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Abstract

Paraffin wax was microencapsulated by suspension polymerization with a polymer shell of methylmetacrylate (MMA)-styrene (St) copolymer. The influence of the copolymer/paraffin mass ratio and the MMA/St mass ratio on the encapsulation process and the physical properties of the microcapsules obtained were studied. It was observed that paraffin is difficultly encapsulated when the ratio polymer/paraffin was lower than 2.5, as a consequence of a shortage of copolymer that could not completely cover the amount of paraffin added. When a large proportion of monomer was employed the polymer trends to polymerize outside the bead in a segregated way. As the amount of MMA increases, the reaction time decreases and the mean particle size decreases.

Keywords: methyl methacrylate, styrene, suspension polymerization, microencapsulation, paraffin wax.

1. Introduction

Microencapsulation is often employed to encapsulate PCMs as core using plastic or cross-linking polymers as shell. Although the PCM is the responsible of the storage and absorption or release of thermal energy the encapsulation of them inside a mechanically and physical-chemically stable shell is the main technical and scientific problem.

Up to now some attempts to develop a cheap and technically simple process for the microencapsulation of paraffin have been done. The most common methods used are interfacial polymerization, emulsion polymerization, in situ polymerization, spray drying and coacervation (Hawlader et al., 2003). The development of simple, cheap and robust methods for the encapsulation of PCMs in suitable sized particles is very important for textile applications. The microencapsulation method developed in this work is simpler than other methods referenced in literature. In this work, we used a copolymerization process with styrene (St) and methyl metacrylate (MMA) to form the microcapsule shell.

Suspension like polymerization was carried out in a 2 L double-jacketed glass reactor at 100ºC. A mixture of St monomer, MMA monomer and benzoyl peroxide initiator was added into a continuous phase containing poly(vinylpirrolidone) and

water. The influence of polymer/paraffin (from 0 to 4) mass ratio and MMA/St (from 2 to 5) mass ratio on the encapsulation process was studied.

DSC analyses of samples obtained at different paraffin/polymer values and a constant MMA/St of 4 demonstrated the effectiveness of the encapsulation process and agrees with around a 40wt% of paraffin inside the microcapsule.

Figure 1 shows that a paraffin/polymer of 2 and 2.5 exhibit unimodal PSD ranging in the interval between 20 to 2000 microns, whereas a bimodal PSD was obtained when a 3.5 and 4 polymer/paraffin mass ratio was studied. This heterogeneity of sizes is due to the agglomeration of the microparticles formed. In the second case, the smaller particles formed correspond to polymer bead without paraffin wax and the bigger particles obtained correspond to microcapsules containing paraffin wax. Finally, it was observed a homogeneous particle size distribution for polymer/paraffin ratio of 3.

Figure 2 shows the experimental conversion data obtained for the sample obtained at 3 polymer/paraffin mass ratio as an example due that all the samples exhibit the same trends. The kinetic of the process agree with that of a suspension free radical polymerization reaction. From a kinetic point of view, each bead may be regarded as a small isolated reactor and the observed copolymerization kinetic corresponds directly to that for bulk polymerization (Cordoví et al., 2000). Figure 2 also shows the increment of volume particle size during the copolymerization process. The final particle size is already established at very low conversion (≈40%). Polymerizing droplets maintain their identity during the experiment, and subsequent variance in stirring speed has no influence on particle size.

Concluding a paraffin/polymer mass ratio of 3 was selected to study the effect of MMA/St mass ratio. When a MMA/St mass ratio of 2 and 5 was used the microencapsulation was not successful. DSC analyses of samples obtained with a MMA/St of 3, 3.5 and 4 show a phase change enthalpy of 75.4, 87.5 and 104.8 J/g, respectively. Moreover, when the amount of MMA increases, the reaction time decreases. This fact is due to the high reactivity of methyl methacrylate. Finally, the particle size decreases when the mass ratio MMA/St increases.

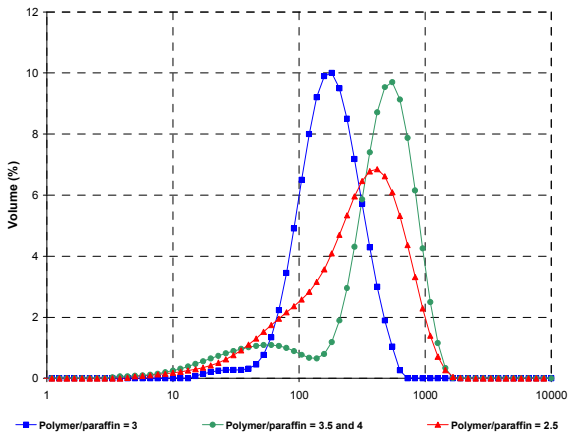

Figure 1: Particle size distribution for different polymer/paraffin mass ratios.

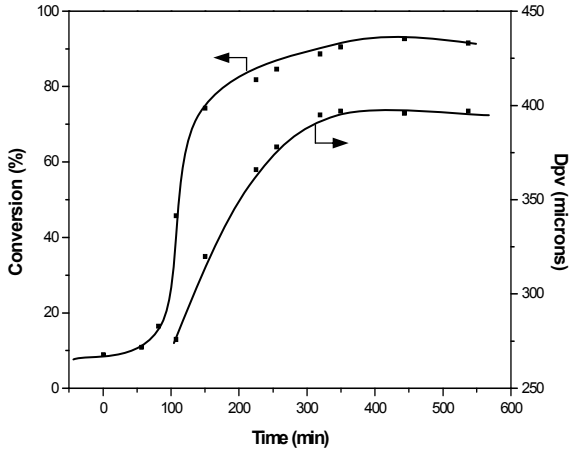

Figure 2: Evolution of conversion and volume average diameter of microcapsules during the polymerization.

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