Computational Fluid Dynamics Based Correlation to Find the Final Cement Volume Fraction in Annuli during the Primary Cementing

Abstract

Efficient mud removal is critical in a good primary cementing job and light weight spacers are usually helpful in achieving this goal. In this study the effect of changing the spacer rheological properties and displacement rate on the final cement fraction in the annulus are quantified in the form of a correlation. This correlation is based on a series of Computational Fluid Dynamics (CFD) simulation results. The CFD tool was first validated against experimental results of the similar type of fluid displacement phenomenon and the results were very promising showing good reasonable agreement with the experimental results. Then a series of numerical experiments were carried out, in which the spacer rheological properties were varied, keeping the cement and mud properties fixed. The lower limits for the spacer density and viscosity were set to be the fresh water and maximum were that of cement. The displacement rate based on the cement rheological properties was in the range of Reynolds number 100 to 400. The results of these simulations are also presented in the form of instantaneous fluid volume fractions and overall displacement efficiency. CFD is a good tool to have both qualitative and quantitative insight into the complex phenomenon of non-Newtonian fluid displacements in complex geometries under varying conditions.