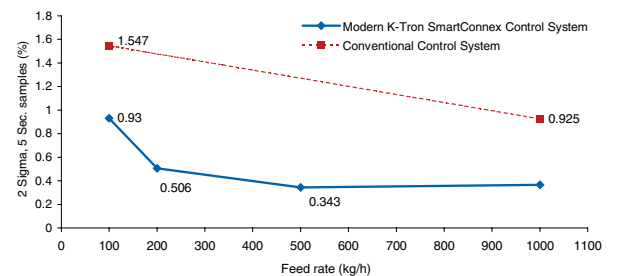
## Massflow during setpoint change

This image shows the requirements of an extruder manufacturer with regard to the desired behaviour during a setpoint change in the line. It is nice to show that this challenge could be met in the test lab well beyond any expectations. Instead of overriding the new values first and then working them in, the desired value could be obtained almost directly. This is extremely advantageous for high speed extruder feeding.

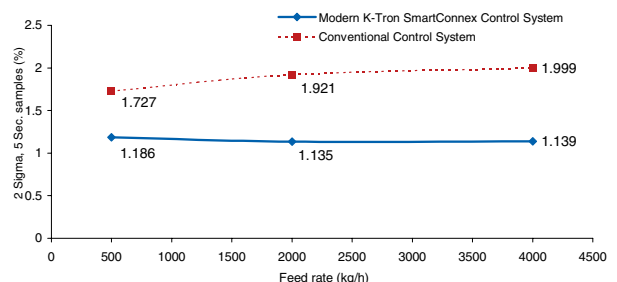


Coperion K-Tron feeding station with refill system

## Feeding test with free flowing material



## Feeding test with poor flowing material



The graphs above show a comparison of feeding accuracy, which was obtained with different gravimetric control systems. To obtain these results, the following conditions must be given: a high sampling rate (here 112/sec.), efficient digital filtering and a fast control algorithm. In other words: the sampling rate must be higher than the controlled elements can react.



# High Performance Compounding

## Advantages of Coperion K-Tron Modular Feeders

- Practically no wear parts
- Smooth surfaces avoid contamination
- Weighing technology with integrated digital filter for dynamic weighing even in difficult environments
- Feeder does not cause weight fluctuations

## References

Several thousand customers worldwide are successfully using Coperion K-Tron Modular Feeders in their compounding processes. Our Sales department will be glad to provide you with a reference list.

We will be glad to provide contact information or to help arrange visits to reference sites.

## Future Potential

The plastic compounding market is steady growing approximately 3% annually. The auto industry is replacing more and more steel parts with highly reliable plastic parts. New plastic composites will be developed which will lead to the building of new compounding lines.

Retrofitting and debottlenecking of existing compounding lines also offers the opportunity for process improvement.

## Typical Applications

There are a number of well known users of high performance compounding lines in the following industries/processes:

- Technopolymers compounding
- Engineering plastics
- Thermoplastic
- Masterbatch producers
- Special areas in BOPP-Film lines
- Adhesives and sealants

## Testing Facilities

Coperion K-Tron has well-equipped testing facilities to test high rates of PE powder and additives. We can handle up to 20 t/hr of PE powder for accuracy testing. Long term testing is also available since material can be recirculated.

## Services

Additional services are also available, such as:

- System engineering
- Installation start-up
- Operator and maintenance training



Coperion K-Tron feeders with refill system on a compounder



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