Vinylidene Fluoride Emulsion Polymerization: Experimental Study

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Emulsion polymerization is a common industrial process for the production of latex for products such as paints, coats and other film forming materials, as well as for making polymer particles that are sold in powder form. Conventional emulsion polymerization is a heterogeneous reaction that allows one to obtain a final product that consists of solid polymer particles dispersed in an aqueous media. The heterogeneous nature of the process can render it quite complex, since we are required to master stochastically-controlled kinetics, the stability of nano-scale colloids, as well as heat and mass transfer phenomena in multiple phases. These quantities depend on a number of interacting parameters (e.g. temperatures, concentrations, shear rates, etc.) that can vary as function of time and space.

In the case of the emulsion polymerisation of vinylidene fluoride (VDF), the situation is more complicated than for the majority of industrial processes because the monomer is typically either a gas or a supercritical fluid under the polymerization conditions of interest. This aspect increases the process challenges, since we are working with a solid-liquid-gas reactions, and in this case the standard notions starved or flooded operation are not pertinent, and the reaction rate can be a strong function of agitation in the reaction. Furthermore, given the relatively high pressure required for this process (30bar < P < 90bar), there is a lack of information in the open literature about VDF emulsion polymerization.

Therefore, as part of an integrated experimental and modelling, we have built a 4 litre, high pressure reactor to perform a kinetic study of the emulsion polymerization of VDF under conditions of temperature and pressure similar to those found in industrial processes. In order to understand how to optimize, trouble-shoot and scale-up such processes, we need to develop a deeper comprehension of how polymerization proceeds. For this reason, the objective of the presented work was to generate relevant kinetic data of the VDF emulsion polymerization. Specifically, an experimental study of the VDF polymerization using batch and semi-batch mode operation was performed to identify the appropriate values of certain operational parameters (such as agitation speed, and agitation set-up), and the impact of certain compositional changes (e.g. chain transfer agent, surfactant, pressure) on the reactor rate, monomer conversion and molecular weight distribution.

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