A coarse-grained particle model for incompressible Navier-Stokes (NS) equation is proposed based on spatial filtering by utilizing smoothed particle hydrodynamics (SPH) approximations. This model is similar to our previous developed SPH discretization of NS equation (Hu X.Y. & N.A. Adams, J. Comput. Physics, 227:264-278, 2007 and 228:2082-2091, 2009) and the Lagrangian averaged NS (LANS-\(\alpha\)) turbulence model. Other than using smoothing approaches, this model obtains particle transport velocity by imposing constant \(\sigma\) which is associated with the particle density, and is called SPH-\(\sigma\) model. Numerical tests on two-dimensional decay and forced turbulences with high Reynolds number suggest that the model is able to reproduce both the inverse energy cascade and direct enstrophy cascade of the kinetic energy spectrum, the time scaling of enstrophy decay and the non-Gaussian probability density function (PDF) of particle acceleration.