CFD analysis of LNG Bunkering system through coding mass balance equations

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Natural gas cooled and condensed to a temperature of approximately −160C (LNG) serves as a fuel in LNG Fueled Vessels (LFV). The fuel tank serves to store LNG under various pressure ranges which exists as both gas and liquid phases. The tank is maintained as an open system, pseudo-steady state due to constant heat intake from outer sources and usage of LNG. The fuel in the tank evaporates forming a gas called Boil-Off Gas (BOG) which causes vigorous internal changes in the tank. This phenomena occurs especially during the refueling phase and the need to regard the formation of BOG arises to accurately assess the phenomena that occurs inside the fuel tank.
In this study, Computational Fluid Dynamics (CFD) is utilized to simulate the internal changes in the tank. Specifically, equations that suffice the mass transfer between the liquid phase and the gas phase are coded (euler-euler Volume of Fluid (VOF), valve equations) as User Defined Functions (UDF). The coding of the equations ensures correct analysis on phase change that occurs in BOG formation and enables accurate observations on the fuel tank overall as CFD tools do not supply accurate analysis on multiphase problems.