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A NOVEL INTENSIFIED DEVICE FOR THE PRODUCTION OF HIGHLY MONODISPERSE POLYMER PARTICLES IN THE LOW NANOMETER RANGE THROUGH MINIEMULSION POLYMERIZATION

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An original device called RMX was used to synthesize miniemulsions of poly(methyl methacrylate). This mixer/reactor is based on a strong elongational flow component contributing to a highly efficient dispersive mixing compared to existing laboratory mixers. It presents the following important technical features:
mixing volumes in the range of 5 to 45 cc.
easy feeding of components even for reactive systems.
tightness of liquids and gases is maintained during all steps, authorizing the processing of materials containing volatile components.
The principle of operation is based on the alternative displacement of two opposite pistons placed themselves in two different cylindrical chambers. Each piston pushes the material from one chamber to the other through a static mixing element, fitted with a given number of holes of diameter in the range 0.2 -1 mm (Figure 1).
The first part of this work consists on testing the efficiency of this device as a mixer. That's why we worked on a direct emulsion (oil in water) stabilized with a surfactant (Brij). Large oil to water viscosity ratios were tested (5 to 350). The elongational flow generated by the RMX allows creating oil droplets with a mean diameter of approximately 200nm. This is much lower than the usual droplet diameter obtained with more conventional device for these viscosity ratios (Figure 2).
The second part consists on synthesizing miniemulsions of poly(methyl methacrylate). This synthesis was based on two steps: first, a dispersion of all reagents followed by the polymerization of the monomer induced by increasing the temperature.
Figure 3 shows the evolution of the droplet size of monomer during the dispersion step at different operating pressures compared to the ultrasonification and ultraturrax. The results show that it is possible to reach a very small droplet size (lower than 80nm) even with very low pressure.
Upon polymerization, it was found that polymer particles with diameters below 100nm could be obtained, thus differing from conventional dispersion methods that have not yet reached this size domain.