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Effects of formation time and flexibility on the starting and stopping vortices in piston-cylinder devices[1] MEHDI SAADAT, HOSSEIN HAJ-HARIRI, University of Virginia — A computational study has been conducted to address the formation of vortex rings ejected from a weakly flexible nozzle at the end of a piston-cylinder device. The first observation is that, regardless of flexibility, for small enough duration of a push on the piston, the negatively-signed induced vorticity on the outside of the cylinder merges with the stopping vortex and spills into the core and pairs up with the primary (starting) vortex. The second observation is that the flexibility of the exit nozzle affects the behavior of the vortex by changing the effective diameter of the exit. Also, the snapping back of the nozzle strengthens this interaction. To model the flexibility, two approaches have been used in the study. First, the nozzle is modeled using a torsional-spring-mass-rigid system which is allowed to rotate about a hinge and its rotation is coupled with the flow solver. Second, the nozzle is considered as an elastic material and its deflection is solved using a FEM solver. It is hypothesized that the presence of flexibility in the model increases the time scale as well as the thrust as compared with results from rigid nozzle models. A study is conducted to find the highest thrust generated versus the flexural parameters.

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