ENERGY STUDIES & SCALE-UP OF SUPERCRITICAL FLUID-BASED EXTRUSION PROCESSES

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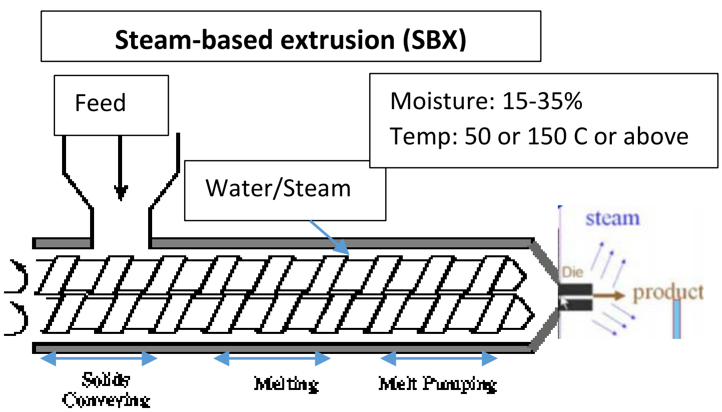
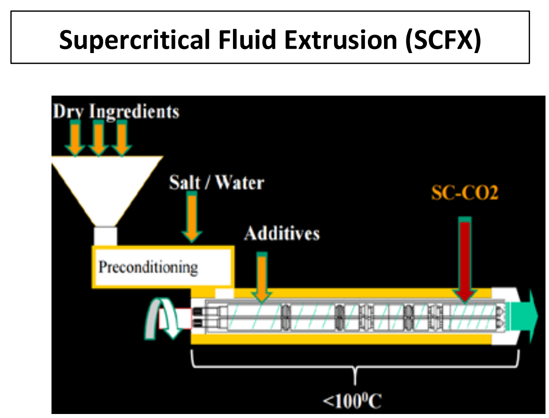
Conventional steam-based extrusion (SBX) process is a commercially practiced technology to produce a large variety of expanded food products. During SBX, a heterogeneous melt of starch and other ingredients undergoes a high-temperature (120-180^{o} C), high-shear cooking where water acts both as a plasticizer for melt formation and a blowing agent for expansion. The harsh operating conditions of the SBX process often prevent effective utilization of formulations containing heat and shear sensitive ingredients. Steam-expanded products usually show non-uniform cellular structures and cell sizes. Supercritical fluid extrusion (SCFX) is a novel technology that uses supercritical carbon dioxide (SC-CO2) as a blowing agent, and hence formulations containing heat-sensitive ingredients can be employed to make expanded products at temperatures below 100^{o} C. A higher moisture content (i.e., 30-45 wt.%) in the extruder barrel is utilized to keep the product temperature low via reduction of viscous dissipation of mechanical energy and to maximize SC-CO2 solubilization in the melt. The SCFX results in a more homogenous nucleation and uniform microporous structure.





However, the advantage of maintaining low temperatures to minimize thermal degradation of ingredients also poses a major engineering challenge in the process scale-up. When a supercritical extruder is scaled-up, the extruder volume is tripled, whereas the cooling surface area is just doubled resulting in an inefficient cooling and high temperatures. The objective of this project is to perform energy studies on a supercritical twin-screw extruder as a function of its operating parameters to quantify and optimize the cooling efficiency needed for scale-up of the process.

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