Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Shape Optimization for Stability of a Cyclone Separator
MATTHEW JUNIPER, JACK BREWSTER, University of Cambridge — A cyclone separator uses a swirling flow to remove particles from a particle-laden fluid. Cyclone separators are frequently used in domestic appliances and in industry to clean contaminants from gases. At practical Reynolds and swirl numbers, the steady axisymmetric flow through a cyclone becomes linearly unstable. It develops a precessing vortex core (PVC) which is responsible for increased pressure loss and unwanted acoustic noise. Unsteady mixing caused by the precession also leads to the re-entrainment of separated particles. We perform shape optimization of a cyclone separator in order to weaken this instability. The onset of the PVC appears as an unstable global mode with azimuthal wavenumber $m = 1$. We calculate the shape gradient of the growth rate of this global mode. We identify the boundary regions that most influence the growth-rate and then use a gradient-based method to update and optimize the geometry. We interpret this physically and also present a family of orthogonal geometry changes that cause the greatest changes in the cyclones baseflow. Theis process highlights the geometry changes that a parametrisation must be able to reproduce in order to effectively optimize a cyclone.

Matthew Juniper
University of Cambridge

Date submitted: 01 Aug 2019 Electronic form version 1.4