Different Viscosities Combined in a Material-Friendly Way

Higher Product Quality at Lower Costs in a Continuous Process

The challenge of compounding a rubber-bitumen mixture was to bring the raw materials together in a way that was gentle on the material despite their very different viscosities. The material is to be melted, mixed, dispersed, homogenized, degassed and discharged under controlled temperature conditions in a consistently high quality and viscosity. With the planetary roller extruder, Entex has transferred the manufacturing process from a batch process to a continuous process.

From its inception to the present day, the planetary roller extruder (**Fig. 1**) has been widely used as a processing unit in the PVC industry [1]. Thanks to extensive technological developments, a wide range of processes in compounding and reaction technology can be covered today. This is made possible in particular by the further development of the materials used and the greatly improved thermodynamic process control, which only the Entex planetary roller extruder has and thus offers the highest performance density of all extrusion systems.

Continuous Preparation instead of Batch Process

The modular system of the Entex planetary roller extruder makes continuous compounding technology possible where batch processes used to predominate. The rubber compound developed is an intermediate product for the production of multi-layer synthetic roofing membranes, which have been used in roof waterproofing since the early 1950s. Requirements include elasticity, high impermeability, resistance to weathering and UV radiation, high fire resistance and high resistance to aging. These properties must be guaranteed over a wide temperature spectrum [2].

The original compound [3] for the production of the plastic roofing membranes is a rubber-bitumen mixture, which is conventionally produced on the basis of rubber powder from ethylene-propylene-diene rubber (EPDM) as the main raw material in a discontinuous process with internal punch kneaders. However, this type of machine has some disadvantages. For the compounding process only powdery basic raw materials can be used due to the limited and uneven tempering possibilities, which are more cost-intensive compared to granulates. Due to the uneven tempering of the internal kneader, polymer stippling and color changes in the product occur due to temperature hotspots and dead spaces. In addition, the discontinuous process in the internal die kneader, for which some raw materials must first be premixed, leads to batch fluctuations and an inhomogeneous end product and is also associated with a very high energy input due to the necessity of repeated heating processes [4].

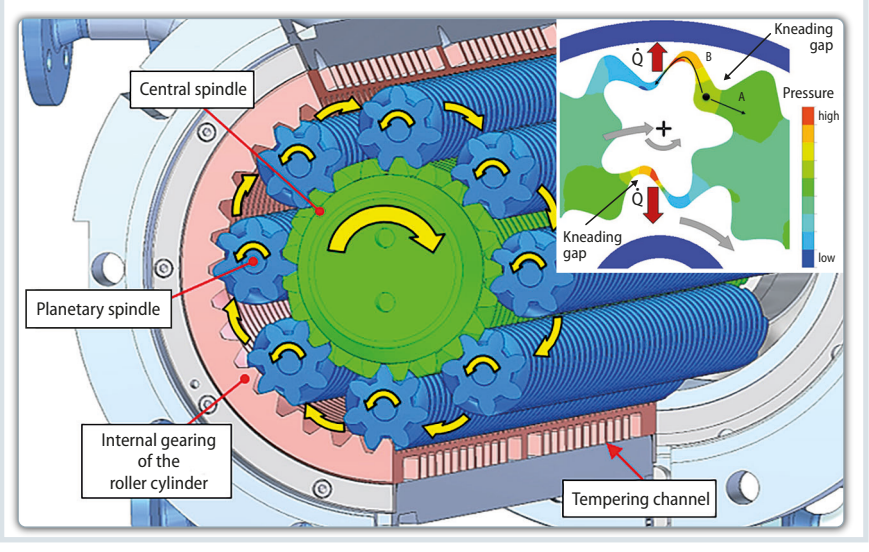

Fig. 1. Roller barrel module of the planetary roller extruder: whereas twin-screw extruders have only one kneading gap over the entire length of the processing section, planetary roller extruders have two kneading gaps per planetary spindle, in which the compound is mixed, frictionally mixed and rolled Source: Entex; graphic: © Hanser

Controlled Temperature Conditions for Consistent Quality

The challenge of an optimized and energy-efficient process is to combine raw materials with very different viscosities in a continuous process in a way that is gentle on the material. The material is to be melted, mixed, dispersed, homogenized, degassed and discharged in a uni-

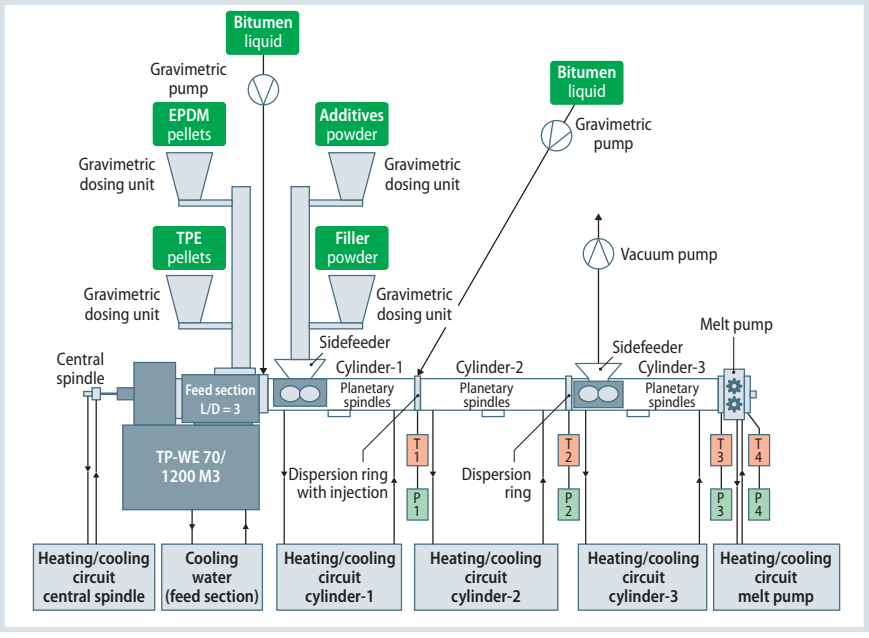

Fig. 2. Plant design for continuous preparation of the mixture. Bitumen is supplied at two points to achieve mastification (breaking up the molecular chains) Source: Entex; graphic: © Hanser

formly high quality and viscosity under very controlled temperature conditions.

For the rubber-bitumen mixture, all raw materials – granulates, powder and liquid components – are fed into the ongoing process according to the recipe at points that are technically useful for the process and are temperature-controlled over a large area in different zones (**Fig. 2**). The dwell time, mixing, friction and the degree of rolling can be configured by the mechanical components of the extruder process section according to the process requirements and thus controlled in a targeted manner. The process section is divided into individual, independent tempering zones, each of which is characterized by precise temperature control and can be monitored with temperature sensors. Gases, vapors and other volatile substances are effectively evacuated from the processing section by means of a vacuum pump via a side-mounted side-feeder with tightly intermeshing twin screws, so that the extrudate is discharged as a uniformly homogeneous mass without air inclusions via a melt pump.

In a comparison of the material samples, the differences in quality become visible under the microscope (**Fig. 3**). The compound prepared with the internal die kneader on the basis of rubber powder has non-homogenized polymer tips and, due to the higher temperature load, also shows distinct color differences. The compound based on rubber granules extruded with the Entex planetary roller extruder (**Fig. 4**) is more homogeneous and less thermally stressed and thus also exhibits higher tensile strength.

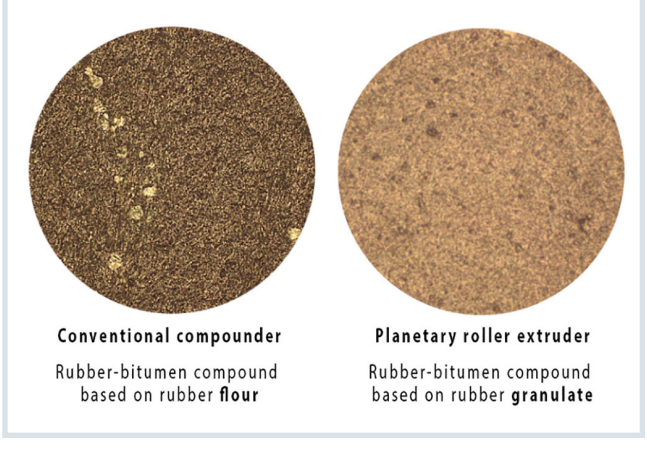

Fig. 3. Section through differently prepared rubber-bitumen products: on the left, the mixture produced on the basis of rubber powder from a conventional compounder, on the right the mixture produced on the basis of rubber granulate in the planetary roller extruder © Entex

Fig. 4. Rubber-bitumen compound prepared with the planetary roller extruder © Entex

Conclusion

Due to the continuous preparation process with the Entex planetary roller extruder, the compound quality in terms of tensile strength, homogeneity and color consistency has improved measurably and visibly. Furthermore, raw material costs can be saved by using inexpensive rubber granulates instead of expensive rubber powders. The elimination of intermediate work steps for premixing processes and continuous preparation prevent batch fluctuations and save labor and energy costs [5]. ■

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