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Due to the spontaneous heat flux from the Earth and the action of the gravitational field, no petroleum reservoir is in thermodynamic equilibrium especially in the case of tight reservoirs. Lower Cretaceous chalk field is the example of a tight petroleum reservoir over which the fluid compositions are varying and there remains an uncertainty in the fluid properties. The observed variation in composition is puzzling and could be formed by non-equilibrium effects which behavior is unknown. A pressure-volume-temperature (PVT) model is required to capture the variations seen in the composition of reservoir fluid samples and in the produced Gas Oil Ratio (GOR). To obtain the correct PVT model, it is recommended that a single Equation of State (EOS) is tuned versus experimental PVT data at different depths to ensure that the compositional grading model can correctly give the composition of all the samples at different depths. As the PVT experiments are not free of systematic errors, we check the fluid properties from the sampling reports determined by the laboratory before application in the PVT model. Therefore in the first phase, we have studied the quality control of PVT measurements on collected samples from Lower Cretaceous chalk fields to select the representative reservoir fluid. Different methods such as material balance, cross plots and the K-values equilibrium trend analysis have been studied for verifying the consistency of PVT data. In the next step, we have developed the model to simulate variation in composition of a petroleum fluid column using an EOS. In the developed model, we have considered the effect of gravity segregation with the assumption of stationary fluid (no net mass flux, steady state). Furthermore, the algorithm can predict the location of GOC in a two-phase hydrocarbon reservoir system. The model will be further improved by including the thermal effects in the next phase.