Residence time distribution: a powerful concept for building up emulsification curves for polymer blends

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Most polymers are mutually immiscible. Therefore, emulsifiers such as block or graft copolymers are often used for improving the adhesion of the interfaces and control the morphology of the resulting blends. The efficiency of a copolymer as an emulsifier is often evaluated by a so-called emulsification curve. Studies reported in the literature concerning emulsification curves often use batch mixers and not screw extruders. The main reason is that batch mixers are often more accessible in a laboratory than twin-screw extruders and that they are easier to operate too. More importantly, the amount of the copolymer required for building up an emulsification curve in a batch mixer is often much smaller than in a twin-screw extruder. This is especially true for a pilot or industrial-scale screw extruder. This paper aims at extending the residence time distribution (RTD) to polymer blending in order that a very small amount of copolymer still allows building up an emulsification curve in a pilot or industrial-scale screw extruder. The idea is based on RTD transient experiments. The polymer components are first charged to the hopper of the extruder. When the process reaches its steady state, a given amount of the copolymer is then introduced to the hopper of the extruder as a pulse. Samples are taken at the die exit as a function of time. Both the evolution of the copolymer concentration and that of the morphology as a function of time can be obtained. The former provides the RTD and the latter the morphology distribution (MD) or the dispersed phase domain size distribution (DSD) for dispersed type polymer blends. From both distributions, the emulsification curve can be easily deduced. (Cai-Liang Zhang, Lian-Fang Feng, Sandrine Hoppe, Guo-Hua Hu, AIChE Journal 55, 279-283, 2009).