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Energy Dissipation in Compounding, a Comparative Study on Discontinous vs Continous Mixers

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A new approach to the analysis of the energy dissipation in compounding high-viscosity polymer melts in the continuous and discontinuous way is presented.
The basic variable in the discontinuous (batchtype) mixing process is mixing time. Customarily, the performance of continuous compounders, e.g. extruders, is analysed in terms of the geometric dimensions of the mixer.
However, it should be kept in mind that the geometric axis of the extruder is the time axis of the mixing process as well.
Subdividing the time axis in a succession of small increments, the energy balance of each increment can be determined, provided, the basic torque equation in terms of rotor speed, melt temperature, filling of the increment, and, in the melting section, the content of unmolten particles is known.
As for the extruder, time increments form small extruder sections whose individuell length depends on the time scale selected. There exists an analogy between the discontinuous and the continuous mixing process in the way that the array of extruder increments can be regarded as a succession of small batch mixers each representing a fixed mixing time and a fixed set of process variables.
Based on this analogy, it can be concluded that the torque- and the melt-temperature curve of both systems must be similar in shape.
This is demonstrated by comparung the results from a mixing test on the Brabender Plasticorder equipped with twin helical rotors and a number of extrusion tests performed on a co-rotating twin-screw extruder.
The enrgy balance of an increment leads to the determination of the change in melt temperature which than serves as input data for the adjacent increment. The time-temperature curve and the time-torque curve is, thus, developed movimg along the time-(extruder) axis.
A melting model is provided to determine the performance of the mixer in the melting section.