EFFECT OF PARTICLE SIZE ON HIGH AND LOW RATE RESPONSES OF SHEAR THICKENING SUSPENSION OF HARD-SPHERE PARTICLES

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MOTIVATION

♦ Goal: To characterize and synthesize STF-fabric composites.
  ♦ Evaluate the effect of particle size on high and low rate responses of shear thickening suspensions of hard-sphere particles

INTRODUCTION

♦ Shear Thickening Fluid (STF)
  ♦ Non-Newtonian fluid that undergoes viscosity increase at critical shear stress/strain rate
  ♦ Generally used in protective material applications to improve stab resistance

MATERIALS

♦ Synthesis
  ♦ Spherical Silica Particles (100 nm)
  ♦ Polyethylene glycol (PEG, 200 MW)
  ♦ Roll mixed at room temperature for 24 hours

♦ STF suspension characterized at 52, 50, 45, 40, and 20 percent silica particles to liquid.

METHOD

♦ Rheology
  ♦ AR-2000 used to determine the viscosity of the STF suspension
  ♦ Measured with a 40 mm cone plate with a 62 truncation gap and 2 degree angle

♦ Split-Hopkinson Pressure Bar
  ♦ The SHPB consists of a gas gun and three cylindrical bars
  ♦ Striker bar (SB), incident bar (IB), and transmission bar (TB)

♦ Through the SHPB technique, it is possible to evaluate the overall response of a STF fluid specimen at shear rates over 10^7 s^-1 and at high stress levels

RESULTS

♦ Rheology
  ♦ Comparison of 500 nm and 100 nm silica particles (φ = 50%).
  ♦ Shear thickening occurs at higher (1 order of magnitude) critical shear rates/stresses for smaller particle

SHPB RESULTS

♦ Axial stress-strain and stress-strain rate response of the 50% silica suspension after transition shows:
  ♦ Rate dependant elasticity
  ♦ Viscous behavior
  ♦ High stress and strain rates are achievable

♦ Comparison of KE-PE10 and KE-P50 (initial thickness of 0.55mm)
  ♦ Small particles increase stiffness and peak stress achievable in STF in stress-strain plot
  ♦ Small particles change the stress-strain rate response at high stress/strain rate

CONCLUSIONS

♦ In the rheological data, particle size significantly affected viscosity and transition shear stress/strain rate conditions
  ♦ In SHPB post-transition regime at high stress and strain rate, particle size affected elastic and viscous response but to a lesser degree

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