In this study, novel computational techniques for the numerical simulation of premixed combustion based on a progress-variable formulation are proposed. Two new variational multiscale methods within a finite element framework are developed for the system of mass, momentum and progress-variable equations: a purely residual-based variational multiscale method and an algebraic variational multiscale-multigrid method. The proposed methods are tested for the numerical example case of a flame-vortex interaction using Arrhenius chemical kinetics. This actually laminar reactive flow problem may serve as a model problem for interactions of turbulent flows and (premixed) flames. The results obtained from this test case show that both methods are capable of accurately predicting the features expected during the progression of the flame-vortex interaction. The evolution of both a pocket of unburned gas and a secluded, drop-like structure, which detaches itself and moves upwards, are accurately predicted already for a relatively coarse discretization.