Two models for deposit formation in suspension firing of biomass have been developed. Both models describe deposit buildup by diffusion and subsequent condensation of vapors, thermophoresis of aerosols, convective diffusion of small particles, impaction of large particles, and reaction. The models differ in the description of the sticking probability of impacted particles: model #1 employs a reference viscosity in the description of the sticking probability, while model #2 combines impaction of viscoelastic particles on a solid surface with particle capture by a viscous surface. Both models were used to describe the deposit formation rates and deposit chemistry observed in a series of entrained flow reactor (EFR) experiments using straw and wood as fuels. It was found that model #1 was not able to describe the observed influence of temperature on the deposit buildup rates, predicting a much stronger influence of this parameter. Model #2 was able to provide a reasonable description of the influence of temperature on the deposit buildup rates observed in the EFR experiments. A parametric study was conducted to examine the influence of some physical parameters, including ash concentration, viscosity of ash and deposits, surface tension, Young's modulus, and porosity. On the basis of this model evaluation, where a wide range of temperatures (700–1000 °C) and fuels (straw and wood) were applied, model #2 can be regarded as a promising tool for the description of deposit formation from biomass ashes.