22b The Adiabatic-Core Case in Electrokinetic-Based Coating Processes

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Coating processes require many times the spreading of colloidal particles in a uniform fashion to preserve quality of the coating film. The application of electrical fields has been used to help such spreading on the coated surface but results have not been that promising. This contribution uses fundamental principles of electrohydrodynamics to analyze the flow situation in a typical coating process. The physical aspects involve the motion of a cylindrical metal wire at a constant speed within a coating solution inside an annular shell. The system displays Joule heating and, therefore, buoyancy flows maybe present and they are accounted for by using a heat transfer model based on both, the Batchelor and Boussenesq approximations that yield a sequential coupling of the temperature profile with the velocity profile. The metal wire is modeled by assuming an adiabatic core with an electrical resistance different to that of the coating fluid. This situation captures many physical situation of interest in electrokinetic coating.

The solution is obtained by solving the Navier-Stokes equation with the electro-driven body forces in addition to buoyancy and pressure or the “wall” driven term. The velocity profile is then used to study several flows cases of potential relevance for coating process. Some partial or total “flow reversal” situations are identified. The results help to bring understanding and potential coating strategies when an electrical field is present in a coating process. The study is also useful to analyze the colloidal particles distribution in coating process. Efforts for further studies are identified.