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Entropic Analysis of Laminar Mixing in Single Screw Extruders

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Rigorous measures of mixing are needed to optimize processes and equipment design. The Shannon entropy is the rigorous measure of mixing, universally used across sciences. It is for this reason that we use the Shannon entropy conditional on location to quantify laminar mixing of two miscible melts in an extruder. We use the classical unwound rectangular channel model of a single screw extruder. The influence of extruder geometry on the mixing quality is the focus of this work. Three geometries are analyzed: a simple single screw extruder, a single screw extruder with ridges placed diagonally on the bottom of the channel, and a single screw extruder with pins on the bottom of the channel. We find that the pin geometry is much more efficient at mixing than the other two geometries studied. Furthermore, though the ridge-geometry exhibits better mixing than the simple geometry, the quantitative difference maybe too small to warrant its usage. We also study the influence of the scale of observation on the mixing measure. The scale of observation is determined by the number of bins used to estimate the probability distribution and the entropy. We find that as the number of bins increases, and thus the scale of observation decreases, the entropy decreases. Thus, when studying mixing, the scale of observation must be specified, as mixing may appear satisfactory at a large scale of observation (small number of bins) but may not be satisfactory at a smaller scale of observation.