Newtonian fluid flow in two- and three-dimensional cavities with a moving wall has been studied extensively in a number of previous works. However, relatively a fewer number of studies have considered the motion of non-Newtonian fluids such as shear thinning and shear thickening power law fluids. In this paper, we have simulated the three-dimensional, non-Newtonian flow of a power law fluid in a cubic cavity driven by shear from the top wall. We have used an in-house developed fractional step code, implemented on a Graphics Processor Unit. Three Reynolds numbers have been studied with power law index set to 0.5, 1.0 and 1.5. The flow patterns, viscosity distributions and velocity profiles are presented for Reynolds numbers of 100, 400 and 1000. All three Reynolds numbers are found to yield steady state flows. Tabulated values of velocity are given for the nine cases studied, including the Newtonian cases.