In this talk, we report our recent work in simulating partially miscible, compositional oil-gas two-phase fluid systems of hydrocarbon using diffusive interface models together with cubic Equations of State (EOS), including the Van der Waals EOS and Peng-Robinson EOS. The Van der Waals equation is one of the simplest models that reasonably describe liquid-vapor phase behaviors. It has a non-zero volume for molecules and a pair-wise attractive inter-particle force (such as the Van der Waals force). The Peng-Robinson equation, as an extension of the Van der Waals equation, is a widely used realistic EOS for hydrocarbon fluid in petroleum industry. Both cubic equations of state impose a number of challenges in numerical computation of diffusive interface simulation, while the challenges are more serious for the Peng-Robinson EOS perhaps due to the complicated mixing rules. In our work, a partial differential equation system is proposed to model the compositional two-phase system, and the spatial discretization is then established with a finite volume-based method. We first computationally decouple the resultant ordinary differential equation system by using a splitting scheme, and we integrate in time using a semi-implicit marching scheme. Most fully implicit methods surprisingly fail to have the desired stability, while a properly designed semi-implicit time marching scheme works reasonably well. This proposed semi-implicit time scheme is based on a convex splitting idea, and it is unconditionally energy stable. The proposed algorithm is able to solve successfully the spatially heterogeneous two-phase systems with varied molar density profiles in multiple dimensional domains. We compare our computational results with laboratory experimental data reported in the literature, and we also verify them with the Young-Laplace equation.